Leveling Up Teaching and Learning Through Video Game Construction

by

Kandise Michelle Salerno

A thesis submitted in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

Elementary Education
University of Alberta

Abstract

Video game construction plays an important role for students and teachers. The experience of constructing a video game aligns with students' out-of-school experiences while connecting with the in-school experience of learning content. This qualitative study examined 4 upper elementary teachers, 11 upper elementary students, and 1 principal regarding how they experienced video game construction in the classroom. The following questions guided the study: (1) What pedagogical approaches may upper elementary content-area teachers use to integrate game construction into teaching and learning? (2) How may upper elementary content-area teachers experience student-based game construction with their students? (3) How may students experience video game construction in a content-area classroom?

Using constructionism as the theoretical framework, this study sought to understand the kinds of experiences both teachers and students encountered when constructing video games in the classroom, and the externalized expectations that derived from collaborating with and through the technology and with others. The data collection tools I used were direct observations, interviews with the students, teachers, and principal, and artifacts. Audio recordings of the interviews were transcribed, the transcriptions and field notes of the students' and teachers' artifacts were connected with the interviews, and themes were identified. For the teachers the themes that were constructed include teacher pedagogy, collaboration, planning, writing and gaming, time, and assessment. For the students the themes that were constructed include problem solving, use of video game construction technology, playing, planning and writing, and student collaboration.

The insights gained from this study have the potential to provide valuable insights for teachers, principals, technology coaches, consultants, policy makers, and researchers interested

in creating meaningful connections between the elementary curriculum and the classroom experience with video game construction technologies, while also meeting the constructionist needs of digital learners. Continued exploration of themes such as assessment and teacher pedagogy will be crucial to advance our understanding of how video game construction can be experienced in the classroom.

Preface

This thesis is an original work by Kandise Michelle Salerno. The research projct, of which this thesis is part of research ethics approval from the University of Alberta Research Ethics Board, Project Name "Building in the Sand: Leveling-Up Teaching and Learning Through Game Construction", Pro00047721, July 15, 2014.

Dedication

To Kris Salerno, these words are your love.

They shape the very fabric of our lives.

Acknowledgements

Imagine 90 grade seven students constructing dozens of video games together in one small school library. Imagine these 90 students willing to collaborate and share their expertise with each other. Imagine this collective group excited and motivated to dig deeper and learn more about the Canadian Fur Trade. This extraordinary moment happened over five years ago, which consequently served as the genesis of this research pursuit. I am deeply thankful to these teachers and students for bearing the risk of trying something new.

I also want to thank the teachers, students, principal and school community that participated in this research study. Their excellence in teaching is inspiring and I am thankful for the risk they took in integrating video game construction for the very first time. I am deeply thankful for their time, planning, thoughtfulness and willingness to experiment with their own teaching and learning.

Certainly, as a constructionist, my own experiences are deeply engrained in those who have weaved the very fabric of this study. For there have been many peaks and valleys along the way, but their support made the valleys passable and the peaks lessons to learn through and to live by.

First I would like to the members of my committee including Dr. Patricia Boechler, Dr. Mike Carbonaro, and Dr. Margaret Mackey. Their gift of knowledge and insight, and their passion for education provided key moments for reflection and guidance in this research journey. Without their expertise and generous support, this dissertation would not have gone so deep or journeyed so far.

I would also like to thank my supervisor, Dr. Jennifer Branch. Her guidance, support and kindness provided the strength and fortitude to traverse through moments of such questioning and challenge. I am so deeply appreciative of the balance Dr. Branch brings to her own research, where her timely and connected knowledge of schools and learning is intertwined with her academic research. This balance was vital to my own work as an educator and as an emerging researcher, and will carry with me for the rest of my career. Above all, I am appreciative of our insights into the meaning and purpose of education, which has transpired into what I can only consider a lifelong friendship.

I would also like to thank the love and kindness of my friends and family. The ongoing conversation of this research did not fall of deaf ears. Your words of encouragement are written between the lines of this dissertation, and I am so thankful to be surrounded by such kindness. In addition, I would also like to thank my parents, for it is their own fortitude for learning and curiosity of life that has instilled my own passion for learning.

Finally, I would like to thank the love of my life, the man who was behind every word and every thought. Thank you to my husband Kris. There was never a doubt in his mind that I would complete this journey. His love is my words, and it is this love that allowed me to find my voice in education, which will hopefully support and guide many students and teachers in the future.
To you Kris.

Table of Contents

Abstract ii

Preface iv

List of Tables xiii

List of Figures xiv

Chapter 1: Introduction 1

Background to the Study 2
Study Description and Research Questions 5
Significance of the Study 6
Overview of the Dissertation 6

Chapter 2: Theoretical Framework 8

The Foundations of Constructionism 9
Allegiance with Constructivism 10
Technocentrism and Constructionism 11
Papert's Constructionism: Knowledge Construction 12
Papert's Constructionism: Learning Culture 14
Summary 15

Chapter 3: Literature Review 17

Section A: School Culture and Technology 18
- Constructionist technologies. 18
  - 21st-century school culture. 18
  - The maker movement. 20
  - Agency and structure. 22
  - Critique of high agency / low structure paradigm. 23
  - Epistemic frames. 24
  - Summary. 26
- Technology integration. 26
  - Introduction of technology in schools 26
  - Teacher pedagogy and technology. 29
  - Time. 31
    - Time and teacher training. 32
    - Time and video game construction. 34
  - Assessment. 35
- Collaboration. 40
  - Teacher collaboration. 40
  - Student collaboration. 43
  - Affinity spaces. 47

Section B: Playing and Constructing Video Games 49
Video games....................49
Exogenous and endogenous games....................55
Motivation....................58
Gender....................59
Video game construction....................62
Problem solving....................62
Smart tools and scaffolding....................64
Creative communication and production....................67
Hanging out, messing around, and geeking out....................68
Remixing....................69
Planning and writing....................71
Case 1: Instructional Software Design Project....................71
Case 2: Game Design Project....................71
Case 3: Game construction without questions....................72
Case 4: From Logo to Scratch....................74
Case 5: Writing and video games....................75
Learning benefits of video game construction....................77
Cautionary notes....................79
Summary....................80

Chapter 4: Methodology....................82

Personal Exploration of Constructionism and Teaching....................82
Research Questions....................83
Case Study Design....................84
Explanation of Kodu game program....................85
Data collection....................86
Interviews....................88
Direct observation....................90
Physical artifacts....................90
Data analysis....................91
Role of the Researcher....................93
Delimitations and Limitations....................95
Ethical Considerations....................96
Summary....................97

Chapter 5: Research Context....................99

Research Context: The School Community....................99
Principal Profile....................102
Teacher Profiles....................106
Patrick....................106
Heather....................109
Angela....................112
Student Profiles....................114
Grade 6: Patrick's class....................114
Stella....................114

Aiden. 115
John. 116
Grade 6: Angela's class. 117
Clara. 117
Beth. 118
Robert. 119
Samantha. 119
Grade 4: Heather's class. 120
Meghan. 120
Ellen. 120
Caleb. 121
Colin. 122
Summary 123

Chapter 6: Findings 124

Question 1: What may video game construction look like in an elementary classroom? 124
Grade 6. 126
Lesson 1. 126
Lesson 2. 126
Lesson 3. 126
Lesson 4. 127
Lesson 5. 129
Lesson 6. 131
Lesson 7. 131
Lesson 8. 133
Lesson 9. 134
Lesson 10. 135
Lesson 11. 135
Lesson 12. 136
Lesson 13. 136
Lesson 14. 137
Lesson 15. 138
Lesson 16. 138
Lesson 17. 139
Lesson 18. 139
Lesson 19. 140
Lesson 20. 141
Lesson 21. 142
Lesson 22. 143
Lesson 23. 143
Lesson 24. 144
Lesson 25. 145
Lesson 26. 145
Lesson 27. 146
Grade 4. 147
Lesson 1. 148

Lesson 2. 148
Lesson 3. 149
Lesson 4. 150
Lesson 5. 150
Lesson 6. 152
Lesson 7. 153
Lesson 8. 154
Lesson 9. 156
Lesson 10. 156
Lesson 11. 156
Lesson 12. 157
Lesson 13. 157
Lesson 14. 158
Question 2: How may elementary teachers experience video game construction in the classroom?162
Theme 1: Teacher pedagogy. 162
Instructionism and constructionism. 162
Fluidity between pedagogies. 165
Theme 2: Teacher collaboration. 168
Teacher-to-teacher. 169
Personal connections. 170
Teacher-to-student. 173
Student leaders. 174
Moments of frustration. 175
Teacher-to-principal. 176
Principal-to-teacher. 178
Teacher-to-technology. 179
Accessibility. 179
Curricular connections. 180
Repeat experience. 181
Theme 3: The process of planning, writing, and gaming. 183
Theme 4: Time. 189
Classroom time. 190
Longer periods of time. 194
Theme 5: Assessment. 196
Traditional and non-traditional forms of assessment. 196
Provincial achievement tests. 198
The future of assessment. 199
Question 3: How may elementary students experience video game construction in the classroom?200
Theme 1: Problem solving. 201
Forwards and backwards. 201
Expert support. 205
Playing around. 207
Thinking out loud. 208
Problem solving through demonstrating. 209
Theme 2: Use of video game construction technology. 211
Student experiences with Kodu. 211

Kodu tutorials....215
Ease of use. 217
Challenges with Kodu....220
Theme 3: Playing, planning, and the process of game construction....223
Playing video games. 223
Planning (story writing, mapping, math problems). 224
Story plan. 227
Visualization. 229
Story exemplar. 231
Mapping. 232
Math questions. 235
Process of game construction....238
Theme 4: Collaboration. 241
Student-to-teacher. 241
Student-to-student. 242
Student experts. 242
Group work. 244
Summary 247

Chapter 7: Discussion 249

Pedagogy and Technology Integration 249
Confidence and risk taking. 250
Agency and structure. 251
Reflections for teaching and research. 252
Time 253
Reflections for teaching and research. 255
Assessment....257
Teacher concerns. 259
Reflections for teaching and research. 260
Teacher Collaboration....261
Reflections for teaching and research. 264
Student Collaboration 265
Collaborative agency. 266
Structured support. 267
Sharing. 267
Reflections for teaching and research. 268
Problem Solving....269
Messing around. 270
Remixing. 271
Iterative problem solving. 272
Compromise. 274
Reflections for teaching and research. 276
Planning and Writing 278
Motivation. 278
Gender. 278
The importance of planning. 279

Extrinsic and intrinsic games. 281
Math questions. 282
Reflections for teaching and research. 283
Conclusion 286

Chapter 8: Implications and Conclusions....287

Lesson 1: Teachers Play a Pivotal Role in Video Game Construction....289
Questions for future research. 290
Lesson 2: Students and Teachers Must Work Together in Video Game Construction 291
Question for future research....292
Lesson 3: Integrating Video Game Construction Requires Multiple Attempts....292
Questions for future research. 294
Lesson 4: Video Game Construction is Aligned with Constructionism....294
Question for future research....295
Lesson 5: Assessment is a Challenging Component of Video Game Construction 296
Questions for future research. 297
Lesson 6: Video Game Construction is Not Only Good for Learning, But for Education....297
Final Thoughts 298

References....301

Appendix A: Coding Themes....323

Appendix B: Quick Student Reference....324

Appendix C: Kodu Tutorial Lesson....326

Appendix D: Sample Video Game Story 330

Appendix E: Example Pages from the Start Writing Adventure Stories Book....336

Appendix F: Student Example of Kodu Story Highlighted With Game Portion 337

Appendix G: Students' Guide Sheet 338

Appendix H: Student Example of Jacket Cover for Video Game....339

Appendix I: Curricular Guide....340

Appendix J: Students' Initial Stories and Game Stories....345

Appendix K: Students' Initial Maps and Final Game Views 350

List of Tables

Table 1. Exogenous and Endogenous Games (Squire, 2006) 57
Table 2. Grade 6 Lesson Descriptions 124
Table 3: Example of "Somebody, Somewhere…" Student Planning 126
Table 4: Assessment Rubric for Teacher-Generated Reflective Questions 132
Table 5: Grade 4 Lesson Descriptions 147
Table 6: "Somebody, Somewhere…" Student Planning 155
Table 7: Assessment Rubric for Teacher-Generated Reflective Questions 159
Table 8. Comparison of Stella's Initial Story and Final Game Story (Grade 6) 225
Table 9: Comparison of John's Initial Map and Final Game View (Grade 6) 225

List of Figures

Figure 1. Student-generated ideas of a good video game. 127
Figure 2. Patrick's class discussion surrounding a good video game. 128
Figure 3. Angela's class discussion surrounding a good video game. 128
Figure 4. Class discussion written on Smart Board regarding the story elements of Icarus Needs. 130
Figure 5. Example of student responses to reflective questions about Icarus Needs. 133
Figure 6. Example of student's reflection regarding their perceptions of video games. 134
Figure 7. Example of class discussion of the elements located in Patrick's Kodu story. 136
Figure 8. Example of student's personal game story. 137
Figure 9. Example of student math problems for video game. 138
Figure 10. Example of student's final draft with game highlights. 139
Figure 11. Assessment rubric used to assess the students' game stories. 140
Figure 12. Example of a student's list of steps for the video game. 141
Figure 13. Student example of a game map. 142
Figure 14. Example of the tech ninja program and nomination form. 143
Figure 15. Beth's initial cut scene. 144
Figure 16. Video game construction questions for the demonstration of learning. 146
Figure 17. Four areas of focus for each of the regions of Alberta. 149
Figure 18. Brainstorming lists of what makes a good game. 150
Figure 19. Colin's flipbook. 151
Figure 20. Caleb's Kodu guide sheet. 152
Figure 21. Caleb's true and false questions. 153
Figure 22. Caleb's map of the boreal forest region. 154
Figure 23. Caleb's boreal forest story plan. 155
Figure 24. Caleb's Kodu reflection. 158
Figure 25. Transform initiative. 177
Figure 26. Kodu directions in top left corner. 218
Figure 27. Kodu game wheel. 219

Chapter 1: Introduction

When my brother and I were children, we were enthusiastic experts of Super Mario World. My brother was Mario and I was Luigi. These games became shared entities of our collaborative experience, something that brought my brother and me together during our most formative years. We loved to play games, and although we never truly reflected on why we woke up early on Saturday morning to play, I am certain our motivation was driven by our feelings of success. Each time we played we moved closer to experiencing an epic win, which for us meant defeating the green and beastly boss known as Bowser. The epic win was the epicentre of our gaming experience.

My brother and I also encountered games that fell short of our expectations, including games such as Sonic the Hedgehog; however, we didn't expect the video games introduced at school to fall outside the realm of a good video game. Math Blaster fell far outside our interpretation of a good video game because it was extremely difficult to level up. The number operations would simply fly across the screen, and little to no support was provided to blast the numbers faster. For many of us, particularly for my brother and me, the games we played at home offered far better learning opportunities than the games we played at school.

My brother and I have gotten older, and although our gaming glory days are behind us, we continue to play games because they are an essential part of how we experience the world. As an educator, I am deeply appreciative of the time we spent playing good video games, because it has allowed me to understand the value video games have for learning. In essence, my epistemological gaming self has developed an understanding that good video games are good for education.

My personal anecdote of playing video games as a child and as a teacher highlights the value of good video games in the classroom. I include it here to introduce this study, which explores how teachers and students can experience video game construction in the upper elementary classroom, and the pedagogy a teacher uses to design and implement the experience. After providing background to the study, which includes a statement of the problem, this chapter briefly describes the study, identifies the research questions, and highlights the study's significance. The chapter ends with an overview of the dissertation.

Background to the Study

Video games can provide a transformative learning experience in which children achieve higher level thinking (Salen, 2007), analytic and conceptual thinking (Clark & Sheridan, 2010), reflection and evaluation (Dickey, 2006), and a context in which to learn about and with technology (Kafai, Ching, & Marshall, 1997). However, video games for education continue to hold to a tradition set during the 1980s, one that facilitates a relatively poor learning experience (Chee & Tan, 2012; Egenfeldt-Nielsen, 2007; Egenfeldt-Nielsen et al., 2012; Gaydos & Squire, 2012; Gee 2005, 2007a; Foster, 2008; Rice, 2007). The problem lies partially with perception. Educational video games continue to be perceived as teaching machines, devices to educate the masses. Papert (1980) eloquently suggests that the focus of video games should "not be on the machine but on the mind" (p. 9). That is, video games should be 'objects to think with' (Papert, 1980); "objects in the physical and digital world, such as programs, robots, and games, can become objects of the mind that help to construct, examine, and revise connections between old and new knowledge" (Kafai, Peppler, & Chapman, 2009, p. 3). Gee (2007a) argues, however, that video games are in fact "learning machines"—but ones that facilitate a constructionist, learning-by-doing experience. Video games support learning in which the "student draws on different perspectives, gives rise to a variety of actions and offers a fuller understanding of the given topic" (Egenfeldt-Nielsen et al., 2012, p. 237). Unfortunately, most educational video games do not model this constructionist paradigm. Rather, they continue to run parallel to the behaviourist learning theory that dominated early educational game design.

Another barrier to integrating video games in the classroom is that educators may lack the contextual understanding to identify the significance of video games and the potential they hold for student learning. This problem becomes more complex because the agency and structure (Brennan, 2012) within classrooms may be more aligned with the drill-and-practice reality found in instructionist educational video games (Cuban, Kirkpatrick & Peck, 2001; Kenny & Gunter, 2011; Kynigos, 2004; Lim, 2008) than with the constructionist, learning-by-doing experience that researchers such as Gee (2007a) have associated with effective educational video games. Many classrooms are designed to support a highly structured environment, in which the teacher stands at the front of the classroom and disseminates knowledge to the students. Papert (1993) suggests that in the traditional classroom, the teacher is the only active subject: "the teacher is in control and is therefore the one who needs skill; the learner simply has to obey instructions" (p. 83). This closed learning system may not align with the experiences provided by video games. Therefore, this study focuses on engaging young learners in constructing their own video games and building understanding of how video game construction can be integrated into school environments.

Student-based game construction provides good learning experiences (Kafai et al., 1997; Kafai & Ching, 2001; Peppler & Kafai, 2007; Salen, 2007; Squire, 2006). Game construction is perhaps more meaningful and applicable than playing games; Squire (2008) suggests that, when video games are used in the classroom to support children's learning, "the focus should be less on content and more on designing experiences to stimulate new ways of thinking, acting and being in the world" (pp. 14–15).

Constructing video games can meet the participatory needs of digital-age learners (Jenkins, 2006; Kafai & Burke, 2014; Peppler & Kafai, 2007; Salen, 2007; Squire, 2006). However, several barriers exist in relation to integrating video games, and video game construction, into the classroom. First, it seems that very few educators understand the value of video games as learning tools. Some educators have little to no context of the overarching purpose and value of video games (Kenny & Gunter, 2011; Shaffer, Squire, & Gee, 2005). Kenny and McDaniel (2011) concluded that although educators can experience an increase in positive attitude towards video games when time is dedicated to playing games, most educators simply do not play video games on a regular basis. Second, educators may lack pedagogical understanding of how to integrate video game construction into the classroom (Beavis & O'Mara, 2010; Salen, 2008). In addition, research suggests a relationship between a teacher's pedagogy and how they integrate technology into the classroom (Andrew, 2007; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Hayes, 2007; Tondeur, Keer, Braak, & Valcke, 2008), which is a concern because many classrooms continue to be defined through an instructionist drill-and-practice experience. Third, due to constraints such as time, assessment, curricula, expectations, and limited opportunities to collaborate, teachers may have few opportunities to use digital technologies in the classroom beyond drill-and-practice applications.

As an educator, I experienced a promising way to explore student-based video game construction. The Centre for Mathematics, Science, and Technology Education (CMASTE) at the University of Alberta provided me with an opportunity to develop a video game construction project centred on the Canadian fur trade to be used in a grade 7 classroom. The project presented some challenges, because constructing a video game was different from the more traditional pedagogical approaches often used to teach young learners about the Canadian fur trade. The students, however, were not only highly motivated and engaged in the design project, they also achieved a comprehensive understanding of the topic through the multiple narratives they constructed in the game. This game construction experience presented multiple pathways to understanding, thus allowing students to understand the curricular topic through multiple lenses while also understanding the geography and time period of Canada's fur trade.

Although about eight hours were provided to students to complete this game construction project, many of the students spent over 100 hours of their own time, building and adding to their video games. They were immersed in the curricular topic. For me, as an educator who strongly supports the integration of digital technologies in learning environments, this experience confirmed that student-based game construction represents the most meaningful use of technology I have ever experienced, and it sparked this research study.

Study Description and Research Questions

This study employed a qualitative case study, which included three content-area upper elementary teachers, and three to four students from each of three classrooms. The study spanned one content unit, which was determined by the teacher, and a video game construction unit was used as a means to learn and experience the chosen content area. The data were collected through interviews, direct observation, and physical artifacts. Kodu Game Lab, a game construction software program, was used as the game construction technology.

The study is informed by three questions: (1) What pedagogical approaches may upper elementary content-area teachers use to integrate game construction into teaching and learning? (2) How may upper elementary content-area teachers experience student-based game construction with their students? (3) How may students experience video game construction in a content-area classroom?

Significance of the Study

The potential of student-based video game construction is enticing, particularly because the game construction technology is accessible and easy to use. However, there is very little research that explores the role of the teacher in “supporting children as they build their own intellectual structures” (Papert, 1980, p. 32). Although some research has explored the role of media or computer teachers in integrating game construction into the classroom (Beavis & O’Mara, 2010; Peppler & Kafai, 2007), no research has documented and analyzed the role of the content-area teacher in integrating student-based game construction, particularly in upper elementary settings.

This research study is significant in that it seeks to understand how teachers design, facilitate, and experience student-based game construction. It also explores how students experience video game construction.

Overview of the Dissertation

This dissertation is organized into eight chapters. In Chapter 1, I have introduced the context for my study, identified the research questions, and described the study’s significance. In Chapter 2, I identify the study’s theoretical framework, which centres on constructionism and the significance of learning with artifacts such as video game construction technologies. In Chapter 3, I survey both the relevant literature on technology integration in classrooms and the experiences of learners playing and constructing video games. Chapter 4 describes the study’s methodology; I outline the case study and the methods used to collect and analyze the data. Chapter 5 describes each of the study participants (3 teachers and 11 students). In Chapter 6, I present the themes that were constructed from both the experiences of the teachers and students and the pedagogy of the teachers. In Chapter 7 I connect the findings with the literature and also share my interpretations of how the teachers and students experienced video game construction. In the final chapter, I gear the discussion toward teachers and the lessons this study provides to teachers looking to integrate video game construction into the classroom. I also discuss my personal experiences throughout this research journey.

Chapter 2: Theoretical Framework

In this chapter, I present the theoretical framework of this research study, which is defined through Seymour Papert's (1993) interpretation of constructionism. This learning theory identifies the importance of technology, suggesting that technologies such as video game construction are 'objects to think with' (Papert, 1980) or 'objects to share with' (Kafai, Fields, Roque, Burke, & Monroy-Hernandez, 2012). The chapter explores Papert's (1980, 1993) understanding of constructionism in contrast to technocentrism and consequently highlighting the importance of the learning culture. The chapter also defines the differences between constructivism and constructionism, as they are often used interchangeably.

My epistemic perception of the world is inherently framed through the constructionist philosophy of Papert (1980,1993). For Papert (1993), "intelligence is seen as inherent in the human mind and therefore in no need of being learned" (p. 85). Consequently, school has traditionally taught facts, ideas, and values based on the assumption that "human beings (of any age) are empowered by nature with the ability to use them" (Papert, 1993, p. 85). As a child, I was a constructionist working and learning in a positivist environment. The duality of this experience is not uncommon; many children experience multiple pathways of learning. Although it has taken many years to uncover my epistemological paradigm of learning, I now understand that my own learning and the learning of my students is best supported through hands-on, personalized learning-by-doing experiences.

According to Kafai (2006), constructionist learning is framed through the "relationships that exist between old and new knowledge, in the interaction with others, while crafting artifacts of social relevance" (p. 35). Papert (1993) connects constructionist learning to the important role of artifacts in the development of a child:

> The construction that takes place 'in the head' often happens especially felicitously when it is supported by the construction of a more public sort 'in the world'—a sand castle or a cake, a LEGO house or a corporation, a computer program, a poem, or a theory of the universe. (p. 142)

Playing and constructing video games irrevocably informed my epistemic perception of learning. As a child, I loved to play video games because they established an unparalleled positive learning experience. As an adult, I understand that playing and constructing video games can represent the very essence of good learning. Children think a great deal about their thinking (Papert, 1980). As Kafai and Resnick (1996) have argued, "children don't get ideas, they make ideas" (p. 1). In Crotty's (1998) view, we are all "born into a world of meaning. We enter a milieu in which a system of intelligibility prevails. We inherit a system of significant symbols" (p. 54). Therefore physical objects such as a video game can play a pivotal role in a child's learning.

The Foundations of Constructionism

Constructionism suggests that "meanings are constructed by human beings as they engage with the world they are interpreting. Before there was consciousness on earth capable of interpreting the world, the world held no meaning at all" (Crotty, 1998, p. 43). Papert (1980, 1993) suggests that meaning is always bound together, through objectivity and subjectivity, and in direct connection with the social setting.

Papert's work (1980, 1993, 1996) has contributed to the overarching understanding of constructionism, particularly through his perception that objects are knowledge, or more accurately identified as 'objects to think with.' Papert's (1980) interpretation of constructionism is clearly represented through his initial work with Logo, a constructed computational program centred on a cybernetic animal known as the Turtle. As he explains,

> the Turtle is a computer-controlled cybernetic animal. It exists within the cognitive minicultures of the Logo environment. Logo being the computer language in which communication with the Turtle takes place. The Turtle serves no other purpose than of being good to program and good to think with. (Papert, 1980, p. 11)

Logo programming has been influential in facilitating constructionist computing programming experiences for children, currently represented through programs such as Scratch, an educational program used to support students to learn basic programming. These programs support Papert's (1980) belief that by providing children with materials, such as a computer, children can "externalize intuitive expectations" (p. 145). Scratch and Logo are objects that not only externalize thinking, but that also make new connections between old and new knowledge (Kafai et al., 2009).

Allegiance with Constructivism

Papert's (1980, 1991, 1993, 1996) work surrounding constructionism and Logo programming has strong allegiance to the work of Jean Piaget (1973). Piaget (1973) is closely associated with the constructivist paradigm, which is similar but different from constructionism. For Piaget, the knower is an active subject (Packer & Goicoechea, 2000) and is defined through developmental activities. This development is often framed through Piaget's (1973) stage theory, which suggests that children will eventually become detached from concrete objects and be able to internalize ideas and mentally manipulate them in a hypothetical world (Ackerman, 1996).

Kafai (2006) suggests that "constructivism places a primacy on the development of the individual and isolated knowledge structures, while constructionism focuses on the connected nature of knowledge with its personal and social dimensions" (p. 36). Shaw (1996) further suggests that constructivism does emphasize individuals as active builders of knowledge; however, constructionism places "a critical emphasis on particular constructions of the subject that are external and shared" (p. 177).

For Piaget, "construction is only a cognitive activity in which subjectivity applies its forms to data from a distinct and separate objective world" (Packer & Goicoechea, 2000, p. 234). Papert (1980) believed that children build their own intellectual structures and can learn logic without being "taught." However, Papert (1980) believes Piaget made a mistake in separating the subjective and the objective, or, more accurately, the learning process and what is being learned. Herein lies his own distancing from Piaget's constructivism:

> Constructionism—the N word as opposed to the V word—shares constructivism's connotation to learning as building knowledge structures irrespective of the circumstances of learning. It then adds the idea that this happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity whether it's a sand castle on the beach or a theory of the universe. (Papert, 1991, p. 1)

Technocentrism and Constructionism

Building on constructionism, Papert (1987) brings forth the idea of technocentrism, in which "the child has difficulty understanding anything independently of the self" (p. 23). Technocentrism extends to technical objects which, in Papert's (1987) view, betray a tendency to think of computers and of Logo as agents that act directly on thinking and learning; they betray a tendency to reduce what are really the more important components of educational situations—people and cultures—to a secondary role. (p. 23).

Will using the computer to play Math Blaster increase students' understanding of addition and subtraction? Will using a word processor allow children to write more effectively? And, as Papert (1988) asks, "Does Logo lead to more mathematical thinking" (p. 5)? Questions such as these indicate the inaccuracies of technocentrism. In placing the emphasis on the technical object, such as a computer or a game construction program, we come to understand these objects as the central force in students' learning experiences, while neglecting the community that defines how these technologies are used. Papert (1987) asks, "Does wood produce good houses? If I built a house out of wood and it fell down, would this show that wood does not produce good houses" (p. 24)? The community is as important as the tool.

In depicting the success and supposed failures of Logo programming, Papert (1987) further identifies the teacher's significant role in reframing this technocentric view of technology: "Do not ask what Logo can do to people, but what can people do with Logo" (p. 25). It is the imperative role of the teacher that allows for these kinds of experiences to take place. Technology is a tool, and it can be molded and shaped to better suit the needs of students.

Papert's Constructionism: Knowledge Construction

In understanding the heavy weight placed on technology and technocentrism, it is important to understand that constructionism is not simply understood through the interconnected relationship we have with objects, but that these objects can be shared with others. Papert (1980) understands objects to be social entities that facilitate a repository of understanding and knowledge which enhance not only the development of the learner, but of the community of learners. However, Papert (1980) also cautions that not all materials are created equal, and not all will facilitate concrete learning experiences, as some in fact can block their development.

Turkle and Papert (1990) identify epistemological pluralism as a central tenet regarding constructionism and objects of knowledge, particularly surrounding computing programming. They suggest that where Piaget saw "diverse forms of knowledge in terms of stages to a finite end point of formal reason" (p. 129), they "see different approaches to knowledge as styles, each equally valid on its own terms" (p. 129). Turkle and Papert propose that students are often framed into a certain way of learning, often defined as the "right way to learn." They describe one particular learner, who was creative and exploratory with a particular object at the beginning of her learning process; however, because of the restrictive boundaries that framed her learning, she became very uninterested in the topic. Papert (1980) suggests that this is a common situation in many classrooms, arguing that "children are held back in their learning because they have a model of learning in which you have either 'got it' or 'got it wrong'" (p. 23). When learning is framed through epistemological pluralism, however, objects such as a computer can be used in different ways by different people (Turkle & Papert, 1990). Papert (1993) suggests that "rather than pushing children to think like adults, we might do better to remember that they are great learners and to try harder to be more like them" (p. 155).

While formal thinking may be able to do much more that is beyond the scope of concrete methods, the concrete processes have their own power as well. In fact, Kafai (2006) suggests that concrete thought can be just as advanced as abstract thought.

Papert (1993), recognizing the significance of *bricolage*, submits that concrete thought has always existed, but has been marginalized "by the privileged position of text" (p. 156). Levi-Strauss (1966, cited in Crotty, 1998) introduced the term *bricoleur* to describe a "person [who] makes up something new out of a range of materials that had previously made up something different" (p. 50). The object plays a central role for the bricoleur, who is "constantly musing over objects, engaged precisely with what is not themselves, in order to see what possibilities the objects have to offer" (Crotty, 1998, p. 50). Papert (1980) believed that we are all bricoleurs because we use objects in some way to formulate our thoughts. This notion highlights the central role objects have in learning, and that concrete learning can, in fact, facilitate valid and meaningful learning experiences.

Papert's Constructionism: Learning Culture

Constructionism indicates the central role that culture plays in the development of the learner. The interplay between the objective and the subjective indicates that meaning is deeply rooted in culture. Papert (1980) provides a concise description of a constructionist learning culture through the example of a Brazilian samba school:

> These are not schools as we know them; they are social clubs with memberships that may range from a few hundred to many thousands. Each club owns a building, a place for dancing and getting together. Members of a samba school go there most weekend evenings to dance, to drink and to meet their friends. During the year each samba school chooses its theme for the next carnival, the stars are selected, the lyrics are written and rewritten, and the dance is choreographed and practiced. Members of the school range from children to grandparents and in ability from novice to professional. But they dance together and as they dance,

> everyone is learning and teaching as well as dancing. Even the stars are there to learn their difficult parts. (p. 178)

This school culture is unequivocally based on a discovery model of learning: the grandparents demonstrate to the young children new methods of dance, while the stars show the grandparents new techniques and dance steps. Papert (1980) emphasizes that this discovery learning culture is not based on a "teaching without curriculum," where the child is simply left alone; instead, constructionism "supports children as they build their own intellectual structures with materials drawn from the surrounding culture" (p. 32). Learning by design, or learning by doing, has been used as one way to frame the constructionist learning culture.

The pivotal role collaboration has for learning is also identified through Vygotsky's (1978) *zone of proximal development* (ZPD), which is defined as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). It is this dynamic exchange between members of a group, or the reciprocal relationship between a teacher and student, that builds capacity for the learner to take on more difficult challenges.

Summary

This chapter explored Papert's (1981, 1992) philosophy of constructionism, which highlights the importance of the object, and how it supports the learner through their own development. It is the object that is the impetus for a learning-by-doing experience and one that affirms the importance of both concrete and abstract forms of thinking. In learning with these objects and in collaboration with others, students are able to formulate a meaningful and authentic learning experience, which highlights the importance of my research study on exploring how video game construction can work within the elementary classroom.

The next chapter explores the research surrounding both technology integration and video game construction, and the complexities and benefits they present to the learner and to the teacher.

Chapter 3: Literature Review

In this chapter, I provide a survey of literature that is pertinent to my research study, specifically, the research that explores technology in schools, with a focus on video games and video game construction programs. Chapter 3 is organized into two sections: (a) an overview of the literature that pertains to school culture and digital technologies and the inevitable shifts that have transpired regarding a teacher's pedagogy, a student's learning, and the collaboration between teachers and students; and (b) an overview of the literature that pertains to playing and constructing video games and a description of studies regarding students building video games in the classroom.

If you close your classroom door and listen carefully, you can often hear tales of the past from students and teachers who once walked the school halls. What would these stories tell you? Perhaps they would be filled with triumph, of winning the final basketball game or achieving a top mark in a difficult subject. Or the stories might be filled with despair: a friendship being torn apart over a particular boy or girl, or a student receiving a poor mark even though they put countless hours into getting ready for the test. It is the very act of weaving experiences, one thread at a time, that exemplifies the interconnected relationship children have with their learning. Children learn through the experiences that are presented to them, and by weaving them, they create new ideas and interpretations of the world around them.

The following chapter explores the varying threads that comprise the fabric of learning, particularly the threads that connect to digital technologies.

Section A: School Culture and Technology

Constructionist technologies.

This section introduces constructionist technologies and the important role they play for the digital learner. It is important to highlight how digital learners use constructionist technologies in their daily lives, not only because it indicates how constructionist technologies are different from traditional technologies, but also because of the value that video game construction serves to the learner. Traditionally, learning has been framed through structure and control; today's learners, however, demand a greater sense of freedom and agency. Thus, by highlighting the important role these constructionist technologies play for learners, this section begins to clarify why young learners should be provided opportunities to construct video games in the classroom, and why teachers should explore these kinds of experiences in the classroom.

21st-century school culture.

School culture is deeply ingrained in the experiences of the past in those who have lived and breathed the very essence of what it means to be a student. It is the bell that rings every hour, or the break at lunch, or the athletic meeting after school, or the morning announcements that start the day. We learn by being a student, and thus we come to embody the weighty principles that formulate the very notion of school. Barth (2002) suggests that a school culture

> is a complex pattern of norms, attitudes, beliefs, behaviors, values, ceremonies, traditions and myths that are deeply ingrained in the very core of the organization. It is the historically transmitted pattern of meaning that wields astonishing power in shaping what people think and how they act. (p. 7)

The phenomenon of becoming and being a student unquestionably creates a shared understanding between generations; a grandmother can freely talk about school with her granddaughter, for example, because both generations share a contextually similar experience.

However, consider the interests of the granddaughter outside of school, particularly the experiences derived from digital technologies. The granddaughter messes around (Horst, Herr-Stephenson, & Robinson, 2010) with technology as a means to construct her own idealized version of the tool. Whether it is playing and constructing in Roblox, or watching and creating Machinima videos of her favourite video game, these digital tools play a vital role in how she experiences the world around her. While the granddaughter spends countless hours messing around in these online spaces, her grandmother and even her own mother might struggle to understand the intrinsic role these technologies serve for their young girl. The relationship many children have with digital technologies is different from the experiences of previous generations. This is particularly true in out-of-school contexts, which not only suggests that many children experience technology differently from their parents and grandparents, but also that they learn with technology differently (Kafai & Burke, 2014; Kafai et al., 2009; Maloney et al., 2004; Peppler & Kafai, 2007).

Jenkins (2006) believes that digital learners experience technology differently because they are defined through a participatory culture, which he defines as having

> relatively low barriers to artistic expression and civic engagement, strong support for creating and sharing one's creations, and some type of informal mentorship whereby what is known by the most experienced is passed along to novices. A participatory culture is also one in which members believe their contributions matter, and feel some degree of social connection with another. (p. 3)

The reciprocal relationship digital learners have with technology exemplifies the role it serves in their own learning. These tools allow learners to anchor their learned understanding of the world and make continued connections to their own beliefs. Although children have the freedom to make connections through playing, constructing, and remixing (Kafai & Burke, 2014) game construction programs such as Kodu and Scratch outside of school, these kinds of experiences are rarely encountered during school hours. It seems some schools do not fully allow for these constructionist experiences to be present in the classroom (Brennan, 2013; Buckingham, 2007; Dougherty, 2013; Kafai, et al., 2009).

A recent study completed by Kafai and Burke (2014) found that students were able to build twice as much programming with Scratch in after-school clubs; however, the completion rate and participation rate was substantially higher when students were provided opportunities to use Scratch during school time. Kafai and Burke (2014) suggest that many of the students who constructed games with the use of Scratch during school hours would not have participated in the after-school club due to other interests or time commitments.

The fact that children experience technology differently than children in previous generations is a salient factor in understanding the challenges schools may experience when meeting learners' needs. Makerspaces and the maker movement represent the glaring differences between in-school and out-of-school contexts.

The maker movement.

The growing popularity of makerspaces and the maker movement suggests the important role that game construction serves to the participatory needs of digital learners. It also brings into focus the struggles teachers face in understanding how video game construction can be integrated into the classroom. Dougherty (2013), the CEO of Maker Media and the founder of Maker Faire, illustrates the differences between in-school and out-of-school contexts:

> the biggest challenge and the biggest opportunity of the Maker Movement is to transform education . . . students are seeking to direct their own educational lives, looking to engage in creative and stimulating experiences. Many understand the difference between the pain of education and the pleasure of real learning. Unfortunately, they are forced to seek opportunities outside of school to express themselves and demonstrate what they can do. (p. 8)

Pritchard (2014) suggests that makerspaces are defined through the application of unstructured technologies that include “peer-to-peer learning, free-form creativity, and rapid prototyping” (p. 471). Martinez and Stager (2013) identify the acronym TMI, which, in an educational context can mean “too much information,” where too few opportunities are provided for students to discover their own ideas. However, in a makerspace, TMI can represent “think, make, improve.” Students gather in a makerspace to tinker (Papert, 1993) and mess around (Horst et al., 2010) with varying technologies, and through an iterative cycle of learning, students can create, for example, an innovative cellphone case with the use of a 3D printer, tinker with Cubelet blocks, or create a new game controller through a Makey Makey kit.

These spaces not only provide the resources to tinker and mess about, but they also allow the freedom to explore an idea, which, as Papert (1993) suggests, is the very essence of bricolage. Buckingham (2007) suggests that the popularity of these after school makerspaces further exemplifies the “widening between children’s everyday life world outside of school and the emphases of many educational systems” (p. 11). There is no question that after-school programs such as the Computer Clubhouse (Kafai et al., 2009) or the technology programming at a public library allow greater flexibility in allowing students to mess about and tinker around with technology (Horst et al., 2010; Ito, 2009); however, participation and completion rates are not as high in these out of school contexts (Kafai & Burke, 2014).

There are many excellent technologies available to young learners to enhance their learning in a makerspace; however, teachers struggle to understand how to integrate these technologies in the classroom. Makerspaces represent an interesting case that exemplifies the challenges schools are facing. The technologies in a makerspace are centred on the philosophy of bricolage, while schools and teachers encounter a variety of barriers that make integrating these kinds of technologies difficult.

The next section discusses these challenges, and highlights the importance of limiting the amount of structure that learners experience in the classroom.

Agency and structure.

Collins and Halverson (2009) present the notion of schools as an institutional channel, where the four walls that frame a classroom encapsulate learning, while in a digital media channel learning happens in ubiquitous, nonstandardized, and unpredictable ways. On the same idea, Brennan (2013) identifies agency and structure, where structure is a lesson that is explicitly planned and defined by the expert teacher, while agency is understood as the learner having the ability to set their own goals, "which enables him or her to play a part in their self-development, adaptation and self-renewal with changing times" (p. 2). Brennan (2013) suggests that agency and structure are often pitted against each other in education, indicating a high structure/low agency paradigm in the classroom. Bandura (2001) observes that this dualism is not an uncommon reality in all facets of life, and suggests that perhaps the impetus of agency often forgets the importance of structure, where personal agency must operate through a set of rules that regulate human affairs.

Brennan (2013) discusses an experience she had with a group of high school girls building with Scratch in an after-school context. She found that one of the participants had a particularly negative attitude due to an in-school experience where she had to follow a formulaic process. The experience made this student believe that all her Scratch experiences would be the same. The amount of structure situated in some classrooms may prevent the agency of constructionist learning to be discovered and experienced; however, Brennan found that learning in school contexts does not need to mirror the high agency/low structure paradigm that exists in out-of-school contexts. Instead, she argues, structure should be used to amplify agency.

Brennan (2013) found that structure was often used to deal with complexities. For example, increased class sizes or lack of time were factors that influenced teachers to increase the structure in their classrooms. One teacher in Brennan's study reflected,

> Although it worked out really, really well for them to have this checklist to go through (and step-by-step tutorials to use Scratch), the one downside about this whole curriculum, looking back on it, is that it was really, really structured. For projects being completed, they were basically told what project to do, and there wasn't too much room for creativity, and I would have liked some other kind of outlet to let them go off and be creative. (p. 141)

Critique of high agency / low structure paradigm.

Structure can serve as a response to the pedagogical realities situated in the classroom. Although reducing the amount of structure in the classroom is one possible solution to help support teachers as they evaluate how to facilitate a more constructionist learning experience, Kirschner, Sweller, and Clark (2006) caution that "minimally guided instruction is less effective and less efficient than instructional approaches that place a strong emphasis on guidance of the student learning process" (p. 75). In fact, Kirschner et al. suggest that most teachers who provide constructivist instruction end up having to provide considerable guidance, which brings forth the authors' concerns associated with the cognitive load of students learning in a constructivist classroom, particularly young novice learners who might not have the proper schemas to work through new information.

Although Kirschner et al. (2006) illustrate the importance of structure in a classroom, there is evidence that suggests that more structure is not always necessary in supporting student learning. Scaffolding (Vygotsky, 1978) plays a vital, if not central, role in the learning experience of students in a constructionist classroom. Although Kirschner et al. (2006) are correct in suggesting that students' cognitive load needs to be supported, both forms of pedagogical practice—instructionism and constructionism—do provide this support. It is the teacher's approach to learning and students that is different, and constructionism inevitably creates a unique form of structure and agency in the classroom.

Epistemic frames.

An epistemic frame is a form of knowing for a particular community, that is, "knowing how to ask questions, knowing what constitutes appropriate evidence, knowing how to go about gathering evidence and knowing when to draw a conclusion" (Shaffer, 2006, p. 228). The epistemic frame is one response to Kirschner et al.'s (2006) concerns regarding the cognitive load of constructivist learning, where the epistemic frame of being a student offloads this cognitive burden because students are not expected to learn in isolation, but rather in the community of others, who inevitably support each other's learning.

It is through an epistemic frame that children are able to develop an island of expertise (Crowley & Jacobs, 2002) in a particular topic depending on the context found in their learning experience. An epistemic frame also creates a sense of authenticity in learning. Kafai and Burke (2014) suggest that students who interact with programming purely to learn how to code miss a vital element of the programming experience; they assert that "students should learn how experts in the domain approach the topics to create real applications" (p. 33).

Shaffer's (2006) understanding of an epistemic frame is similar to Gee's (2005) projective stance, which further illustrates the importance of learning through real-world video game scenarios. Gee (2005) states: "In a video game, players inhabit the goals of a virtual character in a virtual world and a virtual character instantiates the goals of a real-world-player" (p. 212). In considering the projective stance of being a pirate in *Assassins Creed* or a soldier in *Full Spectrum Warrior*, gamers experience "a near perfect fit or mesh between the virtual character's skills and the real-world player," where the "desires, goals and actions are shared out between the virtual character and the real-world-player" (Gee, p. 219).

Although video games provide a unique experience, the games illuminate the importance of learning with and through a certain epistemic frame (Shaffer, 2006), because they provide learners with the opportunity to connect with a specific discourse, such as being a football player in *Madden NFL* or a solider in *Call of Duty*. This is further illustrated in what Gee (1999) identifies as small 'd' and big 'D' Discourse. Small 'd' discourse can be understood as the language that is used in everyday life, while big 'D' Discourse is understood as the language that frames certain ways of "thinking, acting, interacting, valuing, feeling, believing, and using symbols, tools, and objects in the right place at the right time so as to enact and recognize different identities and activities" (p. 13). It is through using the language of being in a certain epistemic frame (Shaffer, 2006) or projective stance (Gee, 2005) that highlights the importance of providing constructionist experiences provide for students.

Summary.

This section has highlighted the important role that constructionist technologies serve for digital learners, particularly considering the popularity of makerspaces. This section also identified the importance of providing more opportunities for production and collaboration in classroom settings, which consequently has the potential to shift learners' epistemic frame. High structure and low agency environments do not necessarily meet the creative and digital needs of learners, thus this section indicates the importance of providing experiences that centre on high agency and low structure.

Technology integration.

This section builds on the important role constructionist technologies serve for digital learners and highlights the complexities that are associated with integrating high-agency technologies into the classroom, particularly as many classrooms continue to be designed through a high-structure context. This section clarifies the struggles a teacher experiences in finding a balance between curricular demands and their desire to support learners' digital needs. Following a section about the introduction of technology in schools, three themes are presented: teacher pedagogy, time, and assessment. These subsections address the complexities teachers face in trying to integrate constructionist technologies into the classroom.

Introduction of technology in schools.

School culture is a complex framework that can be extremely difficult to change. The shared understanding between the grandmother and the granddaughter described above illuminate this continuity. Even the digital technologies that are situated in the 21st-century classroom share a similar heritage to the tools that were experienced by previous generations. The interactive whiteboard is one representation of this continued heritage. Lovell (2014) and Zevenbergen and Lerman (2008) suggest these boards are used in ways that are similar if not the same as how a whiteboard or an overhead projector were used in the classroom. In fact, Lovell (2014) suggests that although teachers believe the interactive whiteboard increases effectiveness and efficiency in the classroom, a teacher's pedagogy remains unchanged whether the whiteboard is the traditional physical kind or the newer interactive kind.

The teaching machine introduced by Skinner (1986) is another representation of this regulated continuity. During the mid 20^{th} century, the teaching machine was identified as a tool that would teach students, through a repetitive experience, in mathematics and spelling. Students would move knobs and dials on a large, wooden box to match up the correct answers to the questions. Skinner (1986) and many educators believed that this technology would not only redefine the classroom experience, but also save a considerable amount of money because students would learn more quickly and with less teacher support. While these wooden teaching machines are in a museum now, this kind of repetitive drill-and-practice experience can still be seen in the classroom, particularly through some very modern technologies, such as educational video games. Games such as Math Blaster or Reader Rabbit continue this drill-and-practice heritage, but much like the teaching machine, they produce relatively poor learning experiences (Chee & Tan, 2012; Egenfeldt-Nielsen, 2007; Egenfeldt-Nielsen et al., 2012; Gaydos & Squire, 2012; Gee, 2005, 2007a; Foster, 2008). The problem with many of these instructionist technologies is that they dismiss the importance of students learning about learning; rather, the sole focus is the student learning about content.

This continuity can in some regards be explained through German and Barrett’s (2005) discussion regarding functional fixedness, where digital technologies, such as an interactive whiteboard or an educational video game, are used to support traditional purposes. This practice is a particular concern because some school districts continue to spend a considerable amount of money on digital technologies, creating a high-access, low-use paradox in schools (Cuban et al., 2001; Ertmer, 2005; Mueller, Wood, Willoughby, Ross, & Specht, 2008). While schools do have access to technology, there may be serious barriers to making effective use of technologies in the classroom.

Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, and Sendurur (2012) suggest that both external and internal barriers play a significant role in the issues surrounding technology integration in schools. External barriers include resources, training, and support, while internal barriers include teacher confidence and beliefs about how students learn and the value technology serves for the learner. Both types of barriers play a significant role in the investigation of technology in the classroom, and are often used as a framework to analyze technology integration in school settings. However in using these barriers as a framework for further investigation, it is easy, if not natural, to pit them against each other.

In most regards, the teacher is the primary focus of external and internal barriers, particularly because, as Fullan (2001) suggests, “educational change depends on what teachers do and think, it’s as simple and complex as that” (p. 107). Mueller et al. (2008) also support this central focus regarding teachers, stating that “educators are the focus of interest because it is educators that have the primary contact with students and it is educators that experience the barriers and supports to the integration of technology first-hand” (p. 1524).

The following section discusses the impact a teacher's pedagogy has on how technology is experienced in the classroom.

Teacher pedagogy and technology.

This section identifies the relationship between a teacher's pedagogy and how technology is integrated into the classroom. Themes associated with structure and agency will be discussed, along with the impact teacher pedagogy has on technology integration.

Research suggests a relationship between teacher pedagogy and technology integration (Andrew, 2007; Ertmer, et al., 2012; Hayes, 2008; Tondeur et al., 2008). McGrail (2005) and Ertmer et al. (2012) suggest that a teacher's past experiences directly influence how technology is integrated into the classroom. Ertmer et al., for example, found that teachers with constructivist beliefs often used technology to support student-centred learning, while teachers with more traditional beliefs used technology to support more teacher-directed learning. Ertmer (2005) states:

> Low-level technology uses (e.g., word processing, using technology to teach remedial skills) tend to be associated with teacher-centered practices, whereas high-level uses (e.g., engaging students in inquiry-based activities, collaborating with peers at a distance) tend to be associated with student-centered, or constructivist practices. (p. 26)

In addition, Evans-Andris (1995) suggests that student-centred, constructivist teachers generally embrace technology and spend more time learning and engaging than instructionist-based teachers, who generally use distancing techniques to either avoid technology or use technology to instruct through drill-and-practice programs. This finding suggests that constructionist teachers are not only more likely to integrate technology into the classroom but that they will use technology on a more frequent basis (Overbay, Patterson, Vasu, & Grable, 2010). This phenomenon can be seen in the success of the Quest to Learn school (Salen, Torres, Wolozin, Rufo-Tepper & Shapiro, 2011), where the focus of the curriculum is project-based, collaborative learning, through and with technology. Schools such as Quest to Learn "recognize the need to embrace a constructionist approach with technology over the traditional instructionist model" (Kafai & Burke, 2014, p. 704). This finding also suggests that technology does not impact teacher practice (Hayes, 2007; Lovell, 2014; Smeets, 2005). According to Hayes (2005), most teachers do not "fundamentally change the way in which they teach or the ways they design learning experiences within the classroom" (p. 389).

Concern has been directed towards the predominance of lower-order, instructionist experiences within the classroom (Ertmer, 2005; Ertmer & Ottenbreit-Leftwich, 2010). Squire, Giovanetto, Devane, and Durga (2005) further identify the impact of standardization on integrating technology, particularly video games, into the classroom, arguing that "any open-ended game-based learning scenario will involve participants in a range of difficult practices in any given moment on any given day" (p. 41).

Ertmer and Ottenbreit-Leftwich (2010) also suggest that the predominance of lower-order technology use connects to the continual changes in technology, creating a teacher who is a "perceptual novice" (p. 261) as teachers are continually presented with new technologies to integrate. In addition, Sandford (2014) found that when teachers experienced tension in trying to integrate a technology into the classroom, they often referred back to existing approaches rather than exploring new forms of practice.

Teacher openness was found to be a significant factor that supported teacher change. Baylor and Ritchie (2002) found a positive relationship between teacher openness and teachers' use of technology to facilitate higher order thinking skills. Drent and Meelissen (2008) also found that teachers who developed personal entrepreneurship were able to develop personal contacts that supported the development of ICT integration.

Beyond personal entrepreneurship (Drent & Meelissen, 2008), Ertmer and Ottenbreit-Leftwich (2010) and Hughes (2005) suggest that teachers are more successful integrating technology into the classroom when it connects to a specific content area. Ertmer and Ottenbreit-Leftwich state: “When learning experiences are focused solely on the technology itself, with no specific connections to grade or content learning goals, teachers are unlikely to incorporate technology into their practices” (p. 263). It is important for teachers to make specific connections with the content they are teaching and the technology they are choosing to integrate into the classroom. This connection will strengthen the tool’s role in the classroom and the likelihood that the tool will be integrated in the future. Not only will teachers be able to make a more intrinsic connection with the content, but Hughes (2005) also suggests that teachers will likely value the technology more.

This section identified the significant role teachers play in integrating technology in the classroom. Generally teachers who are more student-centred will integrate technology in a more constructionist manner, while a more traditional teacher will likely integrate technology in an instructionist manner. Understanding a teacher’s pedagogy provides insight into how they integrate video game construction into the classroom, and how different forms of pedagogy impact how game construction is experienced in the classroom.

Time.

This section explores the important and constricting presence that time, a finite resource, has for teachers and students. The amount of time a teacher spends learning with technology and the amount of time a teacher allocates for a project that centres on video game construction are the two main themes of this section.

Time and teacher training.

Consider the amount of time a particular subject is taught, the amount of time a student has to complete an assignment, or the amount of time a teacher spends learning a new technology. They each impact how learning is experienced in the classroom. In fact, Vannatta and Fordham (2004) found higher levels of classroom technology use often associated with the amount of time a teacher spent outside the class preparing for lessons.

It seems as though learning more about technology requires teachers to go beyond the call of duty and explore and practice with technology. This finding also suggests that teachers are not provided enough time to prepare their computer-based lessons (Baylor & Ritchie, 2002) or learn new methods (Russell, Bebell, O'Dwyer, & O'Connor, 2003), which suggests that teachers will generally revert back to traditional methods.

Although many teachers spend a considerable amount of non-school time learning about technology, Baylor and Ritchie (2002) suggest that this can negatively impact a teacher's pedagogy. They write:

> It was found that teacher non-school use of technology negatively affected the impact on content acquisition. Perhaps the more the teacher used technology out of the classroom, the more s/he was a more advanced user and may have focused on the technology itself rather than the application of the technology in the classroom. (p. 409)

This situation creates a sense of juxtaposition, where teachers are not provided enough time to learn about technology during school time; however, when they use and learn about technology in out-of-school contexts, it becomes more difficult to locate ways to use the technology within content areas.

Van den Dool and Kirschner (2003) also found that time played an important factor in allowing the technology to become a "normal" part of the day. When technology is used repeatedly in a class, it not only becomes a normal entity, such as using a textbook or writing a story, the technology is also used more effectively. This finding suggests that technology needs to be used repeatedly in order for it to be a more effective and lasting part of the classroom experience. It also aligns with Cuban et al.'s (2001) research which suggests that education is a slow revolution, where educational change can take a considerable amount of time.

The amount of time available also contributes to the training a teacher may receive regarding technology integration. However, Vannatta and Fordham (2004) also suggest that teachers need to be equipped with a sense of risk taking, which means that teachers need to be open to change and spend additional time to learn more about the technology. Mueller et al. (2008) and Ertmer and Ottenbreit-Leftwich (2010) further elaborate that confidence-building opportunities need to be provided to teachers to facilitate a sense of risk taking. These confidence-building opportunities are often experienced when teachers and students work together to learn the technology (Mueller et al., 2008). In fact, in a ten-year longitudinal study that investigated the Apple Classroom of Tomorrow (ACOT) program, "teachers' observations of changes in their students prompted them to reflect on their current beliefs about teachers and learning, which inevitably led to changes in their pedagogical beliefs" (Ertmer & Ottenbreit-Leftwich, 2010, p. 263).

Learning about how to integrate technology into the classroom can also be driven by the students. Borko and Putnam (1995) found that "workshops alone did not change these teachers.

It was listening to their own students solving problems that made the greatest difference in their instructional practice." (p. 55). Moreover, students can also serve a pivotal role in technology integration. Consider the prominence of mobile technologies in the classroom; teachers rarely instruct students in how to use them as an instructional tool, but students use their mobile devices frequently during class to organize their homework, calculate a math question, register for online sessions, and check their marks. This observation suggests that students can and do use technology without the support of their teacher during class time.

Pelgrum (2001) suggests that "educational innovations usually do not succeed if teachers are not provided with the skills and the knowledge needed to carry them out" (p. 165). Overbay et al. (2010) further emphasize that, "without adequate access and training, we can expect that classroom use of technology to support learning will be limited, whatever teachers' pedagogical orientation may be" (p. 116). Teacher training, or training in general, is perhaps one of the most important resources that can be provided to support technology integration.

Time and video game construction.

Time is particularly important when thinking about constructionist experiences. Ertmer (2005) suggests that it will likely take longer to integrate technology in a more constructivist manner. Carver (2006) also attests that constructivist approaches are more complex, but must take place in classrooms that are defined with finite time and resources. Harel and Papert's (1990) research backs up Carver's assertion. Their instructional software design project study took place over a 15-week period, and they found software design to be time consuming and difficult for teachers to fully understand how it can fit into the average class schedule. However, Baytak and Land (2011) report that in their game construction study, students were able to program and create their own video game in a much shorter period of time, highlighting that game construction can take less time in the class than indicated by previous game construction research studies (Harel & Papert, 1990; Kafai, 1995).

Robertson and Howells (2008) found that children need to be given more time in their game construction project to "consolidate the skills introduced and to discover the creative potential of the software" (p. 575). They suggest that teachers must find a balance between the amount of time they provide children to explore and play with software on their own terms and the amount of time they provide for direct instruction to ensure that the essential skills and features are introduced. This suggestion is similar to Brennan's (2013) discussion surrounding a balance between agency and structure. Robertson and Howells (2008) also note that "there is no guarantee that the children will learn the target skills in an open-ended discussion" (p. 575). Thus, although both teachers and children need to be provided sufficient time to work through constructionist experiences, there is no certainty that they will learn the content.

This section identified two important themes associated with time: the amount of time a teacher has both to learn the technology and to develop a sense of confidence and knowledge to use it successfully in the classroom; and the amount of time allocated to facilitate video game construction opportunities in the classroom. This section identified some of the constraints associated with the amount of time available to integrate game construction in the classroom.

Assessment.

Assessment is the focal point of this section, particularly the role it serves for the teacher and the student regarding the evaluation of video games. In addition, this section highlights some of the challenges a teacher may face in evaluating a student-constructed video game.

In a traditionalist, instructionist-based classroom, the focus is on summative assessment (a test-based process), where "students are viewed as subjects of testing rather than partners in the testing" (Tangdhanakanond, Pitiyanuwat, & Archwamety, 2006, p. 25). In general, traditional tests (multiple choice, fill-in-the-blank, true and false, short answer, and essay) "fail to allow students to demonstrate the multidimensional aspects of what they have learned" (Tangdhanakanond et al., 2006, p. 25). Formative assessment provides a more authentic representation of student learning. Kafai and Burke (2014) suggest that when students are constructing video games for a real-world audience, "they are provided with genuine feedback and meaningful and translatable assessment" (p. 33). The importance of authenticity is aligned with Shaffer's (2006) discussion of epistemic frames and the importance of real-world experiences.

Creating authentic and well-represented assessment practices is essential when considering the relative uniqueness of video game construction. Assessment might pose some challenges for teachers, particularly if they are required to formulate a grade to substantiate the project. Brennan (2013) identifies an array of concerns teachers brought forth regarding assessment and game construction. One concern centres on student collaboration: teachers in Brennan's study "often described a tension between wanting to support social learning activities, such as pair programming and group design, but also wanting to assess an individual student's understanding and development over time" (p. 158). Certainly the value of collaborative experiences is significant, particularly regarding video game construction (Kafai et al., 2012); however, it may be difficult for teachers to understand how to assess a collaborative project when they send individual report cards home.

Brennan (2013) also noted that teachers struggled to communicate the complexity of learning that took place in their classrooms to the outside community. Many felt that because they were trying something new, they needed to "market, sell or prove Scratch, to convince colleagues, administrators, and parents about its validity" (Brennan, 2013, p. 163). One teacher reflected,

> I think I'm struggling with Scratch, I want them to be creative, but, and this is another dilemma that is interesting, I feel this pressure. This isn't a pressure from anything anyone has said explicitly, but it's this undercurrent of educational that if you deviate from the curriculum, you still have to prove it works, even more so. (Brennan, 2013, p. 164)

For teachers trying to integrate programs such as Scratch and Kodu into the classroom, it seems as though they are using assessment to legitimize the work they are doing with their students.

However, Brennan (2013) also suggests that many teachers were unable to assess their students, or simply omitted assessment from the project because they felt that poor assessment might undermine their teacher goals or limit student creativity. Thus, instead of any concrete form of assessment, pass/fail or complete/incomplete was used to report the students' progress. Squire (2006) also stated that it can be difficult to assess student video games, particularly when working around a single curricular outcome. A core outcome makes it difficult to assess the diverse and unique work produced by the students, and it is possible that assessment does not fully validate the work of some students.

Kafai and Ching (2001) emphasize that the individualized nature of student video games means that a "sweeping statement about trends or progressions turns out to be more complicated given the complex nature of software design work" (pp. 358–359). The unique and autonomous nature of game construction formulates a sense of tension regarding assessment, which is generally not as apparent in other projects, such as writing assignments or presentations.

In response to these challenges, Tanghanakanond et al. (2006) suggest portfolio-based assessment as one response to the complexity of game construction assessment. Portfolios facilitate multiple layers of evidence to illustrate the learning that transpired within a student-constructed video game (e.g., written statements, drawings, project maps). Baytak and Land (2011) suggest that when assessing artifacts such as student-constructed video games, both the artifact and an explanation of the conceptual relationship that has been established needs to constructed to develop a more in-depth perspective of student learning.

Beyond portfolio assessment, Robertson and Howells (2008) provide three important suggestions in evaluating student-constructed video game construction. The first relates to the importance of teachers taking a step back and observing the students while they are immersed in game construction. The second highlights the importance of peer assessment, which can create opportunities for students to see their game through the perspective of the player. Finally, Robertson and Howells (2008) suggest that assessment should be paced throughout the game construction project, where the student's video games are assessed on a weekly basis.

In considering the time constraints teachers often face, it may be difficult to assess the student's video games on a weekly basis. Kafai and Burke (2014) present an alternate solution, where students build from preconstructed or partially constructed games. These partial versions provide a consistent base for the teachers to evaluate from and potentially remove some of the stress placed on the student, as they don't have to construct from an empty world. Although Kafai and Burke (2014) suggest providing a framework to students as a way to build a video game, Salen (2007) found that students would rather have the opportunity to have complete control over the design.

There is no question that assessment is a challenging issue, particularly considering the complexities associated with an emerging technology such as game construction. Although assessment can be a challenge, Kafai and Burke (2014) affirm the important role assessment serves for both the students and teachers, as reporting the progress of a student immersed in game construction validates the technology and learning to the school community.

Kafai and Burke (2014) introduce the idea of "yearners" and "schoolers." Yearners are teachers who seek out new technologies and new experiences in the classroom, while schoolers are teachers who are satisfied with maintaining a sense of consistency in the classroom. Kafai and Burke go on to state that, "despite the wishes of some yearners to rid school of grading scales, assessment plays a significant role in ensuring that project-based learning enters classrooms and remains there as part of instruction" (p. 119). Without assessment, the use of emerging technology and experiences such as video game construction can potentially have a limited life span, as assessment and measurable reporting are an ingrained part of school culture. It is important that teachers locate strategies to situate assessment in these projects.

This section identified the complexities associated with assessment of student-constructed video games. Teachers are challenged with locating meaningful and appropriate ways to assess video games, particularly as many of the games are individualized. Portfolios and partially constructed games highlight potential solutions regarding the complexities associated with assessment and student-constructed games. Each of the studies discussed indicate that video game construction is difficult to assess, which signifies that extra attention should be paid to how teachers attempt to assess a student-constructed video game.

Collaboration.

This section identifies the central role collaboration plays for the students and teachers. Collaboration is an important area of focus in video game construction because it highlights how students collaborate differently when immersed in video game construction, as compared to a more traditional activity, such as creating a poster. Three themes are discussed in this section: teacher collaboration, student collaboration, and affinity spaces. While these themes are separated into sections, there is some overlap between them, both in practice and in this discussion.

Teacher collaboration.

Consider the structure that is situated in a school environment. Generally the walls are built out of concrete, the doors to each classroom are closed and locked to ensure the safety of the students, and any space that was initially decreed as a conference area has likely been turned into something else, such as a book room, a counsellor's office, or a quiet work space for students. Schools have not been designed to optimize the experience of collaboration. Consider the act of placing a teacher in a classroom with thirty students with little opportunity for collaboration with colleagues.

Collaboration, as identified by Montiel-Overall (2005), can be understood as "working together," between teachers, administrators, students, and other stakeholders in a school environment. However, collaboration in school settings is a difficult process to establish and achieve (John-Stiener, Weber, & Minnis, 1998; Leonard & Leonard, 2001; Montiel-Overall & Jones, 2011). Welch (1998) suggests that "most educators neither know what collaboration is nor how to practice it" (p. 27). Pugach and Johnson (1995) assert that "collaboration is acknowledged to have been one of the most glaring, persistently absent characteristics of teachers' work, and the one most in need of being implemented (p. 11). Welch (1998) believes that it is essential to identify barriers to collaboration or else "teacher and teacher educators are doomed to failure and frustration in their efforts to promote collaboration" (p. 31).

Leonard and Leonard (2001) found that teachers do not believe that their schools expect high levels of collaboration, particularly given the work of a teacher is often characterized by competition and individualism. Leonard and Leonard (2001) argued that schools need to create a greater appreciation of professional opinion and more opportunities for teachers to work together. In considering the limited presence of collaboration in schools, Allan, Erickson, Brookhouse, and Johnson (2010) found that "the conditions of professional isolation and minimal preparation time during the school day virtually assure that teachers will not make fundamental advances in their instruction or experiment with technology" (p. 42). Leonard and Leonard (2001) also found time to be an inhibiting factor in facilitating opportunities for collaboration. In unpacking these impeding factors, it seems as though some schools are unable to create an internal structure that actively promotes and validates the importance of teachers working together.

Montiel-Overall (2005) highlights four different forms of collaboration: coordination, cooperation, integrated instruction, and integrated curriculum. Although Montiel-Overall references the collaborative relationship between teachers and teacher-librarians in this collaboration continuum, these varying forms of collaboration also are pertinent to the collaboration that takes place among and between teachers, administrators, and other educational support personnel. The following explores Montiel-Overall's discussion of the four varying factors of collaboration:

- Coordination: This model involves two or more participants working together to accomplish something that benefits either or both of them or their partners by making things run more efficiently. (p. 42)

- Cooperation: This model involves teachers working together but each having a separate goal for instruction. Goals are not coordinated. (p. 44)
- Integrated instruction: This model involves teachers collaborating on activities, lessons, and units by thinking about how to integrate what each wants to teach. (p. 46)
- Integrated curriculum: This model includes all the characteristics of integrated instruction. However, instead of occurring between the librarian and a few teachers, it occurs across the school or across the district. (p. 48)

In considering the four elements of collaboration, the last two categories are the most desirable and achieve the highest levels of collaboration; however, they are the most difficult to achieve in school settings. This is likely attributed to the fact that collaboration in most schools is framed through coordination, where a coach or strong teacher might organize and direct other teachers to participate in a certain initiative, while integrated instruction or curriculum suggests the importance of synergy, where instruction and curricula are jointly constructed, experienced, and assessed.

In understanding both the complexity of achieving a higher level of collaboration and the relative absence of collaboration within school settings, it is important to identify some factors that support teachers in gaining a higher level of collaboration. These factors are particularly important given that Ertmer et al. (2012) suggest that "the attitudes and beliefs of others are the most impactful barrier" (p.433) regarding technology integration in schools. It is particularly important that teachers find ways to collaborate with each other, not only so that they can have a greater understanding of what their colleagues are thinking and doing in the classroom, but also so that their exchange of ideas can enhance their own classroom practice.

One of the most prominent enabling conditions Montiel-Overall (2005) identifies regarding collaboration is the presence of time. The allocation of time not only plays a pivotal role in allowing teachers to learn how to integrate technology into the classroom, but it is also important for teachers to have sufficient time to discuss their ideas with others. Papert (1988) suggests that the presence of technology can initiate collaborative experiences.

Traditionally, schools have not been organized to facilitate opportunities for extensive collaboration; however, new ideas such as altered time schedules, weekly collaboration times, and shared assessment practices are some potential ways that collaboration can be experienced in the classroom. In addition, Montiel-Overall (2005, 2010) suggests that the school culture is important to consider, including such factors as creating a caring environment, developing a shared worldview, respecting each other, and developing a sense of reciprocity, collegiality, and a propensity to share. Leonard and Leonard (2001) also suggests that "staff members need to come together on a regular basis in their continuing attempts to be more effective teachers so that their students can become more successful learners" (p. 7).

This section identified the different levels of collaboration experienced between teachers. It also highlighted the challenges teachers face regarding collaboration given that teaching can often be experienced as an individualistic profession. Strategies were also highlighted to support greater opportunities for collaboration between teachers.

Student collaboration.

This section highlights the kind of collaboration that can take place between students when immersed in video game construction. Terms such as collaborative agency indicate a unique form of collaboration that occurs when students are immersed in video game construction.

Student collaboration is driven by moments of opportunity that move beyond individual desks and individual assignments and provide experiences that allow students to discuss and work together in creating a shared understanding. Piaget (1973) identified the importance of collaboration among children, as children can experience higher order experiences when immersed in collaborative experiences. Collaboration between students seems to be a natural component of building a video game, where Robertson and Howell (2008) found that students "frequently collaborated to learn how the software worked. The teachers were struck by this behavior, as it did not seem to be a normal part of their classroom experience" (p. 571). In addition, the researchers also found more knowledgeable students collaborated with less knowledgeable students, which did not require any teacher intervention; in fact these experienced students were able to help the teachers.

When provided with the opportunity, student collaboration can be a self-driven entity, where there is a situated apprenticeship between old-timers and newcomers. Ching (2000) found that students with a greater understanding of software design were able to provide collaborative assistance to newcomers, and also recognized the importance of not taking over, by allowing the newcomer to still make mistakes. In contrast, Ching (2000) also found that when younger students were placed in groups with older, inexperienced students, they were given more direct instruction by the older students, which resulted in a reduced understanding of the program by the younger students.

Kafai et al. (2012) also found an old-timer and newcomer dynamic in students working and remixing with Scratch. They found that the collaborative community provided newcomers with a greater participation in the project, while the collaboration revitalized and re-engaged old-timers. Some of the old-timers also experienced a greater degree of knowledge, as the student group pushed them to go deeper into their understanding of Scratch. Teachers also experience the dynamic interchange between newcomers and old-timers in their own collaboration. Scharber (2008) suggests "engaging both novice and veteran teachers simultaneously in new technologies and new literacies to create a moment of cognitive conflict during which they will evaluate and deliberately think about their professional knowledge" (p. 103).

Mueller et al. (2008) found that it is important to have a key teacher on staff who is knowledgeable about educational technologies. This key teacher will support newcomers in using technology in the classroom. Although the newcomer/old-timer relationship is present among teachers, it does not seem to be as fluid as the collaboration that transpires among students. Age and experience both play an important role in the newcomer/old-timer relationship for teachers, where experience plays a more vital role in the collaboration among students.

Mevarech and Kramarski (1993) found that students who collaborated with Logo outperformed students who worked independently. Mikropolous and Natsis (2011) also found that student collaboration not only enhanced learning outcomes, but also provided opportunities for students to discuss their ideas, which consequently allowed for a better game-playing experience.

Brennan (2013) also found collaboration to be pivotal in supporting students constructing games through the use of Scratch programming. In fact, it seems as though students are naturally prone to collaborate when using video game construction programs (Brennan, 2013; Brennan, Resnick, & Monroy-Herendez, 2010). Brennan (2013) suggests that students both work with others and help others to learn more about the program. For some of the students in their study, helping others was simply "part of the process of generalized reciprocity, paying forward benefits that they had received (and continue to receive) from others in the community" (p. 111). This help took place both in a face-to-face context and in virtual forums, such as creating an online tutorial.

Although Brennan (2013) found that collaboration was a pivotal component of using Scratch programming, students often struggled with knowing how to ask for help. Considering the Scratch forum, sometimes students felt that they were not able to articulate their problem or the kind of support they needed. Some students also found it difficult to make a connection with someone who could help.

Kafai et al. (2012) discuss the different kinds of work distribution between students who collaborate. They identify the following distributions:

- Splitting up work between individuals
- Sharing one computer and working together the whole time
- Exchanging a project back and forth between members as they took turns working on the project. (p. 77)

Kafai et al. (2012) suggest that this new kind of collaboration can be referred to a collaborative agency and explain that "the concept of collaborative agency articulates learners' efforts for searching out, organizing and distributing responsibilities in collaboration with others as they create collaborative artifacts" (p. 67). In constructing these artifacts, collaboration moves from Papert's (1980) objects to think with, to objects to share with, where collaborating together, with artifacts, facilitates a dynamic exchange of ideas. Collaborative agency also suggests that collaboration is continually changing in online and game construction experiences depending on the needs of the project. Kafai et al. (2012) state: "It is not enough to pick a model, youth must learn to identify whether a type of collaboration is working and change it to something more successful as needed in different stages of project" (p. 81).

This section discussed the kind of collaboration that takes place among students when immersed in video game construction. Collaborative agency was highlighted as a relatively distinct form of collaboration among students, suggesting that video game construction offers opportunities for unique and fluid forms of collaboration. Because digital learners naturally collaborate when immersed in game construction experiences, it is important to consider the highly structured nature of many classrooms, which potentially brings to question whether collaborative agency can take place in a classroom setting, and how game construction can facilitate collaborative agency in a highly structured environment.

Affinity spaces.

This section highlights the important role that affinity spaces serve to the video game community. Affinity spaces offer a collective space for members looking to advance their gaming skill set and to support others learning about video games.

From the research of Kafai et al. (2012), Ching (2000), and Robertson and Howells (2008), it seems as though students are incredibly willing to collaborate with each other to support the growth and development of video game construction. However, Kafai et al. (2012) question why students are so willing to collaborate and share their work with others on online forums and game-sharing sites. The answer, perhaps, is that students are striving for affinity (Gee, 2004). Devane (2012) suggests that affinity spaces are "not centered on a social group's constitution or boundaries of membership, but rather on the knowledgeable activity undertaken by learners and knowledge domain in which said activity takes place" (p. 166). Much like the experiences Kafai et al. (2012) found in relation to collective agency, where students sometimes worked together and at other times independently, this is a similar representation of affinity, where collaborative dynamics are no longer defined through the same understanding. Gee (2004) suggests that although there is a hierarchy among members within these spaces, it is incredibly fluid, and all members are encouraged to participate and share their expertise in the subject. The following is a representation of some of the factors that comprise an affinity space:

1. Common endeavour, not race, class, gender, or disability, is primary.
2. "Newbies," masters, and everyone else share common space.
3. Some portals are strong generators.
4. Content organization is transformed by interactional organization.
5. Both intensive and extensive knowledge are encouraged.
6. Both individual and distributed knowledge are encouraged.
7. Dispersed knowledge is encouraged.
8. Tacit knowledge is encouraged and honoured.
9. There are many different forms and routes to participation.
10. There are lots of different routes to status.
11. Leadership is porous and leaders are resources. (Gee, 2004, pp. 85–87)

Gaming affinity spaces almost solely exist in digital spaces such as blogs and forums, and they generally strike a balance "between official editorially approved content and the purely user-generated stuff" (Squire, 2011, p. 66). A wide range of gamers frequent affinity spaces, and participation constantly evolves depending on the expertise and needs of the gaming community. Affinity spaces are rarely stagnant, particularly when centred on popular video games such as World of Warcraft. Individuals who participate in World of Warcraft experience a dynamic affinity space; the gaming experience depends on the response from the community, so the gamer has a more involved role in "exploring and manipulating the ever changing world" (Egenfeldt-Nielsen et al., 2012, p. 50). Consequently, games such as World of Warcraft, The Sims, or Zoo Tycoon require affinity spaces to further guide the projective stance of the gamer, and consequently the epistemic frame of the game participants.

This section highlighted the unique role affinity spaces serve to the video game community. It also brought into focus the important role they play in the skill and knowledge development of those immersed in game construction. Due to the relative newness of these collaborative spaces, it is important to explore whether digital learners utilize them when engaged in game construction at school, or if they seek collaboration beyond the classroom.

This section also serves as a transition to Chapter 3's second main section, which highlights the research centred on video games. By facilitating opportunities for gamers to become more knowledgeable and more able to share their knowledge, affinity spaces support video games.

Section B: Playing and Constructing Video Games

Video games.

This section unpacks and reinforces why video games are good for learning and why they benefit digital learners. After elaborating the idea of what makes a video game and, consequently, how a video game is good for learning, the section discusses three themes: exogenous and endogenous games, motivation, and gender.

McGonigal (2011) suggests that there are two kinds of video games, finite and infinite. Games such as *Donkey Kong* and *Super Mario Brothers* are finite games because they have a definite end, while games such as *Tetris* offer an infinite game experience because gamers play until they level out. Although these two kinds of games are contextually different, they both offer an experience that is both engaging and motivating, where gamers are intrinsically motivated to pick up the controller again and again to level up on their previous experience. In fact there is resounding evidence which suggests that video games, such as *Tetris* and *Super Mario Brothers*, produce good learning experiences (Egenfeldt-Nielsen, 2007; Egenfeldt-Nielsen et al., 2012; Gee, 2005, 2007a, 2007b; McGonigal, 2011; Papert, 1980, 1993; Prensky, 2007; Salen, 2007; Salen & Zimmerman, 2004; Shaffer, 2006; Squire, 2006, 2011).

Consider the debate that has been raging for the past two decades surrounding violent video games such as *Grand Theft Auto.* Concerned parents and researchers such as Anderson and Bushman (2001) and Gentile, Lynch, Linder, and Walsh (2004), believe violent video games can increase aggressive behaviours, aggressive cognitions, and aggressive emotions. There is no doubt this concerned group would likely frame violent video games as a detriment to society, particularly to adolescent learners. However, *Grand Theft Auto* does have a very large following, in which millions of gamers patiently await the next version of the game. These followers in fact would go so far as to classify games such as *Grand Theft Auto, Halo*, and *Assassins' Creed* as video games, not necessarily due to the violent nature of the games, but because of the excitement and engagement derived from playing them.

Many research studies have found that violent video games do not produce aggressive behaviours. For example, Ferguson et al. (2008) found that "once family violence was controlled, direct exposure to violent video games did not hold any predictive power regarding the commission of violent crimes" (p. 329).

In addition, Przybylski et al. (2010) discovered that violent video games contain more challenging content than nonviolent games, making them more popular among gaming communities. Olson (2010) also found that adolescent gamers were more likely to play violent video games because of the "action, challenge and options" (p. 184) found in games such as *Grand Theft Auto*, as compared to nonviolent games. Interestingly, Olson (2010) also found that the participants who played *Grand Theft Auto* did not perceive the violence as fun; instead, they viewed it more as a moral lesson.

Certainly the debate surrounding violent video games continues to rage, with each side defined by a unique pedagogical praxis (Shaffer, 2006). Video games can also be seen as good for learning, where it is the design found in video games that irrevocably facilitates this learning experience. As Gee (2007a) suggests, "game designers have hit on profoundly good methods of getting people to learn and to enjoy learning" (p. 29). He asks, "How do good game designers manage to get new players to learn their long, complex, and difficult games and not only learn them but pay to do so" (Gee, 2007a, p. 28)? For Gee (2007a), the response goes beyond the pleasure or motivation that is derived from the game. It is the overarching mechanics, narrative, and design found in a video game that stirs the hearts of gamers and produces deeply meaningful learning experiences.

In understanding the difference between certain video games, Gee (2007a) presents the following checklist regarding what constitutes a "good" video game:

- Empowered learners
    - Co-design: In a video game, players make things happen. They don't just consume what the "author" has placed before them.
    - Customize: Good games are customizable. They allow gamers to customize the game to fit their learning style.

- Identity: Good games allow the player to inhabit the character and readily project their fantasies onto the character.
- Manipulation and distributed knowledge: Good games offer characters that the player can move intricately, effectively, and easily through the world. Good games also offer intricate, effective, and easy manipulation of the world's objects, objects which become tools for carrying out the player's goals.

- Problem solving
  - Well-ordered problems: Good games offer early problems which are designed to lead players to form good guesses about how to proceed when they face harder problems later on in the game.
  - Pleasantly frustrating: Good games adjust challenges and give feedback in such a way that different players feel the game is challenging but doable and that their effort is paying off.
  - Cycles of expertise: Good games create and support the cycle of expertise, with cycles of extended practice, a test of mastery of that practice, then a new challenge, and then a new extended practice.
  - Information on demand and just in time: Players don't need to read the manual to start, but can use the manual as a reference after they have played a while and the game has already made much of the verbal information in the manual concrete through the players' experiences in the game.
  - Fish tanks: Fish tanks are stripped-down versions of the game. Good games offer players fish tanks, either as tutorials or as their first level or two.

- Sandboxes: Sandboxes are game play much like the real game, but where things cannot go too wrong too quickly or perhaps even at all.
- Skills as strategies: Players learn and practice skill packages as part of accomplishing things they need and want to accomplish.

- Understanding
  - System thinking: Good games help players see and understand how each of the elements in the game fit into the overall system of the game and its genre.
  - Meaning as action symbol: Even barely adequate games make the meanings of words and concepts clear through experiences the player has had. Good games can achieve a strong effect by making even philosophical points concretely realized in image or action. (Gee, 2007a, pp. 30–43)

Gee (2007b) suggests that a video game facilitates a four-part cycle that demands that a gamer first probe the virtual world, then hypothesize about what something might mean in a situated way, then reprobe the world with that hypothesis in mind, and finally rethink his or her original hypothesis. Without this cycle, gamers will not get very far, because the lack of reflection will likely cause them to crash their plane, run out of ammo, or fall off the side of a cliff.

Gee's (2007b) four-part gaming cycle also facilitates a performance-before-competence learning experience "where players can perform before they are competent, supported by the design of the game, the 'smart tools' the game offers, and often, too, other more advanced players (in the game or in chat rooms)" (p. 218). Gee (2007a) references smart tools as the distributed learning experience that takes place between the "virtual character (smart tools) and the real-world player—the player is guided and supported by the knowledge built into the virtual character" (Gee. 2007a, p. 27). The smart tool consequently offloads some of the "cognitive burden from the learner" (Gee, 2007a, p. 27), which allows the learner to do more than what he is capable of on his own.

This offloading is not unlike Vygotsky's (1978) play-development relationship, where "in play a child always behaves beyond his average age, above his daily behavior; in play it is as though he were a head taller than himself" (p. 102). Squire (2011) suggests that games such as *Civilization* or *Sid Meier's Pirates!* can facilitate a "head taller" experience, because children learn geography and historical content well before it is introduced at school, or before they have the ability to contextually understand the content. Gee (2007a) writes about *Full Metal Spectrum* and the embodied relationship that is derived from being a solider in the video game. The real-life player becomes a virtual soldier in the game without the cognitive burden of learning the varied rules and systems associated with being an American soldier. In fact, games such as *Full Metal Spectrum* have been around for longer than most commercially produced games because the military initially designed and developed the first video game for didactic purposes (Abrams, 2009).

The design of a video game is the structural frame that substantiates the "goodness" of a game. However, when we delve deeper into the design of a game, we begin to see a causal relationship between the real-life gamer and the virtual character. In essence, the embodied relationship that a gamer experiences in a game such as *Full Metal Spectrum* is derived from the distributed knowledge, the well-ordered problems, and the sandbox play environments. However, without the embodied relationship between the virtual character and the real-life gamer, the design of the game would have little value.

This section identified the divided perspective regarding violent video games and their impact on children. It also identified the characteristics that Gee (2007a) suggests makes a video game. These characteristics can also be aligned with good learning experiences, which suggests that video games can be good for learning and provides rationale for integrating them into the classroom.

Exogenous and endogenous games.

This section introduces two different forms of video games: exogenous and endogenous. Exogenous games are often situated in the classroom because they are relatively easy to integrate due to their drill-and-practice framework, while endogenous games are potentially more difficult to integrate, but offer higher order learning experiences.

Gee (2007a) suggests that video games are "action-and-goal-directed preparations for, and simulations of, embodied experience" (p. 27). The fantasy in the video game is the facilitating factor in bringing forth the embodied experience that coexists between the real-world gamer and the virtual character. Rieber (1996) pointedly suggests that fantasy facilitates imaginative and creative thinking, which are essential factors, not only for video game play, but also for 21st-century learning.

Malone (1981) notes that games can either be comprised of extrinsic or intrinsic fantasy. Extrinsic fantasies are generally comprised of learning content that can easily be replaced by something different, such as the aforementioned Math Blaster. The extrinsic fantasy of Math Blaster could easily be replaced with a completely different task, such as spelling, or fact recall. Gee (2005) carries this notion further to assert that these extrinsic fantasy games are based on a gamer's projective stance. As I play Math Blaster, for example, I generally don't need to understand the solar system or how to navigate an aircraft. I simply need to know how to shoot down numbers as quickly as possible.

In contrast, intrinsic fantasy generally facilitates a more embodied experience, and games such as *Full Metal Spectrum* produce an experience that is not unlike that of a solider at war. The intrinsic fantasy blurs the line between game play and the fantasy of the game. Habgood and Ainsworth (2011) discuss the intrinsic fantasy associated with football fantasy games, which not only allow but facilitate embodied relationships with a football player, team manager, accountant, and statistician.

Rieber (1996) further delineates the gamer's embodied relationship with the game, through a framework of exogenous and endogenous games that is similar to Malone's (1981) description of extrinsic and intrinsic fantasy. Exogenous fantasy is analogous to simply adding sugar to tea or cereal; it doesn't add any more additional nutritional value to the food, it simply makes the food taste a little bit better. Endogenous fantasy is much different from this sugar-coating effect, because it is often "difficult to tell where the game stops and the content (fantasy) begins" (Rieber, 1996, p. 50). Rieber (1996) notes that "if the learner is interested in the fantasy, he or she will consequently be interested in the content" (p. 50), which is significant because most games for education are solely based on an exogenous, extrinsic fantasy model. Thus, for many educational video games, the content is of subsidiary importance.

Squire (2006) presents an interesting comparison regarding exogenous and endogenous video games, and further emphasizes the direct correlation between exogenous games and educational video games. This comparison is illustrated below in Table 1.

Table 1. Exogenous and Endogenous Games (Squire, 2006)

Aspects	**Exogenous Games**	**Endogenous Games**
A learner is…	An empty receptacle. An example is Math Blaster, where the learner is "motivated" to learn a prescribed set of skills and facts.	An active, sense-making, social organism. An example is *Grand Theft Auto*, where the learner brings existing identities and experiences that colour interpretations of the game experience.
Knowledge is…	Knowledge of discrete facts. The facts are "true" by authority (generally the authority of the game designer).	A tool set used to solve problems. The right answer in *Civilization* is that which is efficacious for solving problems in the game world.
Learning is…	Memorizing. Learners reproduce a set of prescribed facts, such as mathematics tables.	Doing, experimenting, discovering for the purposes of action in the world. Players learn in role-playing games for the purposes of acting within an identity.
Instruction is …	Transmission. The goal of a drill-and-practice game is to transmit information effectively and to "train" a set of desired responses.	Making meaning/construction, discovery, social negotiation process. Instruction in *Super Charged!* involves creating a set of well-designed experiences that elicit identities and encourage learners to confront existing beliefs, perform skills in context, and reflect on their understanding.

The learner participates in a very different learning experience depending on the fantasy derived from the video game. Squire (2006) uses words such as *memorizing*, *transmission*, *truth*, and *empty receptacle* in defining exogenous fantasy games, while words such as *active*, *self-making*, *experimenting*, *discovering*, and *social negotiation* represent endogenous fantasy. Certainly video games are more analogous with endogenous fantasy, because they produce a more rigorous and context-driven learning experience.

This section identified the differences between exogenous and endogenous games. These differences are important to highlight because endogenous games play an important role for the digital learner as they allow for a greater degree of agency and constructionist learning.

Motivation.

This section highlights the central role that motivation plays for the gamer, given that most video games are intrinsically motivating. This section also suggests that learning with video games in the classroom can be motivating and consequently engaging.

Gee (2007a) explains the significant role that good game design and subsequently good game fantasy play in the development of good learning experiences. However, motivation also plays a significant role in bringing students to the game experience, whether it is the first or the thousandth video game experience. Linnenbrink and Pintrich (2002) indicate that motivation is the enabler for learning and academic success, which means that the good game design elements Gee (2007a) identifies must consequently produce a motivating experience, because gamers learn an incredible amount from playing games. Foster (2008) further emphasizes this point, saying that "well designed video games meet players' need for creating interest, but also focus students' on learning goals" (p. 600).

Malone (1981) suggests that our intrinsic motivation to play video games is identified through curiosity and challenge. Challenge is identified as having goals that offer an uncertainty of attainment. According to Malone, curiosity is framed in an "environment that should be neither too complicated nor too simple with respect to the learner's existing knowledge. [Games] should be novel and surprising, but not completely incomprehensible" (p. 362).

Burn and Carr (2006) present three factors that contribute to the motivation of online role-playing games. The first factor is representational, as the role player is able to customize the personality of the character. Role-playing games (RPG) often allow the gamer to choose a character and then customize it through clothing, hairstyle, weapons, and character disposition. The second factor is ludic motivations, which represents the rules and structure in the game that facilitate a sense of motivation for the gamer. The last category is known as communal motivations. This category indicates the relationship the game has to other games and the expectations that arise from this relationship. A gamer's collective experience brings forth a multifaceted gaming identity that is individually unique. These experiences represent the motivation to play new and alternate games, to develop new experiences, and to develop new skills.

Garris, Ahlers, and Driskell (2002) state that although "games are primarily seen as a means to enhance intrinsic motivation, extrinsic motivation is also important" (p. 445). Scoresby and Shelton (2011) would agree; they found that both extrinsic and intrinsic motivation played a unique role for the experienced and inexperienced video game player alike. They found that for the inexperienced player, a certain degree of extrinsic motivation was required to play (p. 238). Once the inexperienced gamer was immersed in the game, they then had to find something intrinsic that would motivate them to continue and to be successful.

This section identified the important role that motivation plays for the gamer, given that video games facilitate opportunities for both extrinsic and intrinsic motivation. This intrinsic motivation is achieved through the customization and consistent rules situated in many video games.

Gender.

This section discusses the role that gender plays in both integrating video games into the classroom and in the interests of boy and girl gamers. This discussion is particularly important because there has been a misconstrued stereotype of the kind of games that girls and boys play and construct.

Kenny and McDaniel (2011) assert that one of most common reasons reported for educators not using video games is that they do not fully understand them or appreciate their potential in the classroom. In addition, while most elementary school teachers are women, Egenfeldt-Nielsen et al. (2012) note that the video game industry is overwhelmingly dominated by men, who “control both the production and consumption ends of the industry, with the products themselves mainly targeted at a male audience” (p. 172).

Schott and Horrell (2000) found that girl gamers do in fact have a different taste in games than boys: “girl gamers identified a preference for third-person-role-play games that contain animal/creature based characters rather than highly gendered human figures” (p. 50). Hayes (2007) also suggests that girls like short, casual games that do not typically offer the kind of built-in tools or fan communities that might encourage content creation” (p. 104). Turkle (1984) identified a similar gender distinction, where girls were found to be “soft masters,” while boys tended to be “hard masters” of game content. Upitis (1998) elaborates on the idea of hard and soft masters:

> Many girls are soft masters in their appropriation of technology, that is they deal with computers as relations to objects, not quite alive, but things with which one negotiates relationships, although they would never be understood completely. Boys tend to be hard masters, treating computers and programming by planning a course of action, and exercising control over the situation through determination and perseverance. (p. 295)

However, Jenson and de Castell (2010) suggest that these reported gender differences are more dependent upon the access girls often have to games, as they are more "intensively parentally regulated when it comes to what they can and cannot play" (p. 58). In fact, Jenson and de Castell (2008) found that girls often identified that they played with their brothers or a male relative, while none of the boys reported that they played with their sisters or female relatives. Interestingly, Jenson and de Castell (2008) found that girls enjoy the same level of "competitive gameplay as boys do: fighting, beating, racing against one another, building higher, faster, deeper, longer, accumulating the most points, knocking out opponents, all that." (p. 17) Although girls may be more regulated in their access to games, Jenson and de Castell (2008; 2010) report that their gaming interests are often similar.

Video game construction offers immense potential to realign the gender imbalance in video games. Denner, Werner, Bean, and Campe (2005) found that by constructing a video game, girls were able to work through issues centred on social issues and identity. For Denner et al. (2005), video games are a gateway to a more active use of the technology, meaning that by playing and creating games, girls will learn more about how to use a computer. Carbonaro, Szafron, Cutumisu, and Schaeffer (2010) found that "although boys continue to play computer games significantly more than girls, there is no difference in their ability to construct computer games of comparable complexity" (p. 1100). For Carbonaro et al., video game construction represents a viable way to promote female interest in computing science, which may not only create a shift in the types of video games produced, but might also have an impact on the educational environment.

This section identified the mixed research surrounding boys and girls playing video games. However, the research does not indicate a gender difference between girls and boys constructing video games.

Video game construction.

This section explores the research surrounding video game construction and the potential this constructionist experience holds for digital learners. This section is divided into three themes: problem solving, creative communication and production, and planning and writing. Although the research is relatively limited regarding classroom-based video game construction, this section highlights the emerging research that has taken place over the past three decades of game construction.

Problem solving.

This section discusses the kinds of problem-solving strategies students utilize when immersed in constructing a video game. Problem solving is identified as a natural part of constructing a video game, because students are motivated to seek ways to debug, or identify and remove errors from, their games. The section will also discuss the smart tools that are present in game construction programs such as Kodu.

Taylor (1980) discusses three levels of technology use within the classroom. The first is identified as a tutor, which is similar to Skinner's (1987) teaching machine, where the technology tells the student what to think. The next level is identified as a tool, which suggests that the technology provides some level of scaffolding to make learning either easier or quicker. The tools situated in Microsoft Word, such as spell check and automatic formatting, are representative of this level of technology use. The last level identifies technology as a tutee, which parallels the work of Papert (1980) with the Logo program. At this level, the application of technology is altered, where the technology is no longer an object that controls learning, but instead is an object that can facilitate a greater sense of autonomy. Salen (2008) attests that “in the Logo environment the relationship is reversed: The child, even at preschool ages, is in control: The child programs the computer” (p. 101).

It is this autonomous tutee relationship with technology that brings forth the importance of problem solving for the learner, where the student will be presented a wide array of issues when programming their own computer and will need strategies to solve these problems. Brennan (2013) asserts that a greater sense of control over the program naturally leads to varying moments of “getting stuck.” In these moments of getting stuck, Brennan (2013) states that students can end up “flailing” or “fleeing.” Although Brennan (2013) suggests that these are common occurrences in using an open system, she also suggests that students can develop sophisticated strategies to “move them from flailing or fleeing to a stance of fixing” (p. 85).

One of the problem-solving methods Brennan (2013) found the students used when programming their problems with Scratch was experimenting, where they would explore and experiment with the technology as a means to learn more about it. In building on this exploratory problem-solving technique, the students utilized a more systematic method of planning. Brennan writes:

> The kids described how they adopted more planning-oriented and systematic approach to development as the complexity of their work increased, as a way of thwarting getting stuck. For some, planning involved diagrams and pseudocode on whiteboards or sketching project requirements on paper. (p. 89)

Brennan (2013) found that the scale of the students’ project went beyond the amount of time available to create the initial game design. She writes, “In our conversations, kids described how they worked with various constraints to rethink their creative visions—sometimes triumphantly, sometimes satisfyingly, and sometimes frustratedly" (p. 90). Through these constraints, however, the students were resilient, bouncing back from challenges and determined to work through the construction process.

Salen (2007) suggests that in using introductory game construction programs, such as Gamestar Mechanic, Scratch, and Kodu, the principle of iterative design is learned through the edit and play modes. Salen and Zimmerman (2004) identify iterative design "as a play-based design process. Emphasizing play testing and prototyping, iterative design is a method in which design decisions are made based on the experience of playing a game while it is in development" (p. 11). The students move naturally back and forth between the edit and play modes to test if the game is working, whereas playing the game is a method of understanding if the game is working.

Ito (2009) suggests that "the promises and pitfalls of certain technological forms are realized only through active and ongoing struggle over the creation, uptake, and revision" (p. 11). In learning iterative design through game construction, students are developing an awareness of how problems are often solved for a game designer.

Smart tools and scaffolding.

Brennan's (2013) and Salen's (2007) discussion of problem solving highlights the ways technology can support the learner in locating ways to solve problems. If the technology is too complex, students will not be able to fix their own problem and will simply flee. This notion connects to Gee's (2007a) discussion of smart tools, where the tools located in a video game support more advanced gaming experiences. It also connects to Vygotsky's (1978) zone of proximal development, because the supports situated in programs such as Scratch and Kodu run parallel to the scaffolding a teacher might provide to the students in solving a challenging problem. Caci, Chiazzese, and D'Amico (2013) note that the "first studies on Kodu have highlighted that its tale-based programming language is particularly easy to use for novice students" (p. 1497).

Considering the relative scope of research surrounding Scratch programming and the limited research surrounding Kodu*,* it is important to emphasize the relative similarities between the two programs. Stolee and Fristoe (2011) suggest that there are many similarities between Scratch and Kodu. Both, for example, "are visual programming languages that allow users to create their own animations, games, and simulations" (p. 100). Stolee and Fristoe (2011) also suggest that Kodu language can be used to represent fundamental concepts in computer science. In highlighting these two programs, Scratch and Kodu*,* they emphasize that both have the ability to be 'objects to think with' (Papert, 1980) and objects to problem solve with.

Maloney et al. (2004) suggest that "if learners work individually meaningful Scratch projects, such as animated stories, games, and interactive art, they will develop technological fluency, mathematical and problem-solving skills" (p. 36). Lai and Yang (2011) also found that Scratch programming had a positive effect on learners' problem-solving ability, while Holdich and Chung (2003) found that children were able to write better stories through software-mediated guidance, where the technology scaffolded the writing experience for the students.

Harel and Papert (1990) had similar results in their Instructional Software Design Project (ISDP). They write:

> We found that Logo facilitated the on-going personal engagement and gradual evolution of different kinds of knowledge; and at the same time, it also facilitated the sharing of that knowledge with other members of the community, which in turn encouraged the learners to continue and build upon their own and other

> people's ideas. In short, Logo facilitated communications about the processes and acts of cognition and learning. (p. 29)

Problem solving with and through game construction technologies seems like a natural process (Baytak & Land, 2011; Brennan, 2013). However Zaharija, Mladenovic, and Boljat (2013) caution that "learning programming would be easier if students would already be familiar with basic programming concepts and it would be best if those basic concepts were taught in early age thus allowing students enough time to develop problems solving skills and logical thinking" (p. 1577). While Papert (1980) believes that programs such as Logo are "objects to think with," Zaharija et al. (2013) suggest that students need to be taught how to problem solve through these programs, particularly because children "haven't developed abstract, hypothetical thinking" (p. 1577). Therefore it may be "necessary to develop an approach to teaching that would make programming more accessible to the primary school children and would encourage the development of their logical thinking and problem solving" (Zaharija et al., 2013, p. 1577).

Kalelioğlu and Gülbahar (2014) found that although game construction did not increase students' problem-solving ability, students did gain self-confidence in their problem-solving ability.

Although some researchers (Baytak & Land, 2011; Brennan, 2013; Harel & Papert, 1990) do not believe it to be imperative to formally teach problem solving and abstract thinking through programming because the program and the collective community provide enough scaffolds, Koloner (2006) found significant gains through a learning-by-doing pedagogy that included both iterative cycles of investigation as an entire-class activity and opportunities for small-group design work.

This section identified the important role that problem solving plays in the design process of constructing a video game. Students utilize debugging strategies such as iterative design to solve some of their problems, while the smart tools situated in game construction programs support students to ensure they don't feel overwhelmed during the game construction process.

Creative communication and production.

This section explores how digital learners incorporate technology into their daily lives, which is particularly relevant because their creative participation is unique and different, as compared to students in previous generations. Two main themes are discussed: the different levels of participation for digital learners, and the important role that remixing plays for students using digital technologies.

Some researchers (e.g., Kafai & Ching, 2001; Peppler & Kafai, 2007; Salen, 2007; Squire, 2007) believe that playing video games is not enough to meet the production needs of 21^{st}-century learners. Peppler and Kafai (2007) argue that the old "sender-receiver model" (p. 151) does not support the production and design demands of students; they present three key arguments for creative production in school environments:

- Creative production can be seen as a new emphasis on critical writing of texts, broadly defined as written texts, software programs, media images, oral discussion, or other media objects.
- Youth need to move beyond participation via blogging and game playing to create their own video games, media art, or graphical user interfaces.
- Having an audience motivates youth to produce creative work. (pp. 151–152)

Involvement in blogging, website development, video production, and video game construction are indicators of how digital learners not only utilize digital technologies but also participate in social settings, both physically and virtually.

Hanging out, messing around, and geeking out.

Horst et al. (2010) discuss three genres of digital participation: hanging out, messing around, and geeking out. Each represents a different level of investment that includes technical, social, and cultural patterns. The first level, hanging out, suggests that middle school and high school students desire to “hang around, meet friends and just be” (p. 37). Oftentimes, students will choose to hang out first online, whether by coordinating a social activity, such as going over to a friend’s house, or participating in one. The second level is messing around, which involves a more intense and focused form of engagement with media. At this level of participation, digital learners will experiment and play through activities such as manipulating images, creating videos, or constructing video games. Horst et al. (2010) indicate that often students become experts in using programs such as Photoshop, where they become the technology expert to their family, friends, teachers, and classmates.

Geeking out, the last level of digital participation, generally includes an “intense commitment or engagement with media or technology, often with one particular media property, genre or type of technology” (Horst et al., 2010, p. 65). Often geeking out includes participation beyond the technology but through paratexts, such as fan fiction, blogs, or other affinity spaces (Gee, 2004). Geeking out also requires, at times, some level of rewriting the rules, both socially, by the affordances allowed by parents and institutions, and technologically, through “opening the black box technology” (Horst et al., 2010, p. 70).

Remixing.

Kafai and Burke (2014) suggest that creative media production is also characterized by a sense of remixing, which “is the process of creating something new from something old” (p. 74). Students who interact with Scratch rarely work from the ground up, but instead remix the code of a shared Scratch program located on the website. According to Kafai and Burke, “when young people collaborate on a programmed project, solicit feedback online, and welcome others to remix their work, sharing entails real communication, cooperation, and production, all three of which come together in the practice of remix” (p. 88). Media production has been framed through posting content, such as photos on Instagram, or revising content on collaborative websites such as Wikipedia; however, remixing media creates opportunities for what Kafai and Burke (2014) call “deep shareability,” which suggests that youth can share objects and exchange them across different kinds of devices (e.g., desktop, laptop, mobile device). This deep shareability through remixing media creates an altered sense of communication and thus can create an altered sense of how we learn.

It is through these remixing experiences that communication, and perhaps how we interact with texts, begins to shift, where we not only learn by consuming information, but also actively alter it to suit our own interests. This is an important paradox, where the work of students is no longer simply framed by their own hand, but potentially by the hand of many others whom they often don’t know. Fan fiction, Machinima videos, and affinity spaces are all forms of this revised relationship with text and how we communicate, but they also create a tension in how technology such as video game construction lives and breathes within the classroom. Traditionally, if a student handed in a piece of work that was even partially crafted by someone else, this would be cheating. However, as students remix the work of others through varying mediums, teachers will be challenged to accept this as a valid form of work and actively assess it to reflect the students' progress and skill.

Kafai and Burke (2014) suggest the following factors that support teachers in choosing technologies that can potentially meet the creative production needs of learners. In essence, the following is a checklist for their assertion that the technology should have low floors, high ceilings, and wide walls.

- Low floors: A tool needs to be intuitive enough to allow new users to acclimate to it gradually and with a degree of confidence.
- High ceilings: A tool should allow more experienced users to create increasingly complex applications that can become increasingly intricate and nuanced as their proficiency in using the tool increases.
- Wide walls: A tool must allow for a wide range of projects, let users tap into elements of personal experience and popular culture, and let them design and develop programs that are unique and represent their own interests and backgrounds. (p. 55)

This section identified some of the different ways that digital learners incorporate technology into their daily lives. Phrases such as hanging out, messing around, and geeking out illustrate the kind of creative participation that takes place between learners when immersed in a certain application of technology. Remixing is also important because it highlights the key role a community plays for digital learners as they share and build on each other's expertise. Although remixing and creative production are not necessarily new ideas in how technology is experienced, they are relatively new ideas for many classroom teachers.

Planning and writing.

This section highlights five research studies that discuss video game construction in the classroom. These studies span three decades, and although this field of research is relatively limited, these five studies are significant because they provide some strategies to how video game construction can be integrated into the classroom.

Case 1: Instructional Software Design Project.

Harel and Papert's (1990) Instructional Software Design Project (ISDP) responded to criticism surrounding the Logo program. For example, in 1984, *Psychology Today* (Hassett, 1984) reported that no significant learning benefits were experienced from using Logo in the classroom. Harel and Papert found that these critiques were generally associated with how the program was being integrated and what the students were doing with the program. Their study focused on a grade 4 class working with the Logo program for 4 hours a week over a 15-week period. Harel and Papert (1990) wanted to understand how students could use the Logo program to learn fractions, beyond using physical manipulatives to learn mathematics.

Harel and Papert (1990) concluded that the ISDP was a great success, particularly regarding the students' understanding of fractions. The researchers found that students' fraction scores went up drastically, particularly as compared to the two control groups, who either studied fractions and learned Logo, but not at the same time, or simply studied fractions. The study also provided a sense of personal expression to the students in how they understood fractions, and created deep thinking opportunities for young learners to explain their own thinking.

Case 2: Game Design Project.

Kafai (1995) created a follow-up research study to Harel and Papert's ISDP (1990) and was interested in reexamining and extending the ISDP with a greater focus on "how the designer designs as well as how the designer learns other things while designing." (p. 15). Kafai (1995) describes the game designer through the following process: "He or she starts by finding a problem, then continues with parts of the solution, tries to make sense out of it, considers how to reframe the situation, and continues with problem solving" (p. 15). Much like the ISDP, Kafai's study also explored a grade 4 class and framed the study around fractions, but also identified other subjects, such as language arts and art.

Kafai (1995) suggests that students engaged in the ISDP utilized a show-and-tell format for their instructional design. This format was heavily influenced by their own educational experiences, where "their thinking about how one ought to be taught might intersect with their own experiences of the ways they are taught in school, at home, and through other cultural media" (Kafai, 1995, p. 269). Kafai (1995) suggests that the students in the ISDP produced a relatively instructionist product while engaged and working in a constructionist learning environment. In comparison, Kafai's (1995) game design project created a more playful learning context that allowed students to have more freedom in developing their ideas of fractions through stories.

However, Kafai (1995) found that most of the games did not address students' understanding of fractions. Although Kafai found that the students were able to master their understanding of programming and express their personal fantasies and ideas, they were unable to reformulate their ideas to connect to their understanding of fractions.

Case 3: Game construction without questions.

A study conducted by Kafai, Franke, Ching, and Shih (1998) continues the conversation surrounding video game construction in the classroom. Kafai et al. (1998) responded to Kafai's 1995 research, which suggested a good process, but a weak product. They write:

> With the exception of one game designer, all students developed games with extrinsic fraction integration. Extrinsic integration describes a context in which game idea and fraction content are unrelated (e.g., the game player is shooting rockets and solving fraction problems when missing rockets), whereas intrinsic integration describes a context in which game ideas and fraction content are related (e.g., the game player has to assemble fractions of a map to progress through the game). (Kafai et al., 1998, p. 153)

Kafai et al. (1998) devised a research study with grade 5 students and preservice teachers. The researchers provided homework to both groups of participants, asking each participant to create a game about fractions. Each of the students returned with an extrinsic game, which was comprised of questions. If the player got the right answer they moved forward, but if they got the wrong answer they received some form of punishment.

In responding to these initial games created by the students, Kafai et al. (1998) asked the students to create a game about fractions without asking questions. The students found this to be extremely challenging, and they had a difficult time coming up with games that didn't centre on using 'wh' words (who, what, where, why). Kafai et al. (1998) found that the participants' difficulties and reliance on questions were directly correlated to how students had experienced instructional games in the past. Their game-construction ideas included "drill-and-practice and accumulating points" (Kafai et al., 1998, p. 177). However, when prompted, the students were able to create games without questions, and each of these games incorporated an intrinsic integration of content.

For both the teachers and the students, Kafai et al. (1998) suggest that creating a more "sophisticated game required the designer to consider alternatives for a player's thinking and tailoring the game to the player's thinking" (p. 175). Problematizing or conceptual design tools were identified as a support to help designers in creating a sophisticated game. Kafai et al. (1998) identify conceptual design tools that helped the game designers think about the process and the product. The tools focused more on understanding as compared to practicing and memorizing information. These conceptual design tools allowed both the teachers and students to access other types of knowledge, which allowed them to create different kinds of games.

Case 4: From Logo to Scratch.

Moving forward over an entire decade, the conversation regarding integrating software design and game construction into the classroom continues to surround the work of Harel and Papert (1990) and Kafai (1995),. Baytak and Land's (2011) research project extended the work in both of these research studies, which illustrates the seminal role that these two research studies have played for the video game construction community. Baytak and Land's (2011) study was composed of a group of ten grade 5 students using Scratch programming as a means to design video games to teach younger children about environmental problems. The project took place over a 21-day duration, which is shorter than both Harel and Papert's (1990) and Kafai et al.'s (1995) study.

In Baytak and Land's (2011) study, each student had to create their own game. They were provided the freedom to work collaboratively and exchange ideas with each other. As the students were building their games, they were able to ask science and technology teachers questions of clarification and support. The teachers played an important role in "prompting the students to think about new ideas or justify their ideas represented in their games. These conversations were essential for sparking reflection, which led to new actions that showed a more comprehensive representation of the problem under study" (Baytak & Land, 2011, p. 774).

Baytak and Land (2011) report that most of the students' games were "adaptations of real-world scenarios, with some unrealistic features" (p. 771). In referring back to Kafai et al.'s (1998) research regarding extrinsic and intrinsic games, the description that Baytak and Land (2011) provide is more consistent with intrinsic games (because the games explored the environmental principles the students were discussing) than extrinsic games in which questions are rarely asked.

Case 5: Writing and video games.

Robertson and Good (2005) facilitated a game construction workshop for ten secondary school students. This case is different from the other four studies because it takes place outside of school; however, it provides an important focus because the researchers pay particular attention to the planning and writing elements that took place throughout the unit. They used a program called *Neverwinter Nights*, which is a low-cost, commercially available role-playing game that allows novices to create their own games. The workshop took place over four days and included an author, a local visual artist, a professional storyteller, and an experienced amateur game designer.

The students began the process by drawing their character, describing its "motives, personalities, missions within the game, and other background information" (p. 48). The students also made wire molds of their character. The students then used a storyboard to depict each of the scenes in their game, took pictures of their character, and wrote brief captions for each photo.

Once the storyboard was complete, the students began to construct their game, with the support and guidance of other teachers and students. The students identified both character creation and land development as their favourite parts of the game design. And although the planning part of the game construction supported the students in coming to their final game, there was a mixed perspective regarding whether planning before building was the best process. Some students found the initial plot development helpful. One student reflected, “If the game is already planned out, it frees the game designer up to spend time adding extras and improving the look of the game” (Robertson & Good, 2005, p. 52). Other students felt that the planning should have evolved throughout the game construction experience. One student remarked, “Although there’s more score for ‘doing just anything’, if you stick to a plan too rigidly, you may limit your creativity by not including good ideas as they occur” (p. 53).

In a reflection of their work with *Neverwinter Nights*, Robertson and Good (2006) suggested that less-accomplished authors work best within boundaries, where they express more linear stories, while more skilled authors generally experiment with more sophisticated techniques and a more interactive narrative.

For some of the students, their game stories became more simplistic in comparison to what they had initially planned in their plot episodes. In regard to this complexity, Robertson and Good (2005) suggest that “teachers might prefer to use more traditional story planning exercises as a preparation for making the game, such as class discussions, mind maps or short written descriptions of the characters” (p. 58). Certainly these strategies might create a greater sense of familiarity for the students, in planning and writing in more traditional ways; however, this suggestion does not respond to the relative disconnect some students experienced in the planning process when their story or storyboard did not fit within the confines of the game program.

In this section, five research studies that integrated video game construction in the classroom were discussed. These studies indicate that video game construction is possible in school settings, but also that extra attention should be paid to framing games through a more intrinsic design. Intrinsic games are important because they provide opportunities for digital learners to express themselves more fully. However, intrinsic games are also more difficult for students to construct because they differ from the educational video games they have played previously in school.

Learning benefits of video game construction.

This section identifies some of the learning benefits of video game construction. Because game making has been identified as an important experience for digital learners, this section highlights why it is important for digital learners to construct video games and the kind of learning that transpires in the process of building a video game at school.

Kafai and Burke (2014) suggest that schools need to embrace the role of mediator, where reform in accepting new forms of reading and writing is inevitable in allowing the success of new media such as Scratch and Kodu into the classroom. Squire (2008) believes that in schools the focus of learning "should be less on content and more on designing experiences to stimulate new ways of thinking, acting and being in the world" (pp. 14–15). Student-based video game construction can provide learning experiences to support the digital needs of learners.

Kafai and Burke (2014) identify four reasons why children should experience game making. First, they suggest that by building a video game, children are provided the opportunity to learn how to program, which introduces the coding process, making young children more aware of how computers work. Second, building a video game makes digital technologies more accessible to females and other populations of students who are underrepresented in computer science. Third, it makes learning certain subjects, such as math, language arts, or social studies, more concrete or hands on. And finally, the experience of making a video game is an excellent learning experience, regardless of how it ties into a certain academic subject.

In addition, Salen (2007) found game making to be well suited to encourage meta-level reflection on the experience of game designers. Programs such as *Gamestar Mechanic*, for example, teach "procedural thinking, problem solving and logic by learning to program" (Salen, 2007, p. 303). Furthermore, Kafai and Ching (2001) found that designing software "fosters student experiences of science questions and ideas in a concrete computational artifact" (p. 324).

Gaydos and Squire (2012) suggest that in most school activities "one is not encouraged to express difficulty (p. 836); however, "in game-based learning spaces, acknowledging challenges can be a sign of expertise" (p. 836). Gee (2007a) argues that good games are pleasantly frustrating because they place students at "the outer edge but within their 'regime of competence'" with the result that "these challenges feel hard, but doable" (p. 36).

Beyond the cognitive benefits of student-based game construction, Salen (2007) found that student-designed games facilitate a greater degree of risk taking and learning in low-risk settings. Robertson and Good (2005) write about the positive impact student-based game design has on written literacy, in that "creating stories in a non-textual medium can act as a bridge to written literacy" (p. 44). Dickey (2006) further highlights the benefits of game design, arguing that it facilitates a positive narrative writing experience that supports reflection, evaluation, illustration, exemplification, and inquiry. This nontraditional narrative experience not only provides "insight into how and why carrying the narrative through an activity might enhance learning," but also "how narrative may be interwoven to provide motivation and cognitive scaffolding" (Dickey, 2006, p. 257). Dickey (2006) further elaborates that game design is a promising model that demonstrates how to develop an interactive learning environment.

Kafai et al. (1997) illustrate the significance of student-based game design through "a context to learn about and with technology" (p. 122). Notably, student-based game design has the potential to offer a more dynamic epistemic frame / projective stance, or an island of expertise (Shaffer, 2006) because the student is not only playing a game but developing expertise with the content, experiencing the role of game designer, and developing an understanding of the technology. Apperley and Beavis (2011) found the process of game design "allows the student to experience the negotiation between their desired performance for the game and the technical affordances available to them" (p. 138). This negotiation allows students to understand diegetic actions (performed by the hardware and software) and nondiegetic actions (outside the game world) in what they have control over and what is a controlled entity in the game world.

Cautionary notes.

The presented research about student-based game design is positive; however, some researchers are hesitant regarding the complexity and purpose game design serves to the student learner. Prensky (2008), for example, notes that game design is a difficult undertaking. He cites Will Wright, the creator of *The Sims* and *Spore*, who notes that "creating a good game is hard enough; creating one based on educational content is even harder" (p. 1009). Lim (2008) discusses the varying issues that can arise from incorporating game design into the classroom:

> For example, due to a lack of time, inflexible timetable, and a highly structured, discipline-specific curriculum of the school, a computer game may be introduced for an hour on Monday, students may be allowed to explore the features of the game for an hour on Wednesday, they may get to play the game for an hour on Friday, and they are expected to reflect and discuss about the game the following Monday. (Lim, 2008, p. 1002)

Although Lim (2008) questions whether it is indeed possible for students to construct a video game, the research community is fairly certain that students can construct a video game as a way to learn (Baytak & Land, 2011; Kafai et al., 1997; Kafai & Ching, 2001; Papert, 1980, 1991; Peppler & Kafai, 2007; Salen, 2007; Squire, 2006). The question surrounding student-based video game construction is "not whether they will be used for learning, but for whom and in what contexts" (Squire, 2006, p. 27).

This section identified the learning benefits of constructing a video game at school. In considering the participatory needs of learners, constructionist technologies such as video game construction present a response to the needs of digital learners as they facilitate opportunities to learn by doing and with the collaboration of peers. Although some research questions whether game construction is possible in the classroom, particularly regarding the relative structure situated in many classrooms, this section highlights that video game construction presents a strong, authentic learning experience for digital learners.

Summary

This literature review identified how technology is integrated and experienced by both teachers and students, and the role that video game construction plays for the digital learner. The chapter began by identifying the new trends associated with technology, including constructionist technologies such as video game construction and makerspaces. In considering the important role these constructionist technologies play for the digital learner, these technologies can also demonstrate the differences that can exist between in-school and out-of-school spaces. Often schools are defined by a high structure / low agency framework, which can make constructionist technologies difficult to integrate into the classroom.

This chapter also exemplified the challenges a teacher might face trying to integrate constructionist technologies into the classroom, where there are many impeding factors that potentially work against a teacher, including pedagogy, time, and assessment. At times a teacher may find it difficult to integrate constructionist technologies into the classroom due to factors such as technology confidence, overwhelming curricular outcomes, availability of intellectual resources surrounding video game construction, and the availability of collaborative opportunities. Although the research indicates that students can learn to use technology in a relatively independent manner, the teacher still needs to understand how the technology can fit within the curriculum and into their own practice. This section highlighted the complexities of integrating constructionist technologies into the classroom.

This chapter also highlighted the positive benefits of integrating video game construction into the classroom and the positive benefits of playing video games at school. Motivation was identified as an important factor for students playing and constructing video games at school, but there were other factors, including higher order thinking, exploring new problem-solving techniques, having the opportunity to be immersed in creative production and communication, and learning with and about technology at school. This section highlights that game construction can be a positive learning experience for digital learners, but that attention needs to be paid in how it is integrated, particularly because students will tend to construct more extrinsic, exogenous games, as compared to intrinsic games.

Certainly, researchers such as Kafai et al. (1998) and Baytak and Land (2011) begin to paint a picture of how game construction can work within a classroom, but more direction needs to be provided to teachers to ensure they understand how to respond to these complexities surrounding the internal and external barriers of technology integration.

Chapter 4: Methodology

In this chapter, I define the methodology used for this research study, which is founded on case study design. Chapter 4 is organized into six sections: (1) a personal exploration of constructionism and teaching; (2) a restatement of the research questions; (3) a definition of the case study; (4) identification of the role of the researcher; (5) the limitations and delimitations of the study; and (6) the ethical considerations. The purpose of this chapter is to clearly outline and detail the research study.

Personal Exploration of Constructionism and Teaching

The first year of teaching is an overwhelming experience. It is like selecting the expert level of a video game without having any experience playing the game. A beginning teacher enters the classroom with a limited understanding of pedagogy and content; however, they are expected to perform at an expert level. There is no sandbox for the beginning teacher, a place of inconsequential trial and error where they can hone their skills to better understand their role in school. A beginning teacher is provided only a few months of practice in their preservice education and then is recognized as a full-fledged teacher. This rapid levelling up from novice to expert would never take place in a video game.

As with many other beginning teachers, my first few years of teaching were incredibly difficult. There were epic failures and epic wins, which I remember as moments to live by, to learn by, and to grow by. These moments were also filled with questions for other teachers, particularly those who had a strong conceptual understanding of what it meant to be a teacher. When discussing matters of pedagogy or content with me, teachers would often begin with “yes, but…”: *Yes, but wait until you teach grade 6. Yes, but wait until you have a bigger class. Yes, but wait until you have a different principal. Yes, but wait until you have this student. Yes, but wait* *until you are working full time. Yes, but wait until the new curriculum comes out. Yes, but wait until you have this parent come and talk to you.* These cautionary tales were undoubtedly shared with the best intentions. Collectively, they provide insight into the stresses of being a 21st-century teacher.

The subject and object of teaching are clearly understood as separate entities for many teachers. Often the objects that encompass a traditional system, such as the structure of the day, the mode of curriculum implementation, or the use of classroom textbooks, are understood as unchanging entities. Regardless of the action of the teacher, they will remain as constant and controlling entities firmly planted in the classroom. However, constructionism clearly indicates that there is in fact no division between the subject and the object, meaning that the teacher has an interconnected relationship with objects that frame their educational practice.

For me as a constructionist, these questions of duality continue to be alarming in my own practice. I believe I have multifaceted connections with the world around me, including teacher–student, teacher–teacher, teacher–classroom milieu, teacher–community, teacher–society, and teacher–virtual world. I believe that examining the experiences of the teacher and subsequently the role of the student in game construction will highlight educational practice in a manner that aligns with the digital needs of learners. Learning does not transpire in only the abstract frame of mind, but also in the concrete, as demonstrated through epistemological pluralism (Turkle & Papert, 1990). Game construction has the potential to transform the teacher and the learner, not only through facilitating meaningful learning experiences, but also by suggesting that teachers do in fact have an active role in their own pedagogical practice.

Research Questions

Three research questions have guided this study:

(1)What pedagogical approaches may upper elementary content-area teachers use to integrate game construction into teaching and learning?

(2) How may upper elementary content-area teachers experience student-based game construction with their students?

(3) How may students experience video game construction in a content-area classroom?

Case Study Design

This research employed a qualitative case study design in which a school community and the teachers and students within the school framed the case. Merriam (1998) suggests that the difference between quantitative and qualitative research is unearthed in the interpretation of knowledge, and argues that "qualitative research can reveal how all the parts work together to form a whole" (p. 6). Dyson and Genishi (2005) remind us that qualitative research is a means of exploring the meaning people make of their lives.

For Yin (2009), a qualitative case study is an "empirical inquiry that investigates a contemporary phenomenon within its real-life context" (p. 18). Merriam (1998) sees a case study as a bounded system, or an integrated system, in which the case is a "thing, a single entity, a unit around which there are boundaries" (p. 27). The purpose of case study research, Stake (1995) contends, is "not to represent the world but to represent the case" (p. 104). This methodology plays an important role in understanding a particular phenomenon, because it "offers insights and illuminates meanings that expand the reader" (Merriam, 1998, p. 41).

This particular case study focuses on one elementary school in north-central Alberta and three content-area teachers within the school, two of whom teach grade 6 and one grade 4. Content areas were mathematics, social studies, language arts, and science. Each teacher was chosen based on their willingness to participate in the game construction project and their possession of a basic technological understanding of computers. Each teacher is a single case within the larger case study, and they are intrinsically bound (Merriam, 1998) by the school community, the game construction program, identified as Kodu, and the Alberta Program of Studies. Following Dyson and Genishi (2005), this single case study "does not aim to determine context-free association between methodological input and achievement data" (p. 11) meaning that "there is no association that teaching methods per se are causal" (p. 11). Although the results of the study will indicate one particular pedagogical phenomenon of student-based game construction, this pedagogical practice will not necessarily work in another setting. However, Dyson and Genishi (2005) emphasize that what is causal in the case study is "the human interpretations, on the basis of which people act" (p. 12).

Explanation of Kodu game program.

It is important to provide some clarity to the game construction program that was used by the students and teachers in the case study. Kodu is a relatively new real-time 3D gaming environment, which was formerly known as Boku. The game program can run on either a Windows operating system or an Xbox console. MacLaurin (2011) suggests that Kodu "seeks to lower the barrier of entry for new programmers by presenting a radically simplified programming model which nevertheless has significant expressive power" (p. 241). The program uses a graphics-based coding selection in which gamers select images from a wheel to perform certain tasks in the game. Gamers playing and building with Kodu are offered a wide range of tools to populate their world, including a "terrain editor, layout tools, character menus and other mechanisms which allow end-users to create the world data against which their code will operate" (MacLaurin, 2011, p. 241). In addition, the Kodu game lab community offers an affinity space for the game construction program in which gamers can ask questions, upload or download games, and collaborate with expert users.

To ensure that the elementary teachers in this research project had a foundational understanding of the game program, I provided a workshop that explored the basic elements of Kodu. The preestablished tutorials in Kodu, which the participants could use as a resource throughout the gaming project, provided the framework for the workshop. In addition, the teachers were provided with a tip sheet during the workshop which helped them troubleshoot any problems they experienced with the software program.

Data collection.

Dyson and Genishi (2005) suggest the researcher is to achieve analytic insight into the case that is being studied and from the perspective of the participants. Yin (2009) suggests that multiple sources of evidence are needed in the collection of data. Individual sources of evidence are not recommended, particularly because “the major strength of case study data collection is the opportunity to use many difference sources of evidence” (Yin, 2009, p. 115). These multiple sources facilitate the development of converging lines of inquiry, which is a process of triangulation.

Yin (2009) identifies six sources of evidence that are congruent with case study research: documentation, archival records, interviews, direct observations, participant observation, and physical artifacts. Each evidence source is framed through both strengths and weaknesses, and when combined, each contributes to establishing a more accurate interpretation of the research study. For this study, the data were gathered during classes that focused on the chosen game construction content area. The content area was chosen by the teacher, as were the dates and times the content was delivered. Three sources of evidence were used to frame the study: interviews, direct observations, and physical artifacts.

At the beginning of the study I met with the teachers collectively to explore some guiding questions that might help them in the game construction project. The purpose of these guiding questions was not to direct the teachers in planning or implementing the project in a certain way, but to begin a conversation surrounding the various elements that might be considered in game construction. Integrating technology into an educational setting is very challenging (Borko, Whitcomb, & Liston, 2009; Doering, Scharber, Miller, & Veletsianos, 2009; Koehler & Mishra, 2008, 2009), and the purpose of these guiding questions was to offset any anxiety that might arise throughout the game construction project. During these initial conversations, I took an impartial, unbiased stance, allowing each teacher to explore their own thoughts and ideas surrounding game construction.

The following questions were discussed as part of these initial conversations:

- What content do you think would be appropriate to implement game construction?
- What time frame are you considering?
- How do you plan on organizing the students and any support staff?
- What pedagogical approaches do you plan on using?
- What do you plan on doing while the students are participating in game construction?
- How do you plan on organizing the physical space of the classroom(s)?
- Will the students use keyboards or game controllers?
- How do you plan to assess the students' work during game construction?

In addition to conversing with the teachers, a week prior to the start of the game construction project, I introduced myself in each of the classrooms and answered any questions the students had about the forthcoming project.

The teacher for each of the three classrooms was asked to suggest six students for the study: three girls and three boys. Out of these six students, at least one student was selected who had a higher video game competency, and at least one student was selected who had a lower video game competency. Up to four students from each of the classrooms participated in the study, with at least one girl and one boy from each classroom.

Interviews.

Kahn and Cannell (1957) describe an interview as a conversation with a purpose. Interviews are one of the more common forms of data collection for case study research, and they are understood as guided conversations rather than structured queries (Yin, 2009). Yin (2009) emphasizes that an interview is a more fluid, less rigid representation of questioning, which illuminates the importance of the unstructured interview format. Fontana and Frey (2005) suggest that structured interviews provide precise data that aims to explain behaviour within preestablished categories, whereas unstructured interviews provide a greater breadth of understanding. Because this research study explored how elementary teachers experience student-based game construction with their students, it was imperative that the interviews with both the students and the teachers were unstructured. The unstructured interviews provided insight into the participants' complex behaviours, "without imposing any priori categorization that may limit the field of inquiry" (Fontana & Frey, 2005, p. 705).

Although the unstructured interview format allows a more fluid approach, it does not mean that the interview is a "spontaneous exchange of views as in everyday conversations"

(Kvale, 1996, p. 6). The open-ended nature of unstructured interviews presents both strengths and weaknesses as a form of evidence. Yin (2009) suggests that interviews can target the focus of the case study and establish an insightful perception of “causal inferences and explanations” (p. 102). However, interviews can be filled with “bias, inaccuracies due to poor recall and reflexivity as the interviewee gives exactly what the interviewer wants to hear” (Yin, 2009, p. 102).

During the game construction unit, in-depth interviews with the teachers took place on a biweekly basis at lunch time or after school. The interviews explored each teacher’s thoughts and ideas as they experienced student-based game construction in the classroom.

A total of 11 students from the three classrooms participated in at least two focused interviews. Yin (2009) recommends shorter interviews with an open-ended format to allow the exploration of “a certain set of questions derived from the case study” (p. 107). Dyson and Genishi (2005) emphasize that “quick, informal conversations right after a child finishes an activity, or in an interactional lull, can be effective because researcher and child share a common reference point” (p. 77).

Students were interviewed independently to ensure their personal opinions were presented, and the interviews took place several times during the game construction unit. These student interviews helped the researcher understand how students experienced video game construction.

Both the student and teacher interviews were recorded using a digital recording device and were subsequently transcribed. In addition, the interviews focused on asking ‘how’ questions, as compared to ‘why’ questions. Yin (2009) suggests that why questions can create “defensiveness on behalf of the informant’s part” (p. 106). This means that each interview operated on two levels, the first exploring a level of inquiry and the second putting forth nonthreatening questions.

Direct observation.

Direct observation provided another important source of evidence for this case study. Stake (1995) suggests that observations provide the researcher with a "relatively incontestable description for further analysis and ultimate reporting" (p. 62). Certainly, direct observations "cover events in real time" (Yin, 2009, p. 102), which provides a realistic outlook on the case. However, direct observation can also be time consuming and difficult without a team of observers to examine the various events that transpire in the case. With this constraint in mind, particular attention was directed toward what the teacher was doing throughout the lesson and how the students responded. Field notes were taken to document observations of both the students and teachers, with careful attention to not disrupting the flow of the lesson. The direct observations established a more precise understanding of the pedagogical approaches each teacher used to integrate game construction into the classroom. In addition, observations took into account the physical organization of the classroom, how the students were grouped, and what resources they were provided during the unit.

Physical artifacts.

Yin (2009) suggests that physical artifacts can have less relevance in most typical case studies, but when they are when relevant, the artifacts can be an important component in the overall case. Physical artifacts can be extremely "insightful into cultural features and technical operations" (Yin, 2009, p. 102), but a certain amount of bias may result from the selection of certain artifacts as compared to others. To alleviate bias associated with selectivity, this research study examined all the physical artifacts used and created by the three teachers to design, develop, and implement the student-based game construction unit. These artifacts included unit plans, lessons plans, textbooks, reference materials, quizzes, student maps, student stories, and student reflections. In addition, the 11 focal students' video games and planning materials were used as a reference point to understand how the students experienced the game construction unit and what they were able to accomplish as an end product.

Data analysis.

Dyson and Genishi (2005) suggest that a researcher's purpose is not to simply organize data but also to gain insight into the case that is being studied. The process is subsequently grounded in the data collected, through, in this study, physical artifacts, direct observations, and interviews. The overarching purpose of a qualitative case study is not to look for "singular truths nor overly neat stories," but instead to explore for patterns, "thematic threads, meaningful events and powerful factors that allow us entry into multiple realities" (Dyson & Genishi, 2005, p. 111). The repetition of patterns throughout the data is significant because it indicates that multiple people share a similar experience. Stake (1995) suggests that this consistency in patterns can be identified as correspondence, multiple occurrences of a similar event or experience.

Pattern matching is one possible method identified by Yin (2009) to strengthen the internal validity of a study when analyzing case study data. In this research study, the data were analyzed to identify themes and patterns within each case and then across cases using a method described by Miles and Huberman (2013) as three concurrent flows of activity: data reduction, data display, and conclusion drawing/verification. Data reduction is understood as the "process of selecting, focusing, simplifying, abstracting, and transforming the data that appears in written-up field notes or transcriptions" (Miles & Huberman, 1998, p. 10). This form of reduction "sharpens, sorts, focuses, discards, and organizes data in such a way that 'final' conclusions can be drawn and verified" (p. 11). Dyson and Genishi (2005) suggest both close reading and the development of analytic codes as methods to develop analytic order and, consequently, reduction in the data.

For data reduction, I began by reading and rereading the transcribed interviews to begin to understand the experiences of students and teachers and to look for common themes. From this detailed examination of the interviews, themes were constructed by the researcher. Next, the artifacts and observation notes were analyzed and coded to allow better understanding of how these data sources contributed to my understanding of game construction in the classroom.

Data display, the next major flow of Miles and Huberman's (2013) analysis, organizes information into some compressible format. Miles and Huberman (1998) suggest that "looking at displays helps us to understand what is happening and do something—either analyze further or take action based on that understanding" (p. 11). In this study, I selected the themes that would help others best understand the experiences of game construction in a classroom (See Appendix A). They were also the themes that would be most important to those acting in supporting roles (i.e., technology coach, learning coach) and mentoring (i.e., principal, faculty members).

The last analysis stage that Miles and Huberman (2013) identify is conclusion drawing and verification. In their view, "the competent researcher holds [their] conclusions lightly, maintaining openness and skepticism" (p. 13), which suggests that conclusions are only a part of the final configuration of a research study. Essentially, the conclusions are "verified as the analyst proceeds" (p. 13) through a short review of field notes and a thorough review of the data.

Stake (1995) suggests that conclusions are verified through triangulation, which not only illuminates the patterns of each separate data source, but also the patterns that were constructed across the data sources. Triangulation brings forth a deeper understanding of the data, and Stake

(1995) suggests that we “want to make extra sure that we have it right” (p. 112). Although not all data need to be cross analyzed, data that are critical to a particular assertion or a key interpretation require a more in-depth analysis and comparison to create a strong verification. Stake (1995) suggests that the researcher use various protocols to increase verification and “credence in the interpretation” (p. 112). Some of these protocols include triangulating the data, triangulating the overarching theory that supports the study, and triangulating the methodology (Stake, 1995).

In this study I verified, checked, and confirmed the themes that were constructed from the multiple data sources. Final data reduction involved selecting the themes that were consistent across the teacher and student interviews, the artifacts, and the observations. I drew conclusions by continuously referring back to the three collected sources of data. Through this iterative process, all of the data sources were triangulated to create a complete analysis. In addition, similar student-based game construction studies (Baytak & Land, 2011; Kafai, 1995; Kafai et al., 1997; Kafai & Ching, 2001; Papert & Harel, 1990; Peppler & Kafai, 2007; Salen, 2007; Squire, 2006) were used as a reference point for the analysis.

Role of the Researcher

Stake (1995) suggests that the case study researcher can carry out multiple roles, which might include the roles of teacher, advocate, evaluator, biographer, and interpreter. My own contextual experiences lend well to being both a teacher and an advocate for school-based learning experiences. Certainly my years of experience in teaching and learning in elementary and secondary classrooms has established a multifaceted interpretation. However, my own experiences needed to be closely monitored, because the research study was concerned with the experiences of upper elementary students and teachers, as compared to my own experiences with student-based game construction.

I felt as though I had to walk a cautionary line, due to my strong conceptual understanding of how student-based game construction might be experienced in a classroom. However, I was concerned not with my own reality but with the reality that was presented in the three classrooms. Thus I needed to monitor my own interpretations of gaming and game construction to ensure that the stories of each of the three teachers and eleven students were not altered by my own previous experiences and interpretations.

However, I also realize that I am irrevocably linked to this research study, and my presence shifted the balance in the classroom. Freeman and Mathison (2008) suggest that "researchers should explore their own biography" (p. 57) to understand their role in the project. Certainly my own experiences with student-based game construction played a significant role in my research biography, but other factors are also important to consider, including the researcher's age, ethnicity, gender, and disposition (Freeman & Mathison, 2008). I understand that being a middle-class Caucasian woman gives me a particular location in the dominant society that may have had an impact on my relationships with both the students and the teachers who participated in the study.

I understand that my being a woman engaged in video game research may have created confusion for some of the students and teachers due to the fact that the video game world is overwhelmingly dominated by men (Egenfeldt-Nielsen et al., 2012). The participants may have questioned the validity of my interpretation of video games or my ability to conceptualize the game world. I also realize that my own disposition of being a constructionist teacher impacts the study. In identifying my hands-on approach to teaching and learning, I chose to select direct observation as a data collection method rather than participant observation. I understood that it was very possible that I would take over the overarching gaming process if I took on a more active role in the classroom. I realized that it would be difficult to simply observe what transpired in the classroom, because I knew I might feel compelled to help support the teachers and students, particularly if something went astray with the technology. However, to reiterate, the research project was not based on my own experiences, but on the experiences of the teacher and student participants and how they constructed and integrated the gaming experience for others.

My role of being a teacher is also interconnected to the role of being an advocate. Disseminating the experiences of teachers and students engaged in game construction is a form of advocacy. Digital learners need to be provided more opportunities to construct video games (Kafai et al., 1997; Kafai & Ching, 2001; Peppler & Kafai, 2007; Salen, 2007; Squire, 2006), and this research study provides valuable data that explores how game construction was integrated into three upper elementary classrooms.

Delimitations and Limitations

This research project was delimited to a single upper elementary school in one particular school district. The study was also delimited by the teachers and students chosen to participate in the study. However, all students in the classroom participated in the learning experience; all students had the opportunity to engage in video game construction.

This study was also limited to my own ability to collect data. My skills as an observer, listener, interviewer, and interpreter were framed through my own emerging contextual experiences as a researcher. I understood that my ability to collect and analyze data had limits, and thus I also accessed the expertise of my supervisor, Dr. Jennifer Branch, to further support the research process.

Finally, the study was limited by the reliability and consistency of the technology available at the school site. The technology did not always work, which limited what teachers and students were able to accomplish throughout the project.

Ethical Considerations

I used the *Tri-Council Policy Statement: Ethical Conduct for Research with Humans* for this research study. Prior to initiating the study, I obtained approval from the University of Alberta Ethics Review Board and the University of Alberta Cooperative Activities Program (CAPS). CAPS is connected with the local school boards and assists in locating feasible and appropriate school sites for research projects. Once a feasible school site was chosen, I sought, and was granted, approval from the administration of the elementary school, the three classroom teachers, the students, and the parents of the students involved in the study. An information letter and consent form were given to the teachers and parents involved in the study which described the purpose of the study, the participants' involvement in the study, and the overarching process the study would take. The letter also assured and protected the anonymity of the school site, the teachers, and the students. The researcher considered the confidentiality of the students and teachers as an utmost priority.

Particular attention was paid to the ethical considerations of the student participants. Freeman and Mathison (2008) suggest that "ethical research with children requires that research adopts open communication with child participants and critical reflexivity toward all aspects of the research" (p. 70). It has been noted that children often feel obliged to tell certain things when in the company of an adult (Ellis, 2006). This study included only voluntary participation.

However, children perceive voluntary participation differently from adults, and "given the choice to comply or not to comply, different children will likely understand that permission differently" (Freeman & Mathison, 2008, p. 70). To provide clarity regarding the meaning of participation, the researcher clearly outlined the role the students had in the project and the purpose of the research study. The students and teachers were reminded that they had the right to withdraw from the research study at any time, and that no consequences would be held against any of the participants. No participants withdrew from this study.

Eder and Fingerson (2001) describe the valuable role reciprocity has for young participants:

> The researcher's desire to gain information from children participants without giving something in return reflects the underlying sense of the adult researcher's privilege. However by giving something in return for receiving this information, researchers can reduce the potential power inequality. (p. 185)

In the spirit of reciprocity, a party was held to thank the teachers and students for their commitment to the project. This party symbolized the end point of the research project.

Summary

This chapter outlined the methodology of this research study by explaining the design of the case study. Three teachers, eleven students and one principal framed the study, which was situated in an elementary school. Data was collected through interviews, direct observations and physical artifacts. The data was transcribed, coded and analyzed through data reduction, then further synthesized through data display and finally conclusions were drawn and verified. This chapter also identified the varying constraints and considerations that were considered throughout. Next, in Chapter 5, I outline the research context, describing the school setting and each of the participants.

Chapter 5: Research Context

This chapter provides context for the findings and discussion by describing the elementary school where the study took place and profiling the school principal, the three teachers, and the eleven students who participated in the study. This overview highlights the overarching procedure the school community used to integrate game construction into the classroom.

Research Context: The School Community

St. Luigi[1] is a Catholic public elementary school located in a large city in north-central Alberta. The school has a population of about 500 students, from kindergarten (age 5) to grade 6 (age 12). St. Luigi is part of a school district that has over 80 elementary, junior, and senior high schools. The school opened more than 10 years ago. The district identifies St. Luigi as a community school which all Catholic children in the catchment area are welcome to attend. In addition, many non-Catholic children also attend the school. All students at St. Luigi receive a Catholic-based education.

St. Luigi's catchment area includes six communities, two of which are still under initial development. A total of 15,377 residents live in the four communities that feed into St. Luigi School. Almost 5,000 of those residents selected a Catholic school as their desired school. For over 1,800 residents, English is their first and only language. The other two dominant languages that are also spoken at home are Cantonese, with 438 residents speaking this language at home, and Arabic, with 260 residents.

A large majority of the 15,377 residents living in St. Luigi's catchment area are Canadian citizens. Over 7,000 of the residents are employed with either part-time or full-time employment,

[1] The name of the school has been changed to protect confidentiality.

and 278 of the residents are unemployed. This statistic suggests that most of the working-age residents are employed. In addition, St. Luigi's catchment area includes 700 preschool-aged children and 1,286 students who are in kindergarten to grade 6.

The school community boasts a strong music program, with a school choir, a handbell choir, a recorder/Orff ensemble, and annual concerts. Each morning the school offers a live broadcast led by student broadcasters. The daily broadcast highlights school events, the daily prayer, and school birthdays. St. Luigi also offers after-school clubs, including volleyball, floor hockey, and the recently introduced MinecraftEdu.

A few years ago, St. Luigi also offered a robotics club that was initially staffed with a full-time teacher who facilitated a LEGO robotics experience for each class. The school was also represented by a team of students at the city-wide annual First LEGO League (FLL). However, the robotics club is no longer offered at the school.

The community that surrounds St. Luigi is relatively new, with many of the homes built about ten years ago. Growth continues to take place in the school catchment area as new families move in. Although St. Luigi is not at capacity, it has large classes. There are at least two and often three classes for each grade, allowing teachers to support each other as grade partners in planning and curricular development. The classes generally range from 25 to 30 students, with generally smaller classes in grades 1 to 3 and larger ones in grades 4 to 6. Many of the teachers have taught at the school since it opened, and many of their children are students at the school.

The overall structure of the school is centred around the school library. It is based on an open-concept plan, and many of the classrooms (excluding the portable classrooms) face the library. Staff and students generally walk through the library to get to another classroom. The students have scheduled time in the library to take out books and read them. There is a full-time educational assistant who runs and operates the library.

Each classroom is equipped with a Smart Board and a teacher computer, and each of the grades 4 to 6 classes have three new Microsoft Surface computers. The kindergarten to grade 3 classes have access to iPads in their classrooms. There are cubbies located throughout the school. Each cubby has two desktop computers, and students are often found working on projects collaboratively. These cubbies are also found in the hallway leading through the module classrooms. The school is equipped with one computer lab with about 35 desktop computers. The lab is connected to the library, thus it is also an open space that is visible at all times. The school has a laptop cart with 20 computers that can be signed out through an online booking system. Each class is assigned a time for the computer lab, with a few open spaces for flexible use. Finally, the school is equipped with wireless Internet that allows the students to use the laptops and iPads throughout the school.

The two grade 6 classes are situated at the end of the modular classrooms, and they face each other. The three grade 4 classes are located in the core of the school, each facing the library, and they are together in a row.

The school has a very diverse population, with many second and third generation Canadians. Many of the children are of Italian, Lebanese, Filipino, and African descent; however, there are many other cultures represented in the school community.

There is no school on Thursday afternoons, which provides time for teacher professional development. The teachers meet as a group, often led by the principal and assistant principal, to work in their collective grade groups or participate in district-provided professional development. The school also has a learning coach and a technology coach, which is consistent with every school in the district. The learning coach's role is to assist in the planning and development of inclusive education throughout the school. This learning coach supports the development and implementation of individual program plans (IPPs) and supports any planning the teachers and educational assistants require. This is often a full-time teacher position; however, the learning coach at St. Luigi School also teaches a few other subjects. The school has two technology coaches. Each has 0.1 FTE (one half day) to work with teachers and staff to integrate technology in the school. In addition, the school also has a technician who comes into the school once a week for an entire day. The technician supports the technical aspects of the hardware and software offered throughout the school. The technician and the technology coach generally work together to ensure that all technology is working smoothly.

The school district is working through a district-wide initiative called Transform. The principal of each school is required to follow and implement this initiative and support their staff to make these transformative shifts. Transformation includes a move from teacher-centred to student-centred pedagogy. Money has been allocated to each school to provide extra time and support for teachers to make these shifts in their practice. District-wide professional development is also centred on this initiative.

Principal Profile

Natalia is the third principal to work at this school. She began as a high school language teacher and has also worked in junior high settings teaching French as a second language. This is her second year at the school and she feels she needs to continue to make changes to ensure the needs of the students are met. Natalia suggests that the competencies of the teachers vary within the school, saying, "You have some very strong teachers who really want to do nice things and advance professionally and some that basically don't even understand the curriculum."

Natalia reports that the parent community is very supportive, although parents will question what is taking place in the building. Natalia believes that this is because she is transparent in her policies and how she runs the school. This transparency is also found in her relationship with the staff, whom she leads with an honest and direct focus. The parent community trusts Natalia's leadership and the kind of learning that takes place in the classroom. This trusting relationship was apparent during the research project: none of the parents expressed concern about the video game construction project or students playing video games at school.

Natalia suggests that the children in the school are "good and well behaved." She has placed a greater emphasis on testing children who are struggling in school to create more comprehensive understanding of these students, which she notes was not done as actively in previous years.

Natalia also suggests that while the school has access to a lot of resources, they are not being used properly, or they are sometimes not even known about. She says, "Our school has a lot of books that haven't been utilized at all. We try to change the book room and we find tons of books that haven't been in the hands of children. So come on people. What you want?"

In regards to her own vision for the school, she suggests that one of her strengths is assessing a situation or problem and finding a way to come to a solution. She refers back to the lack of comprehensive testing conducted on students as one area that she has been able to successfully address. While she believes that "literacy and numeracy are important," she also emphasizes the importance of bringing "a sparkle" into children's lives.

This year, for example, Natalia has created a new initiative in which the teachers of each grade grouping must hand in a weekly lesson plan that identifies the overarching activities that will transpire in the class and how they connect to the curriculum. She felt that many of her teachers were not addressing the curriculum. She stated that "some teachers do not follow the curriculum; they do not deliver the same program from one class to the other, and if I offer them common planning, they should have something in place." Natalia provides one 30-minute collaborative planning time each week so that each collaborative grade group can complete this weekly lesson plan.

Natalia understands that by undertaking such initiatives and changes within her school she will see changes that will make a difference in the success of children. She asserts, "I won't succeed 100 percent, but if I move them forward, and already within a year I've seen differences in my building. I will continue. I will continue, but I will open it up." In regards to the above-mentioned initiative and other changes she has made, Natalia notes that many of her teachers have been upset about her vision for the school, which has sometimes required moving a teacher to a different grade. She had to phone the Alberta Teacher's Association to ensure she was following policy, because many of the teachers were so upset. She states, "I did have a lot of resistance and I do know that I'm not very popular." However, she recognizes that

> in order to break a culture like this, you need a couple of years and you need to do drastic things and definitely a principal is not going to … how can I say… It can go either way. Like they can hate you or accept or they can even destroy you. So I am walking a fine line.

Natalia highlights her own vision of technology as being a "tool to facilitate the curriculum." She notes that "last year I was observing, it seems that a lot of people here understand technology and embrace technology, some in different ways, but there's a lot of people who can really help." Since taking on the principal role, she has slowly replaced and added new technologies, such as the Surface laptops and iPads. She also added more technology coach time, to encourage specific connections between the technology coach and teachers.

Natalia references the LEGO robotics club that was offered in the school over the past few years and suggests how technology should be integrated into the classroom.

> The robotics club was something I inherited and it was wonderful to have, but to allot one full-time teacher to do robotics, it's ridiculous when it doesn't support inclusiveness. I don't know how they had it in their mind and I'm not saying no. Heather was leading the whole experience for three years, so the staff should be very aware how to use this technology. Yes, grade 4 curriculum is a good connection, so it is grade 4 where they build bridges. There's a lot of things to do. But if you have something you're building, and it wasn't big, why do you continue? Like do I have to micromanage that? That's how I see it. I do believe that they (the teachers) should use the resources.

Natalia questions why the robotics program is not self-sustaining at this point. She believes that the teachers should be able to integrate robotics in their classroom after three years of support, particularly given that there are 24 robotics kits in the school for the students to access and use, both independently and in a collaborative setting. Natalia notes that perhaps the teachers became too reliant on Heather's expertise.

Natalia expressed a lot of interest in the game construction unit and was excited that it connected with the Transform initiative. She said:

> I want to see how the kids feel … like the process, okay … how they felt every day and what they learned, but I want to hear from them personally. I would like

also to hear [what the parents] … like some of it, okay … if it did help, and definitely how the teachers feel after it's done.

A principal has an important role in supporting the growth and development of the students and teachers, and has a considerable amount of influence on how learning is experienced within the school. This influence can be seen at St. Luigi school, where Natalia's vision and her work as the principal has impacted how both the students and teachers experience learning.

Teacher Profiles

Patrick.

Patrick has been a teacher with the same school district for over 17 years and has taught grade 6 for the majority of his career. Patrick has taught in a few different schools, and was one of the teachers who opened St. Luigi School. He left St. Luigi for a few years, but returned four years ago. Patrick notes that when he opened the school, there weren't enough classrooms for all the students, thus he taught in the school's small conference room. He had over 30 students in a room that was intended for small-group meetings. He notes that in order to get from one side of the room to the other, he had to exit one of the doors, walk around the staff room and enter the door on the other side. Patrick was one of the few male teachers in the school when it first opened. His own grade 6 class this year has 30 students: 17 boys and 13 girls.

Patrick is most comfortable teaching math and science, but as an elementary teacher he has learned to collaborate with other teachers to ensure he is successful in all content areas. During class time, Patrick has the students move around on a regular basis. When he is teaching to the entire class, he has the students move from their tables and sit in front of the Smart Board, either on a wood log or on the carpet. Patrick likes to have the students close by when he is teaching to ensure they are focused. At other times the students work at tables, with four or five students per table. At the centre of each table is a basket that includes items such as pencils, calculators, erasers, and a “think pad,” which is a small workbook in which the students write ideas or solve problems. Patrick emphasizes that the think pad is not intended for assessment, but is simply a place for thinking.

Patrick also readily uses a virtual classroom website, where he uploads homework assignments, extra links for resources, math games, and upcoming events. He encourages both students and parents to use this website to stay connected with what is taking place in the class.

Patrick uses his bulletin boards to display collaborative projects, art assignments, and motivational posters. The collaborative projects are large pieces of poster paper, in which each student gets a different coloured marker and records their ideas on a certain topic. Patrick notes that he received this idea at a previous school that used the International Baccalaureate curriculum. Patrick often uses these poster boards to assess the students, as each student has a particular marker colour.

While the students are working on independent and group projects, Patrick often walks around the classroom asking questions or prompting the students. He has an array of interesting and fun ways to address the students. For example, he says, “Houston,” and the students respond, “we have a problem.” He asks the students to show him “moose symbols” to demonstrate they are listening by putting their hands on their head, and he also asks the students to raise their fingers to demonstrate their level of understanding. Three fingers means they are a Jedi master, two means they understand, one finger means they are not very confident, and no fingers means they don’t understand. Patrick suggests that the students feel comfortable and with this mode of response and answer honestly. For Patrick, it is quick way to survey the students’ understanding.

Patrick sponsors two after-school clubs at the school. The first is a volleyball club for grade 5 and 6 students, where the students learn the basics of how to play, which leads to a volleyball tournament hosted by a local junior high school. The second club, which is new this year, centres on building with MinecraftEdu for grades 4 to 6 students.

Patrick enjoys using technology in both his professional practice and his personal life. He notes that he has a MacBook Pro at home that he uses to create the grade 6 farewell video. He also notes that he has "iPads in the house that my family use all the time, but we try to really make sure that my children are limited on that, so they go outside and play." Patrick notes that he is more of a functional user: "Like on my phone I don't have Twitter, I don't have email. It's a conscious choice not to have any email on my phone." Patrick uses technology in his daily practice, but the tools need to fit his lifestyle, and tools such as Twitter don't fit.

Patrick notes that he is online for a considerable part of his day, using his iPad or computer in a ubiquitous manner. He accesses the Internet to search real estate, seek information, look for educational resources, and update his virtual classroom. He notes that he is likely on the computer for at least a couple of hours each day.

Patrick reflected back on his childhood, when many of the predominant game systems were not readily available, and remarked, "I didn't grow up with a game system at home and even when I did it was just like *Nintendo* and *Super Mario*." He stated that he likes

> driving games, because I enjoy the whole driving challenge, or logic puzzles, stuff like that, cause I like there to be something to figure out. I'm not a big fan of sports games and the war games and stuff, because I don't see much point to it. I'm not any good at it. I haven't mastered the controls, the up, down, left, right

sideways. So the games I tend to play are flow and puzzle games and stuff where there's logic to it, there's something for you to figure out and do that.

Patrick is hesitant to identify himself as a gamer; however, from his dialogue it seems as though games play an important part in his life, and other teachers identify him as a gamer.

Finally, because Patrick has shown a leadership role regarding the use of technology, he has become one of the technology coaches for the school, along with Heather. He has 0.1 FTE (one half day) to work with the grade 6, grade 4, and grade 3 classes in locating and supporting meaningful and appropriate ways to integrate technology into the classroom.

Heather.

Heather started her teaching practice in 1994 at a First Nations reserve in north-central Alberta; she worked as a special education teacher for a grade 1 to 4 class in her first year of teaching. She had two educational assistants to support her in the classroom. She worked with this school district for five years, making the two-hour commute to this community each day. She notes that her first few years of teaching were the hardest of her career.

After five years, Heather decided to work in the city and had to begin as a replacement teacher due to the limited number of teaching positions available. However, after some time she received a job as a special education teacher for a grade 4/5 class. From this experience, Heather transitioned to being a kindergarten teacher for four years. It was an extended-experience class, where the students remained at school for the entire day.

Heather then transitioned to St. Luigi Elementary School and was hired as one of the lead teachers. She taught grade 2 for several years, which also included her two maternity leaves. She also worked in various roles, including being the language literacy intervention teacher for primary students, the enrichment teacher, and the robotics teacher. The school purchased 24

LEGO Mindstorm kits, and Heather became the facilitator of the robotics club. Heather specifically commented on the three years she spent as the robotics teacher:

> They just backed me up really well the first three years. That was it. I did it in sort of sections for grades. So, grade 2 I would work for the first two months. So, I would focus on that, so that we do two or three hours a week. That was a lot of their time, but we built it, building like a game, so we did on magnets. We did an island, Treasure Island, and they built robots to seek treasure made of certain metals, such as cobalt and nickel.
>
> I think having that and it's so 'hands on' Some kids who are not verbal at all and wouldn't participate, you just saw them all on that robot and could figure it out. They could program it. They could make it move and you're like, wow, how did you do that? It was amazing. And it was always the boys, which was interesting. A lot of the boys, a lot of English language learner boys, found it was very neat.

Currently, Heather is working as a grade 4 teacher with 26 students: 13 girls and 13 boys. Her classroom is comprised of tables with a bin on top of each table to store pencils and other student tools. The students also have bins around the class where they store their Duo-Tangs for each of the curricular subjects. In one corner of the classroom, she has a reading area where the students often gather around to participate in class discussions. Heather also uses chart paper in this reading corner to write down important information, and posts the paper around the class. Student work also decorates the walls of her classroom in the form of artwork and health lessons. She has implemented an incentive method to keep the classroom organized, where points are assigned to the most organized table at the end of each day.

Heather also uses her Smart Board to play videos, display her virtual classroom (a password-protected website for her students and their parents that shares resources, homework, and important dates), and write the daily message. Her classroom is directly across from the computer lab.

Heather is shares the position of technology coach with Patrick. Generally, most schools in the district have only one technology coach, with the district providing funding for 0.1 FTE; however, St. Luigi School has allocated an additional 0.1 FTE. Heather remarked that it is funny that she is the technology coach at St. Luigi School:

> You would think, 'Oh, she's very techy,' but really the only thing I have at my house is a laptop and my iPad, which is a school iPad. And my cell phone is just a phone, just a flip phone. It's just a phone. I don't have cable, like it's just very basic.

Although Heather doesn't use technology as pervasively in her daily life, her previous experiences with robotics and integrating technology into her classroom provide a foundation in understanding how video game construction could be integrated in the class.

As a technology coach, Heather works with the kindergarten, grade 1, grade 3, and grade 4 classes, while Patrick takes the other classes. Heather is given about one morning a week to work with these teachers and classes. She notes:

> I am willing to do whatever. You can give them options when they're ready. I know they are still trying to figure out their kids, but that's what I presented to them, and I have a collaboration site I made a few years ago as a learning coach for everyone to access, where I've given them—if they want apps, there's a whole

list of great apps for certain kinds of things. There's great websites. It's there for them to have access to, so that's another way to check out what's there.

Angela.

Angela has taught for numerous years and has spent time as a grade 5 teacher and as a Reading Recovery site literacy coordinator at other schools. This latter position often supports young children by providing additional support in the areas of reading and writing to ensure they are prepared for future grades. With this knowledge of supporting students to learn how to read and write, Angela feels that her strengths as a grade 6 teacher also lie in strengthening students' literacy skills; however, because this is her first year teaching grade 6, she feels she has a lot to learn, particularly regarding the Alberta Program of Studies.

Angela has 17 boys and 12 girls in her grade 6 class. Her classroom is very organized. Her students work at tables in groups of four or five, and in the middle of each table is a basket that contains pencils, pens, and varying resources for the students to work on. The students keep their resources on shelves at the back of the classroom. Student art and science projects decorate the bulletin boards. Angela teaches each of the subjects, including French as a second language, to her class. She likes to keep on schedule and she writes the daily schedule and any reminders to the students on the board.

Angela considers technology to play an important role in her classroom, and would like to learn more about technology in the future. She comments, "I want to do more with technology because it really engages, I find it really engages the kids." She uses a variety of technologies in her classroom, including the Smart Board, and she uses the Smart Notebook to project and write notes and ideas on the board. She also has a virtual classroom and uses this tool to communicate with the parents, highlight important dates, and share homework assignments. Angela also uses an assessment tool to organize her assignments and tests.

Angela suggests that she is "not a video game person at all": "I play *Wii* with my daughter. We'll play *Wipeout* or *Wii Sports*; however, I don't know, so I'm coordinating doing all these things so I don't even know how to do this." Although both of Angela's children play video games, she doesn't consider herself a gamer. In addition, she believes that her grade 6 son plays too many video games: "I am way not happy. Just because he would spend his whole day on it, my daughter doesn't spend as much time on it." Angela is continually trying to find a balance in the amount of time her son should be allowed to play video games, particularly because he finds that time goes by so quickly when he is playing. Angela notes, "I'll say, okay, your hour is up. But my son will say, 'that was only five minutes.' So he's losing track of time."

Although Angela understands the value of technology in her classroom, she is also wary about its role, particularly given her concerns about the amount of time her own son plays video games. She said, "I'm finding, yes, that technology's great for certain things, but I think somehow gaming has kind of overtaken the whole aspect of it." Angela is also cautious about video games and the potential role they play for her own students, because she finds some of the games too violent. She stated:

> You know, it's interesting because I think they have, like they play all these violent games. And I think that's what kind of story, even in their story writing, and I said, no violence. There's no killing, no war, we have enough in this world. Well, I don't need to read it.

Angela is cautious about the use of video games in her classroom, and is not entirely comfortable with the role they will serve for her students.

Student Profiles

Grade 6: Patrick's class.

Stella.

Stella is a grade 6 student who is very social and enjoys working collaboratively with other students. In fact she prefers to work in a group, because she feels that she can be more successful when she is sharing ideas and talking with others while she is working. Stella enjoys art class; however, she notes that she is not very good at it, saying, "I sometimes get frustrated because it is not working because I'm not very good at it. I'm not artistic or anything, but I still like being relaxed, painting or colouring or whatever you like." She also enjoys math class because of the problem-solving questions and because it makes her "brain work hard."

Stella prefers to use technology when given the choice, particularly regarding any writing task. She says, "I feel like I don't really like writing things down. I would rather type things out or do a presentation or something or speak instead of writing everything down." The framework that is presented through a traditional writing task is not as appealing for Stella as compared to a project that incorporates technology, including constructing a video game. She also suggests that she rarely becomes frustrated when using technology:

> If I don't know how to do something I usually just look it up on YouTube or something. How to do this—usually just watch a video or going to the website so if I'm doing a presentation and I don't know how to do something then I just Google it and usually find it.

Stella's confidence with technology allows her to use it easily in her daily life.

Stella spends most of her time outside of school taking dance lessons and hanging out with friends. Stella also likes to play video games, often with her older brother. Her favourite video games are Mario games (Mario Kart, Super Mario 3D World) because they make her feel like a young child again and she prefers these kinds of games to games such as Call of Duty, a game her brother often plays. While playing Mario games, Stella likes to be able to "joke around and see how the characters look as they often look really funny." Although Stella plays video games, it is on a more casual basis and she suggests that she can survive without having access to video games.

Aiden.

Aiden enjoys learning about history and sharing his knowledge of historical events with his classmates. He also self-identifies as being a gamer and spends about one hour a day and 16 hours on the weekend playing video games. He plays games such as FIFA, NHL, and Call of Duty. His dad is also a gamer and they play video games together, but his dad also plays video games independently of Aiden on his own game console. Aiden also likes to play Minecraft on his Play Station 3, saying, "I am very creative and I like the construction part of Minecraft." Aiden also likes to plays the video games that are offered at school, including the games on Poptropica; however, he finds them hard to win. He notes, "You have to race and my friend would always beat me because he would get all the questions right really fast for you to win. So my friend always won because he's really good at math."

Aiden understands that the video games he plays at school are different from the games he plays at home. He explains, "Well, the math games are more like using your brain, and then the games at home are more like strategizing something." Aiden feels more successful when he plays games such as Minecraft and NHL as compared to educational math games. He equates these struggles with the fact that school can be challenging, particularly in the areas of math and language arts. Aiden suggests that in language arts it is really difficult to generate ideas in order to begin the writing process and to represent what he visualizes in his head.

For Aiden, his success with playing video games connects to his preference for concrete learning experiences, whereas he feels most successful when he can develop ideas through hands-on, learning-by-doing experiences. Aiden was particularly excited about the video game construction unit, not only because it connected with his passion for playing video games, but also because it was an alternate way for him to represent his ideas.

John.

John enjoys school and is a natural leader in the classroom, particularly regarding his work in the game construction unit. The students often sought John's expertise regarding game design and problem solving, and game construction seemed to be a natural process for John. One of John's favourite subjects is science, particularly because he enjoys doing science experiments, testing things, and engaging in hands-on, learning-by-doing experiences. John enjoys opportunities at school where he can apply his learning through concrete applications.

John was a member of the St. Luigi robotics club and competed at the First LEGO League in the city. He notes that the competition was exciting, but also extremely challenging, particularly when their robot was not successful in the competition. His strategy in working with his robot was a trial-and-error approach; he would make slow changes until he was satisfied with how his robot was working.

John notes that some of the video games that are played at school are enjoyable, particularly the games they have played in math class. However, he thought that the video games they had played in French class were not as fun because "it's just really word talking and I'm really more interesting in making video games." John has a strong understanding of how to build a video game and what makes a video game 'good.' This understanding is likely drawn from his experiences at a university-run summer camp that explored video game design. Although John enjoys playing video games, particularly NHL games, he doesn't have a lot of free time because he plays on a hockey team. He usually plays video games on the weekend, when he has time.

Grade 6: Angela's class.

Clara.

Clara is an avid reader and is interested in reading the Poison Apple and Rotten Apple books. She also enjoys writing. She notes that she "has so many ideas running through my head, like every day I sort of have an new story in my head." She also enjoys playing and building in Minecraft, where she can play for hours or the whole weekend and "time goes by really quickly when I play, so I have no idea what time it is." Clara outlined her process when building in Minecraft:

> The first thing I do when I get in a world is build a house with my personality. Like I build it with random colours, and then I usually like to start from the beginning, so I'd go into survival mode so I'd have to build … like find some stuff, and usually I like taming and riding around with the horses.

Clara suggests that she finds most of her information about Minecraft online by watching YouTube videos.

Clara often plays collaboratively with others in building in Minecraft or playing other video games, particularly with her younger brother. She also enjoys playing racing games, because it is "fun to feel the rush and control of the car." Clara suggests that she likes playing video games because "you get to use parts of your brain that you didn't know you had."

Clara also enjoys using technology at school, particularly because it makes school more interesting. She explains:

> If it's just like paper and pencil activities it is sort of gets boring after a while and plus a computer, you get to make things, like you can change the font of stuff, upload pictures and play some educational video games that don't seem like school games. One is called Hooda Math (http://www.hoodamath.com).

It seems as though Clara has a refined understanding of video games and prefers technologies that allow her some form of autonomy. Her interest in Minecraft and building in the creative mode strongly represents this.

Beth.

Beth is the eldest of three sisters who all attend the same elementary school. She enjoys playing baseball with her family, and they play throughout the year. Beth identifies herself as being shy, but she feels she can express herself more fully at home. She doesn't like to raise her hand in class or do presentations at the front of the class. However, she does well in school and enjoys completing projects and using technology during class time.

Beth says she has played both boring and fun video games at school. She identifies a fun game as having an unexpected twist that keeps the game motivating and engaging, whereas a boring game simply asks questions and there is no challenge. Beth plays Minecraft at home; however, she sometimes finds it boring because it is the same thing over and over again. At the moment she is playing Doll House on her iPad, a game that allows her to customize and design her own house. She notes that she plays either of these games after school for about an hour and maybe a bit more on the weekend.

Robert.

Robert enjoys outdoor sports such as hockey and snowmobiling. He also identifies himself as a gamer, and his favourite video games are Call of Duty and NHL 15. He personally likes NHL 15 because it gives him the opportunity to play against the computer, which is "harder than just playing against a person. You actually have to like work and think how to score." Robert plays video games for about four hours a week, sometimes by himself and other times with his dad and his sister. Robert also emphasized that he likes building in Kodu.

Robert identified his preference for hands-on learning experiences. He enjoys subjects that provide him with opportunities to build, such as art and science. Robert does not feel very successful in language arts, particularly with story writing, because he simply doesn't know where to put the details or the overall form of a story. Robert enjoys using technology in class. He particularly enjoyed a health project he did a few years ago where he built a mind map using an online computer program. However, Robert notes that not all technology located in the classroom is useful. He asserted that the "Smart Board is not very smart—it doesn't really work very well—like whenever you press something it like presses the wrong button—like when you write on the board—it goes all over the place."

Samantha.

Samantha is involved on a competitive cheerleading team. She also enjoys playing video games, such as Fast and Furious 6 and Ice Cream Jump, a game "where they have a scoop of ice cream and you're up in the clouds, make platforms they have to land on. And there's like bees, if they sting you, you die." Samantha plays around three hours a week, and generally only plays when she has free time.

Samantha's favourite subjects include art, gym, and science. She is not crazy about math, particularly because many of the educational games her teacher posts are boring because they simply don't have big problems in them. As a student she prefers to work by herself, because she finds that working with a partner can be a big distraction. Samantha prefers to work through projects and she mentioned that one of her favourite projects took place a few years ago when she had the opportunity to make a huge poster about her understanding of trees. She also received a great mark for that project.

Grade 4: Heather's class.

Meghan.

Meghan takes Italian dance lessons and is a member of a curling team. Both she and her older brothers participate on a curling team on the weekends. Meghan is an organized, academically strong student who likes to use technology, but only when she sees a purpose to it. She was excited about a recent research project she completed with her group about recycling, where they made a PowerPoint about their ideas. Meghan suggested that this was one of her favourite uses of technology that she has done thus far in her schooling.

Meghan enjoys playing video games, particularly a Flintstones game on her iPad. She explained: "It starts off with a small house and then you just add things into it and you build it. And then if you reach a new level, then you get new things." Although Meghan enjoys playing this video game for perhaps an hour a week, she suggests that she would much rather go outside and play or do other activities outside. Meghan does not consider herself to be a gamer.

Ellen.

Ellen is a very organized student and a natural leader in her group. She takes many different dance lessons, including ballet, jazz, and lyrical dance, and would like to take more classes in the future because she enjoys dancing. Ellen likes to play on her iPad at home and she has different games on her iPad, but doesn't really like to play video games in class. However, she does like to build iMovies on her iPad. Ellen also likes to use the laptops that are found in the classroom to do school research and gather information. She also enjoyed building a Prezi presentation at school, prior to the 13 years rule change, when the school district identified and enforced the rule that children under 13 are not allowed to use this tool.

Although Ellen does not enjoy playing video games, she does enjoy building them. This enjoyment connects to her interest in building videos and presentations: she enjoys the constructionist aspect of technology. About her use of Kodu, Ellen says, "The game was lots of fun but my favourite part was to build our land and try to make my game as fun as I can. The great thing about Kodu is that you can get him to do almost everything."

Caleb.

Caleb is a bright and creative student who is a natural leader in his class. He loves to play sports and is really into football at the moment. He also enjoys playing soccer. Because of his interest in sports, he likes to play video games such as Madden or NHL 14 or 15. Caleb is also interested in playing Minecraft on his computer and on the Xbox. He enjoys playing Minecraft because it is an "open world game, and you can build whatever you like, and then you can survive and stuff." Caleb enjoys playing in both creative and survival modes.

Caleb plays video games for about four to five hours a week, usually only on the weekends. To learn more about games such as Minecraft, Caleb will watch tutorials on YouTube. He also likes to watch football videos on YouTube. Watching videos seems to be one way that Caleb is able to learn more about things that are interesting to him. Caleb said that playing and building with Kodu has been one of his favourite activities that he has done in school thus far. Although he enjoyed building in Kodu, if he were given a choice, he would choose Minecraft over building in Kodu. He explains:

> Although I liked Kodu, I like Minecraft more because there are endless possibilities in Minecraft and in Kodu there is not. Also in Minecraft you can join peoples and in Kodu it is not that easy to do this. I would like to do Kodu again, but I would like to do Minecraft EDU more. I know I am practically burying Kodu over Minecraft, but I simply like Minecraft more (sorry to all you Kodu fans).

Colin.

Colin enjoys school and likes being a student. He enjoys building with LEGO, and he particularly enjoys when he gets a new set of LEGO and has the chance to build it. Colin notes that once he has built the LEGO creation, he won't take it apart. In addition to playing with LEGO, Colin also likes to play soccer and was interested in joining the robotics club at St. Luigi school. However, because the club is no longer running and it was only for students in grades 4 to 6, he never had the opportunity to participate in the club. Colin also plays games on his iPad and on his Playstation 4. One of the games he plays is called Road Block, where you have to get through different states into order to move. However, Colin suggests that he really is not a huge gamer.

Colin mainly uses technology at school, and his favourite project has been building in Kodu, which is "a game like Minecraft but much better in many ways. Instead of having to use blocks all you have to do is click and drag your mouse to create land. Mountains are much easier to make. Instead of just having to click a trillion times, you can just hold down a button."

Although Colin self-identifies as not being a gamer, he was able to enjoy the process of gaming, even though he experienced moments of frustration.

Summary

This chapter identified each of the participants in the study and their identifying characteristics. These descriptions will help support the findings and the discussion by allowing understanding of the decisions and choices made by each of the participants in their experiences of video game construction in the classroom. For a quick reference to each of the students, teachers, and principal, please use the "Quick Participant Reference" in Appendix B.

Chapter 6: Findings

This study seeks to understand how teachers and students may experience video game construction in the classroom. This section presents findings using the three research questions as an overarching framework and uses observations, representative quotes, and artifacts to present the themes that were constructed from the data analysis.

Question 1: What may video game construction look like in an elementary classroom?

In response to question 1, this section details the lessons that took place in both the grade 4 and grade 6 classes. The first section identifies the 27 lessons that took place in the two grade 6 classes, while the second section identifies the 14 lessons that took place in the grade 4 class. Each section is introduced with a chart (Tables 2 and 4) that briefly highlights the events that took place in each lesson, while each lesson is subsequently described in detail. Student and teacher artifacts are included throughout to further detail what game construction looks like in these upper elementary classrooms.

Table 2. Grade 6 Lesson Descriptions

Grade 6 Lessons	**Brief Description of Lesson**
Lesson 1	Kodu was introduced to the students.
Lesson 2	The teachers introduced a planning tool entitled "Somebody, Somewhere, Wanted, But, So, Then" to the students.
Lesson 3	The students practiced using the planning tool.
Lesson 4	The students and teachers discussed the characteristics of a good video game.
Lesson 5	The students played video games to determine whether they followed the characteristics of a good video game.
Lesson 6	The students reflected on the games they had played in class.
Lesson 7	The teachers reviewed the reflections and assessed them using a rubric.
Lesson 8	The students and teachers discussed the differences between a

	video game story and a traditional story.
Lesson 9	The students reflected on the factors that constitute a good video game.
Lesson 10	The teachers presented a video game story exemplar.
Lesson 11	The students used the "Somebody, Somewhere, Wanted, But, So, Then" planning tool to retell the game story exemplar.
Lesson 12	The students highlighted the parts of the game story that would likely be included in a video game.
Lesson 13	Each student planned their game story by using the "Somebody, Somewhere, Wanted, But, So, Then" planning tool.
Lesson 14	The students developed their math questions.
Lesson 15	The teachers met with each of the students to discuss their game story plans.
Lesson 16	The students wrote their game story. Some students chose to work collaboratively with a partner, thus they had to amalgamate their stories.
Lesson 17	The students highlighted the parts of their story they believed would be included in their video game.
Lesson 18	The teachers assessed the students' video games using a rubric.
Lesson 19	The students who completed their games early created a list of events that would take place in their game.
Lesson 20	The students developed a map that was a visual representation of their video game.
Lesson 21	The teachers introduced the tech ninja program to the students.
Lesson 22	The students built their video game using Kodu Game Lab. Each student was required to have their landform completed by the end of the class.
Lesson 23	The students completed their video game and provided feedback to other students' video games.
Lesson 24	The students were provided an afternoon to play each other's games.
Lesson 25	The students designed a marketing tool to promote their video game.
Lesson 26	The students showcased their video games at the school's demonstration of learning.
Lesson 27	A curricular guide is created to demonstrate the connections made to mathematics, language arts, and health.

Grade 6.

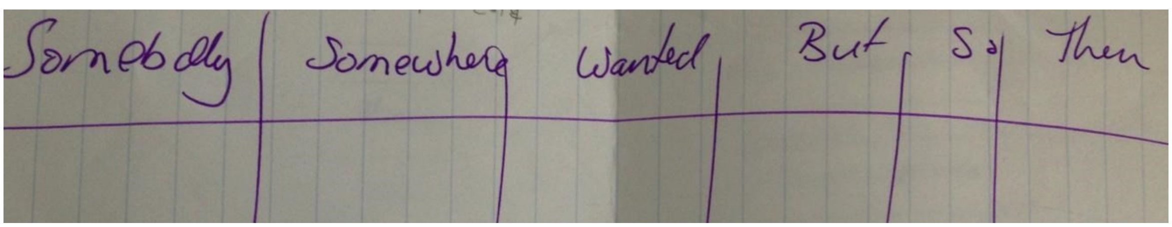
Time Duration: October 10th – November 27th (34 hours)

Lesson 1.

The teacher and teacher researcher introduced Kodu Game Lab to the grade 6 classes, working together to deliver this introductory lesson to the students. See Appendix C for further information regarding how Kodu was introduced. (one and a half hours)

Lesson 2.

The teachers introduced the "Somebody, Somewhere, Wanted, But, So, Then" planning template to the students. This template was created by a district language arts consultant, and had been used in the grade 6 language arts classrooms before. Patrick was the teacher who first introduced this planning method.



Lesson 3.

The teachers read *The Paper Bag Princess* (Munsch, 1980) to the students. After the story was read out loud, they applied the "Somebody, Somewhere…" planning method to retell the story as a class (see Table 3 for an example of what was discussed as a class and what the students wrote down in their journals). (one hour)

Table 3: Example of "Somebody, Somewhere…" Student Planning

Somebody	Somewhere	Wanted	But	So	Then
Elizabeth Dragon Ronald	Castle Dragon Cave Forest	To marry Ronald	Attacked and stole Ronald	Elizabeth tricked the dragon	She saved Ronald, but decided not to marry him

Lesson 4.

Each teacher led a discussion regarding the elements that constitute a good video game. The teachers adapted this discussion from the work of James Paul Gee (2007a) and his book *Good Games for Good Learning*. The students brainstormed in small groups and wrote down some of their ideas for about ten minutes. As a class, the students shared their ideas and they created a larger list. (one hour)

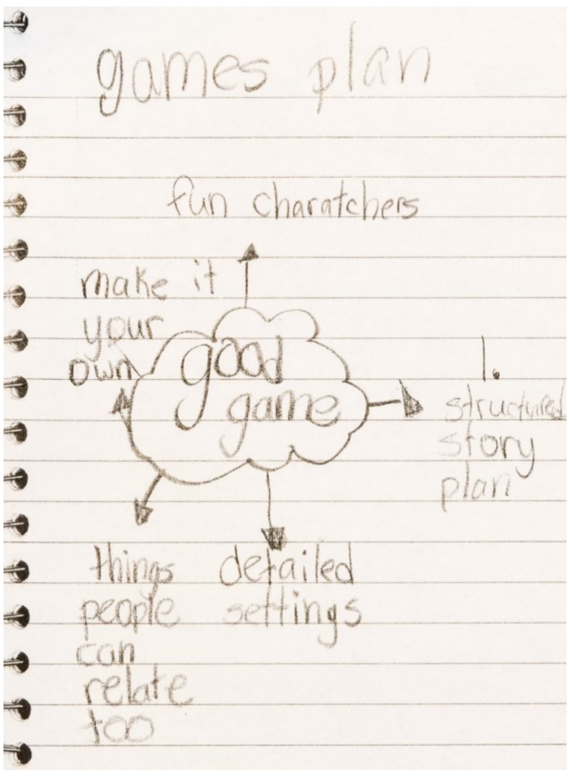


Figure 1. Student-generated ideas of a good video game.

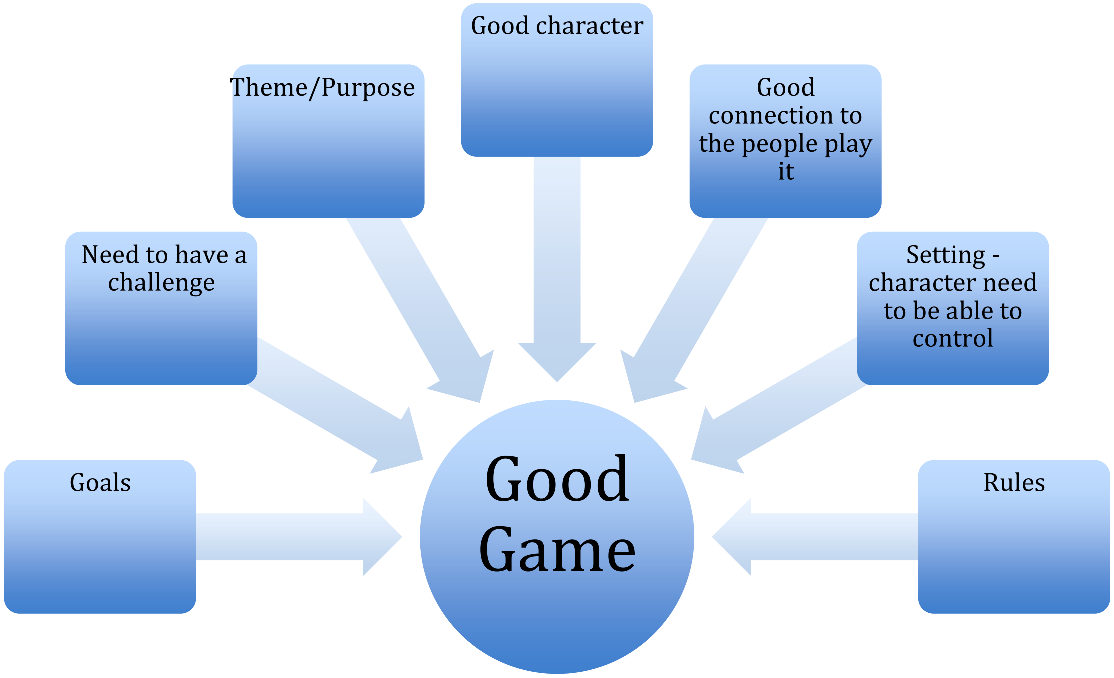


Figure 2. Patrick's class discussion surrounding a good video game.

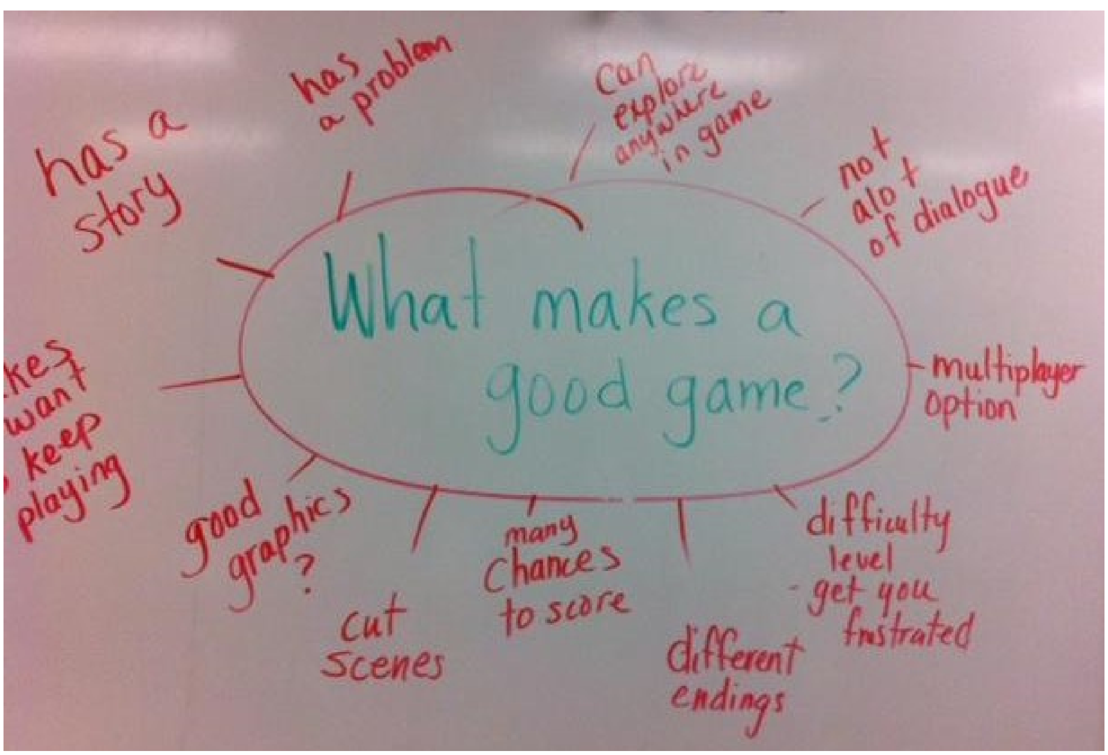


Figure 3. Angela's class discussion surrounding a good video game.

Lesson 5.

The students played four video games:

- Icarus Needs (http://bartbonte.com/portal/icarusneeds.html)
- Sprout (http://www.kongregate.com/games/customlogic/sprout)
- 40 Times Escape (http://bartbonte.com/40xescape/)
- Muck and Brass (http://www.bbc.co.uk/history/interactive/games/victorian_muckbrass/index_embed.shtml)

These games were chosen based on the recommendations of professionals who have integrated video games into the classroom and through the use of the Games for Change website (www.gamesforchange.org). The students played each of the four video games with four or five students. They were given about 20 minutes to play the game. After each game the students retold the events through the "Somebody, Somewhere…" planning tool. For each of the games, the students first worked in small groups to retell the events of the story, and then as a class they went through each of the different elements of the story. (four one-hour classes)

For Patrick it was important that the students play these games and reflect on them as a way of frontloading knowledge prior to building their own game:

> I am frontloading in terms of looking at other games and figuring out the driving force behind it and analyzing the thought process that went into the game, so that they can then use that to come up with some sort of plan of a game that will make sense for their own. . . . Relying heavily on language arts right now to plan out what does a story look like in the game versus a story, and how am I going to make this work in what I do?

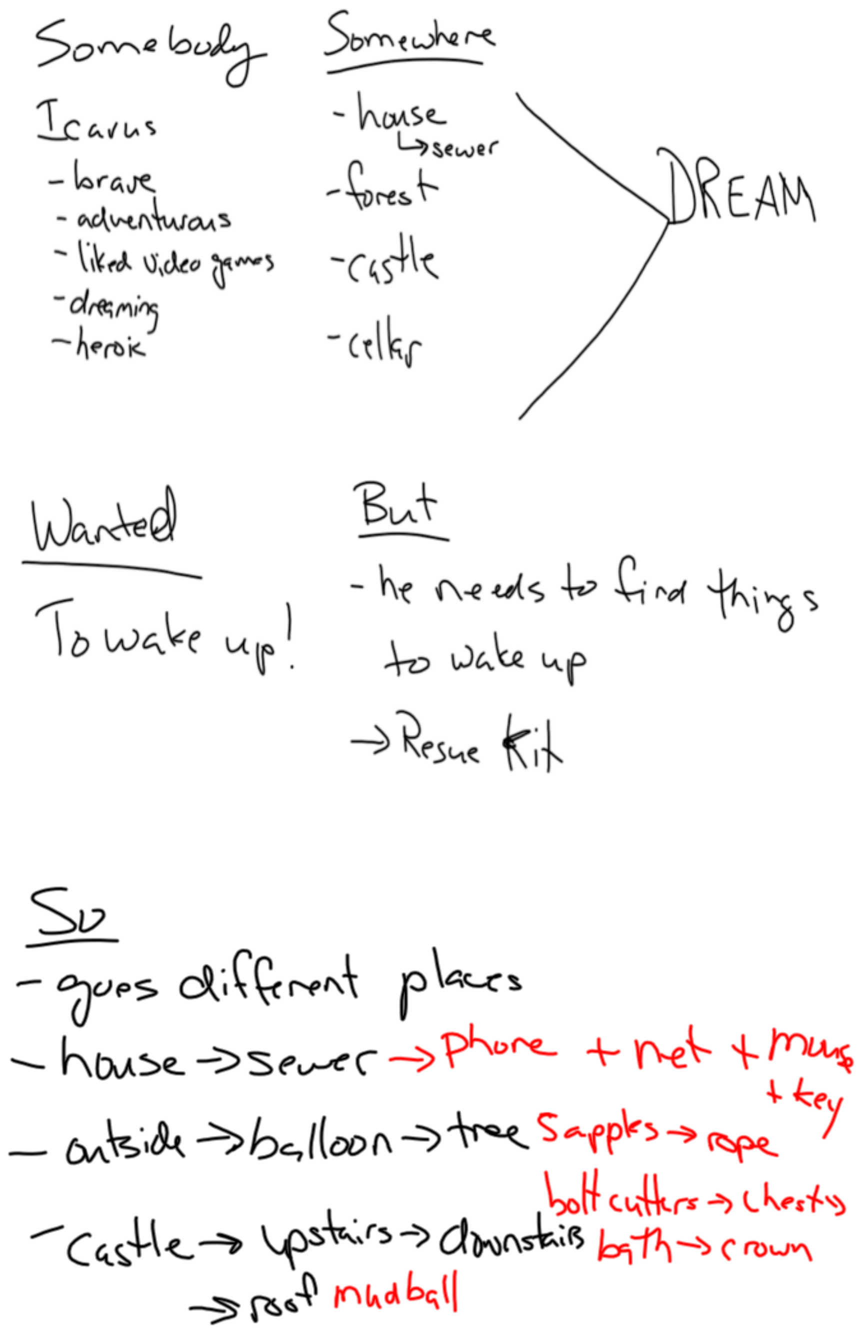


Figure 4. Class discussion written on Smart Board regarding the story elements of Icarus Needs.

Lesson 6.

After each of the four video games, the students individually responded to the following reflective questions:

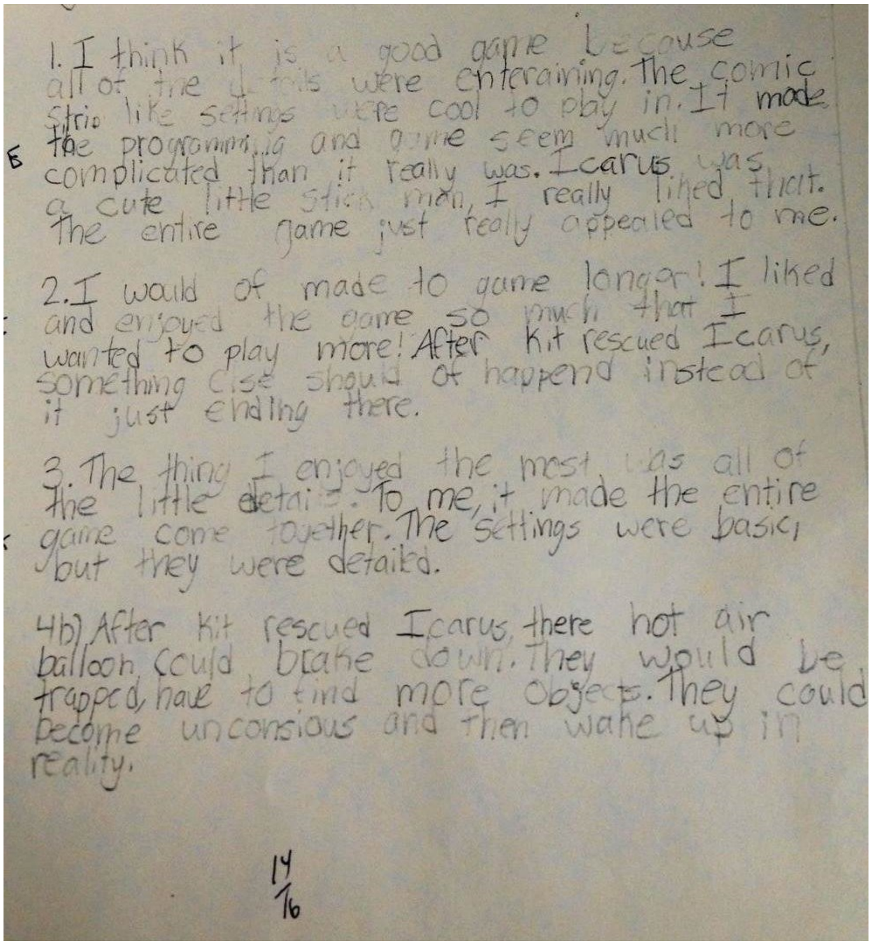
1. Do you consider this to be a good game? Give your opinion and supporting details to explain your answer.
2. What would you change or make different in this game? Give reasons to support your answer and explain why you would make that change.
3. What was your favourite part or thing you liked best about this game? State the feature and give reasons to support your answer.
4. Predict what would happen if the game didn't end. Explain the ending and explain why.

Lesson 7.

The teachers used the rubric in Table 4 to assess the students on their reflections about each of the video games. The students were provided with the rubric before the first reflection was completed. Upon marking the game reflections, both Patrick and Angela found that many of the students struggled to reflect on their understanding of the game and to describe why the game was good or was not good. Both teachers emphasized that reflective writing is a skill that must be taught to students in grade 6, because many simply did not know how to answer questions in a more descriptive manner. (each reflection 30 minutes)

Table 4: Assessment Rubric for Teacher-Generated Reflective Questions

4 - Exemplary	3 - Proficient	2 - Progressing	1 - Beginning
Thorough, in-depth, with precise details	Good understanding, detailed and accurate	Progressing understanding, general, with some accuracy and details	Limited understanding, little comprehension, vague
Accurate events or ideas, well sequenced; comprehensive	Events or ideas well sequenced; detailed	Events or ideas generally correct; general	Events may be partially in sequence; very little or no accuracy
Recalls all main facts/ideas and includes detailed and specific supporting details	Recalls most main ideas/facts and has many supporting details	Recalls some main ideas/facts with some supporting details	Recalls few ideas/facts with limited or no supporting details
Includes personal and consistent inferences; Includes elaboration	General inferences; some elaboration included	Starting to make inferences and may need further prompting to elaborate	Few/no inferences No elaboration
Uses appropriate vocabulary/ specialized vocabulary for the topic, enhances with effective word choice	Uses some appropriate vocabulary/specialized vocabulary and phrases	Uses general vocabulary and phrases	Little or no use of contextual or specific vocabulary or phrases



1. I think it is a good game because all of the details were entertaining. The comic strip like settings were cool to play in. It made the programming and game seem much more complicated than it really was. Icarus was a cute little stick man, I really liked that. The entire game just really appealed to me.

2. I would of made to game longer! I liked and enjoyed the game so much that I wanted to play more! After Kit rescued Icarus, something else should of happend instead of it just ending there.

3. The thing I enjoyed the most was all of the little details. To me, it made the entire game come together. The settings were basic, but they were detailed.

4b) After Kit rescued Icarus, there hot air balloon could brake down. They would be trapped, have to find more objects. They could become unconsious and then wake up in reality.

14/16

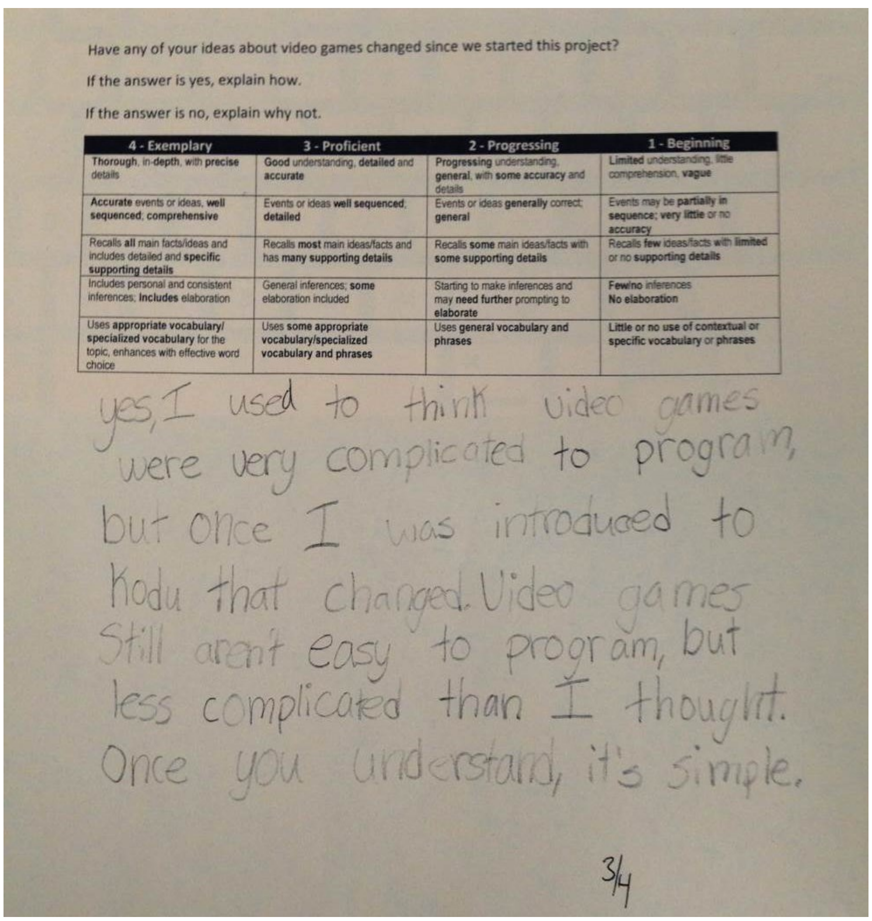
Figure 5. Example of student responses to reflective questions about Icarus Needs.

Lesson 8.

Patrick developed a lesson with the students to highlight the differences that exist between a video game and a traditional story. However, he found it extremely difficult to identify the differences. He began with a Venn diagram to differentiate between a game story and a traditional story. The class then tried to brainstorm the differences. They developed a few ideas, including a sense that a game story is not linear and that you read a traditional story as opposed to playing a game story. Beyond these differences, however, both Patrick and the students struggled to identify additional details. Patrick suggested to Angela that she skip this discussion with her class. (45 minutes)

Lesson 9.

The grade 6 teachers asked the students to reflect on their overall learning that had occurred in terms of playing video games and using the "Somebody, Somewhere…" story planning method. Patrick reported that the majority of the students indicated that their perceptions about video games had changed. Although Patrick and Angela found the responses were limited, they suggested that the students were improving from their initial reflections. The same rubric (Table 4) was used to assess this reflection. (one hour)


Have any of your ideas about video games changed since we started this project?

If the answer is yes, explain how.

If the answer is no, explain why not.

4 - Exemplary	3 - Proficient	2 - Progressing	1 - Beginning
Thorough, in-**depth**, with **precise** details	**Good** understanding, **detailed** and **accurate**	**Progressing** understanding, **general**, with **some accuracy** and details	**Limited** understanding, little comprehension, **vague**
Accurate events or ideas, **well sequenced**; **comprehensive**	Events or ideas **well sequenced**; **detailed**	Events or ideas **generally** correct; **general**	Events may be **partially in sequence**; **very little** or no **accuracy**
Recalls **all** main facts/ideas and includes detailed and **specific supporting details**	Recalls **most** main ideas/facts and has **many supporting details**	Recalls **some** main ideas/facts with **some supporting details**	Recalls **few** ideas/facts with **limited** or no **supporting details**
Includes personal and consistent inferences; **Includes** elaboration	General inferences; **some** elaboration included	Starting to make inferences and may **need further** prompting to **elaborate**	**Few/no** inferences **No elaboration**
Uses **appropriate vocabulary/ specialized vocabulary** for the topic, enhances with effective word choice	Uses **some appropriate vocabulary/specialized vocabulary and phrases**	Uses **general vocabulary and phrases**	**Little or no use of contextual or specific vocabulary** or **phrases**

yes, I used to think video games were very complicated to program, but once I was introduced to Kodu that changed. Video games still aren't easy to program, but less complicated than I thought. Once you understand, it's simple.

3/4

Figure 6. Example of student's reflection regarding their perceptions of video games.

Lesson 10.

Next, the teachers read Patrick's Kodu story out loud to the students (see Appendix D). For Angela, this was a pivotal moment in the game construction unit. After reading the story, she came to a greater awareness of how a game story could be written, with the challenges written in the story and following the basic structure located in Kodu. (one hour)

Lesson 11.

The students used the "Somebody Somewhere…" story planning tool to retell Patrick's Kodu story. The students were also asked to make personal connections to the story, including text-to-text, text-to-self, and text-to-world. In Angela's class, students made connections to various movies and TV shows in the last element of the story plan. The class discussion included references to *Jumangi*, *Dr. Who*, *Cloudy With a Chance of Meatballs*, *Divergent*, *Monsters University*, and *Wipeout*. The students spent a considerable amount of time discussing *Jumanji* and how the movie was like a board game and how the story was defined through the choices of the characters and where they landed in the game. In addition, Angela provided her students with a book called *Start Writing Adventure Stories* (2004), which they used as a guide to help them begin their planning and understand how challenges can be embedded into a story and game (see E). Angela was worried that the students might struggle with getting started and thought the guide would be helpful. This book was made available by the language arts district consultant. (one and a half hours)

Story Plan

Somebody	Somewhere	Wanted	But
Marvin - scientist - not very careful - clumsy - needs to pay close attention to his calculations - Martian Commander Dodgers - leader of Martian society - doesn't like Marvin - very strict - president of Mars	On Mars - the Red Planet - hills - valleys - caves - plains - city - lakes - Forbidden Exile Math Zone of Doom	To be the best scientist on his planet and save it from pollution	He made a mistake in some of his calculations and almost blew up the planet in an experiment. Place value mistake
So	**Then**	**Finally**	**Connections**
He was sent to the Forbidden Math Exile Zone to prove his worth and ability to safely do science calculations and experiments.	He had to make his way through the zone by successfully solving several math challenges that he had done wrong in his disastrous experiment. Multiples & Factors Prime & Composite Numbers Integers Order of Operations	He solved all the math problems, which unlocked the gate that kept him trapped in the math zone. Marvin was permitted to return to civilization.	Book – The Math Curse TV – Bugs Bunny: Marvin the Martian

Figure 7. Example of class discussion of the elements located in Patrick's Kodu story.

Lesson 12.

Each of the students was given a copy of the Kodu sample story and asked to highlight the parts of the story that would be integrated into the video game (see Appendix F). They worked on this activity in groups of four or five. (one hour)

Lesson 13.

Each student was individually assigned the task of writing his or her own game story. They were told to write a story that was similar to Patrick's model story. They began by using the "Somebody Somewhere…" story planning tool to generate ideas.

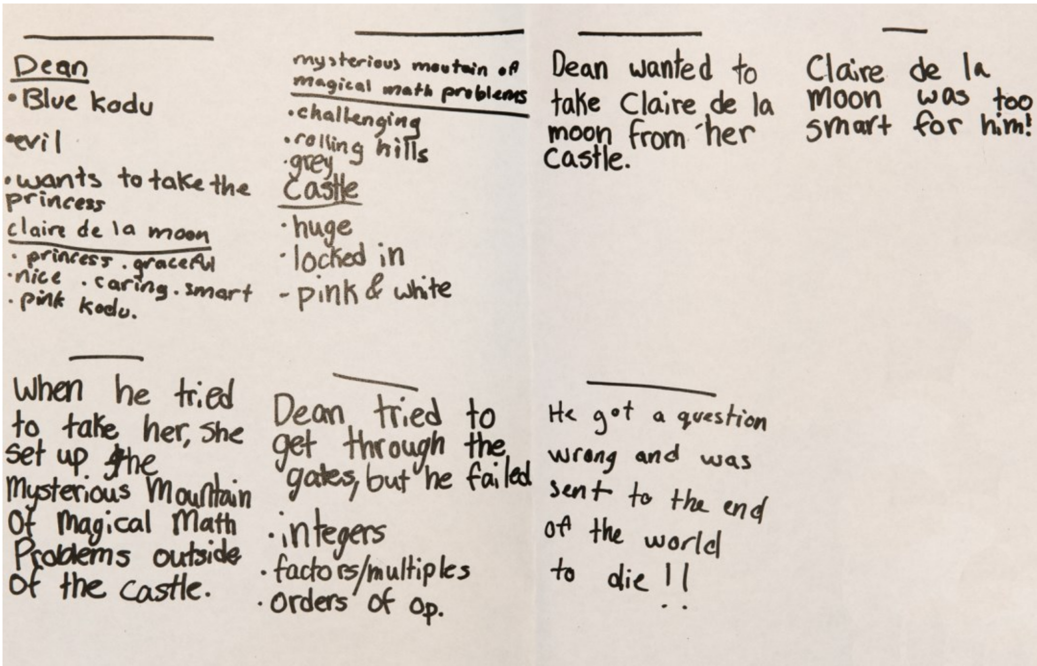


Figure 8. Example of student's personal game story.

Lesson 14.

Once the story plans were developed, the students created their math questions. Patrick asked his students to develop at least four questions, while Angela asked hers for a minimum of three questions. The students were instructed to draw on their knowledge from one chapter of their math textbook, *Understanding Numbers* (Morrow, 2009). Their questions focused on the following elements:

- place value
- factors
- multiples
- prime and composite
- integers
- order of operations (one hour)

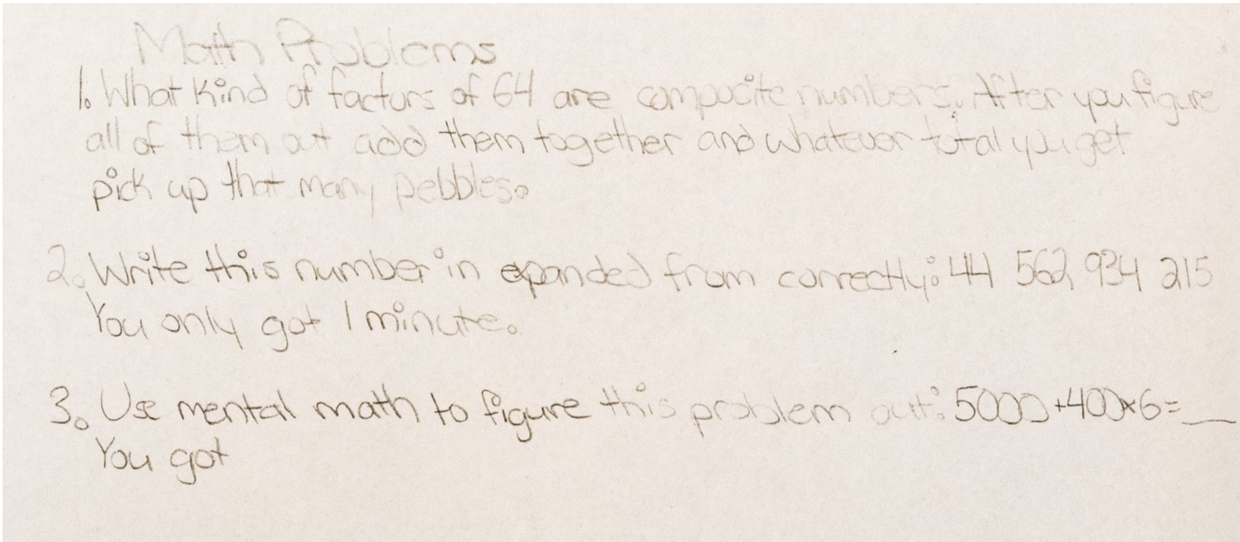

Math Problems
1. What kind of factors of 64 are composite numbers? After you figure all of them out add them together and whatever total you get pick up that many pebbles.
2. Write this number in expanded from correctly: 44 562 934 215 You only got 1 minute.
3. Use mental math to figure this problem out: 5000+400×6=___ You got

Figure 9. Example of student math problems for video game.

Lesson 15.

Once the story plans were developed, the teachers met with students individually to discuss their story plans. The students were asked about their overall plans, their vision for the game, and how math fit into their overall story. (continuous, once the students had finished their game story plan)

Lesson 16.

Once their game plans were approved, the students began writing their game stories. This was generally an independent task, completed using paper and pencil. The students handed in the first drafts to the teachers, and they were given feedback. Some students in Patrick's class requested that they work in a group. Patrick approved the request with the condition that the students use elements located in all their stories and combine them to make a new story. Some students decided to work collaboratively and revised their stories. After revisions from the teacher, the students added or made changes to their final drafts. (four one-hour classes)

Lesson 17.

In Patrick's class, the students highlighted the elements they expected to include in their game story (see example in Figure 10 below). (one hour)

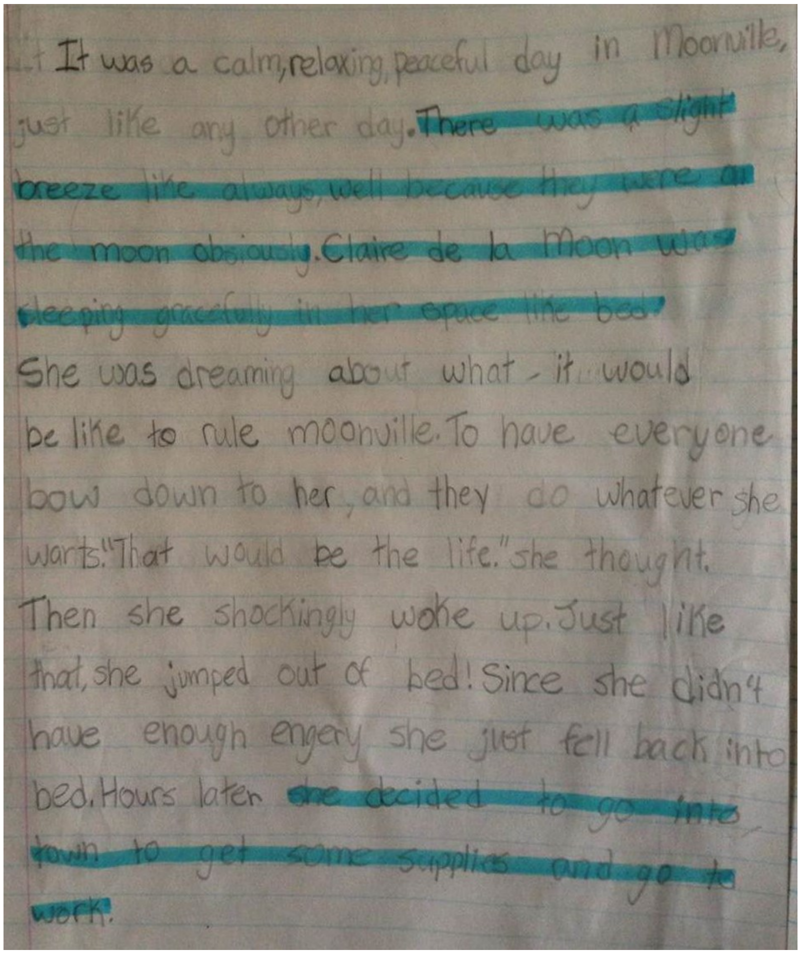
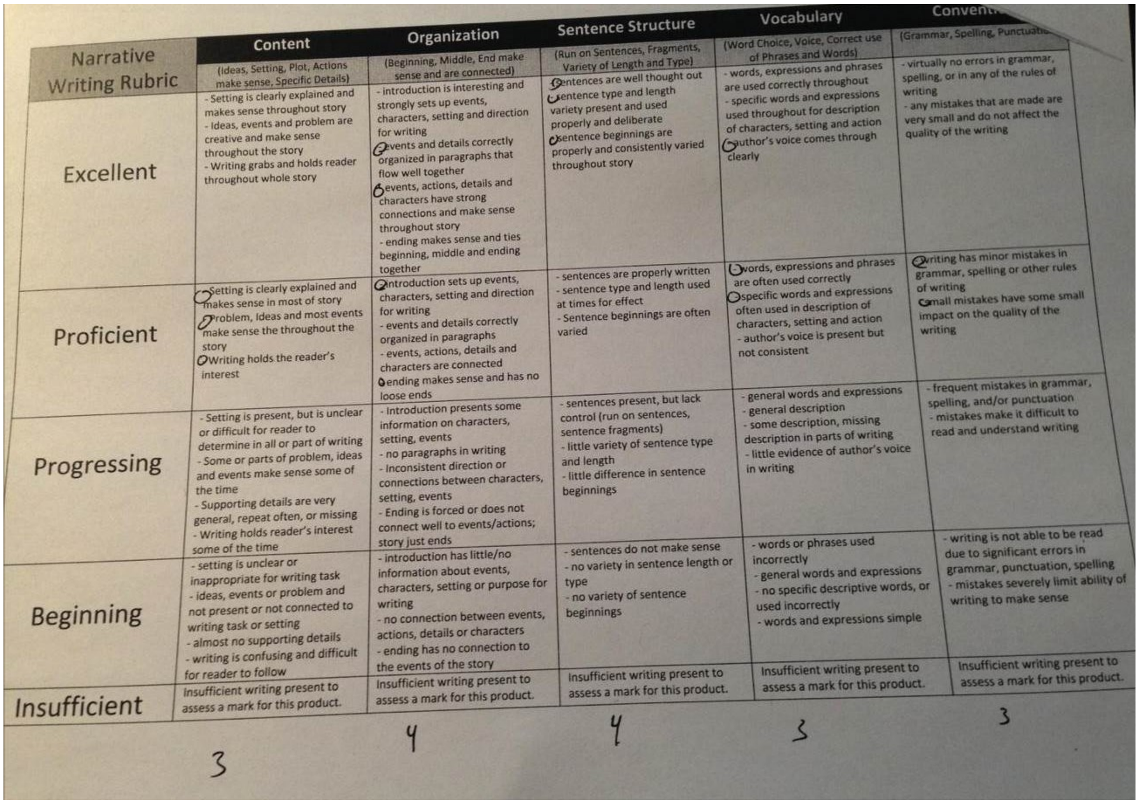

It was a calm, relaxing, peaceful day in Moonville, just like any other day. There was a slight breeze like always, well because they were on the moon obviously. Claire de la Moon was sleeping gracefully in her space like bed.
She was dreaming about what it would be like to rule moonville. To have everyone bow down to her, and they do whatever she wants. "That would be the life." she thought. Then she shockingly woke up. Just like that, she jumped out of bed! Since she didn't have enough engery she just fell back into bed. Hours later she decided to go into town to get some supplies and go to work.

Figure 10. Example of student's final draft with game highlights.

Lesson 18.

The students handed in their game stories to be assessed (see Figure 11). Each story took about 15 to 20 minutes for the teacher to assess.

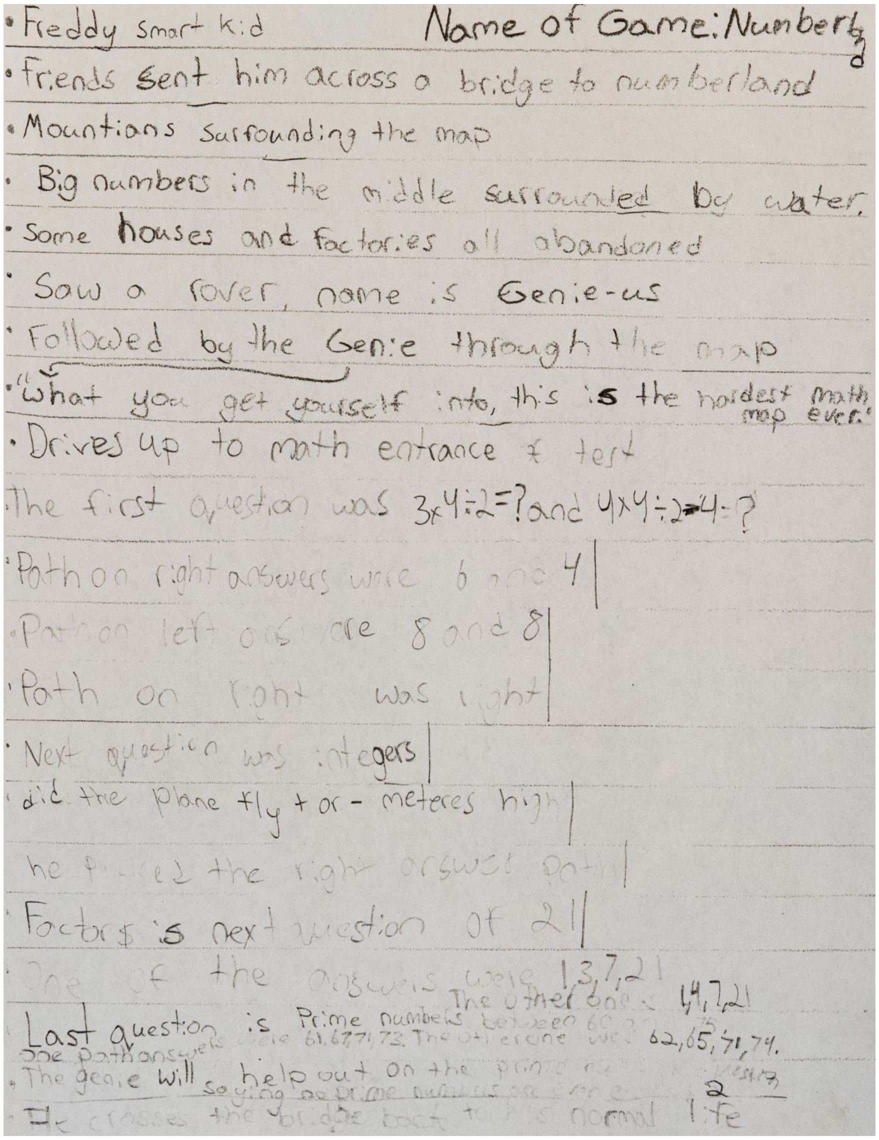


Narrative Writing Rubric	Content (Ideas, Setting, Plot, Actions make sense, Specific Details)	Organization (Beginning, Middle, End make sense and are connected)	Sentence Structure (Run on Sentences, Fragments, Variety of Length and Type)	Vocabulary (Word Choice, Voice, Correct use of Phrases and Words)	Convent (Grammar, Spelling, Punctuatio
Excellent	- Setting is clearly explained and makes sense throughout story - Ideas, events and problem are creative and make sense throughout the story - Writing grabs and holds reader throughout whole story	- introduction is interesting and strongly sets up events, characters, setting and direction for writing events and details correctly organized in paragraphs that flow well together events, actions, details and characters have strong connections and make sense throughout story - ending makes sense and ties beginning, middle and ending together	sentences are well thought out sentence type and length variety present and used properly and deliberate sentence beginnings are properly and consistently varied throughout story	- words, expressions and phrases are used correctly throughout - specific words and expressions used throughout for description of characters, setting and action author's voice comes through clearly	- virtually no errors in grammar, spelling, or in any of the rules of writing - any mistakes that are made are very small and do not affect the quality of the writing
Proficient	Setting is clearly explained and makes sense in most of story Problem, Ideas and most events make sense the throughout the story Writing holds the reader's interest	introduction sets up events, characters, setting and direction for writing - events and details correctly organized in paragraphs - events, actions, details and characters are connected ending makes sense and has no loose ends	- sentences are properly written - sentence type and length used at times for effect - Sentence beginnings are often varied	words, expressions and phrases are often used correctly specific words and expressions often used in description of characters, setting and action - author's voice is present but not consistent	writing has minor mistakes in grammar, spelling or other rules of writing small mistakes have some small impact on the quality of the writing
Progressing	- Setting is present, but is unclear or difficult for reader to determine in all or part of writing - Some or parts of problem, ideas and events make sense some of the time - Supporting details are very general, repeat often, or missing - Writing holds reader's interest some of the time	- Introduction presents some information on characters, setting, events - no paragraphs in writing - Inconsistent direction or connections between characters, setting, events - Ending is forced or does not connect well to events/actions; story just ends	- sentences present, but lack control (run on sentences, sentence fragments) - little variety of sentence type and length - little difference in sentence beginnings	- general words and expressions - general description - some description, missing description in parts of writing - little evidence of author's voice in writing	- frequent mistakes in grammar, spelling, and/or punctuation - mistakes make it difficult to read and understand writing
Beginning	- setting is unclear or inappropriate for writing task - ideas, events or problem and not present or not connected to writing task or setting - almost no supporting details - writing is confusing and difficult for reader to follow	- introduction has little/no information about events, characters, setting or purpose for writing - no connection between events, actions, details or characters - ending has no connection to the events of the story	- sentences do not make sense - no variety in sentence length or type - no variety of sentence beginnings	- words or phrases used incorrectly - general words and expressions - no specific descriptive words, or used incorrectly - words and expressions simple	- writing is not able to be read due to significant errors in grammar, punctuation, spelling - mistakes severely limit ability of writing to make sense
Insufficient	Insufficient writing present to assess a mark for this product.	Insufficient writing present to assess a mark for this product.	Insufficient writing present to assess a mark for this product.	Insufficient writing present to assess a mark for this product.	Insufficient writing present to assess a mark for this product.
	3	4	4	3	3

Figure 11. Assessment rubric used to assess the students' game stories.

Lesson 19.

Some of the students finished early, so they were asked to create a list of what would happen in their actual video games (see Figure 12). (30 minutes)



• Freddy smart kid Name of Game: Numberland
• Friends sent him across a bridge to numberland
• Mountians surrounding the map
• Big numbers in the middle surrounded by water.
• Some houses and factories all abandoned
• Saw a rover, name is Genie-us
• Followed by the Genie through the map
• "what you get yourself into, this is the hardest math map ever."
• Drives up to math entrance & test
The first question was 3x4÷2=? and 4x4÷2×4÷?
• Path on right answers were 6 and 4
• Path on left ans are 8 and 8
• Path on right was right
• Next question was integers
• did the plane fly + or - meteres high
he picked the right answer path
• Factors is next question of 21
One of the answers were 1,3,7,21 The other one 1,4,7,21
Last question is Prime numbers between 60 & 75
One path answers were 61,67,71,73. The other one were 62,65,71,74.
• The genie will help out on the prime numbers saying no prime numbers are even exept 2
• He crosses the bridge back to his normal life

Figure 12. Example of a student's list of steps for the video game.

Lesson 20.

The students developed maps that provided a visual description of their video games. The teachers suggested that the students think like a bird and create maps that had a bird's eye view. The teachers had to approve the game map before the students moved on to the next step, which was game building. Patrick found the map development to be a crucial step in the process "because to just let them loose on the computer and make whatever you feel, like we got our land made in about half an hour. If they don't have a map to work off of, this could have been a three or four day thing.” The teachers discovered that the map saved the students a considerable amount of time because the students had a plan of where they were going. (one hour)

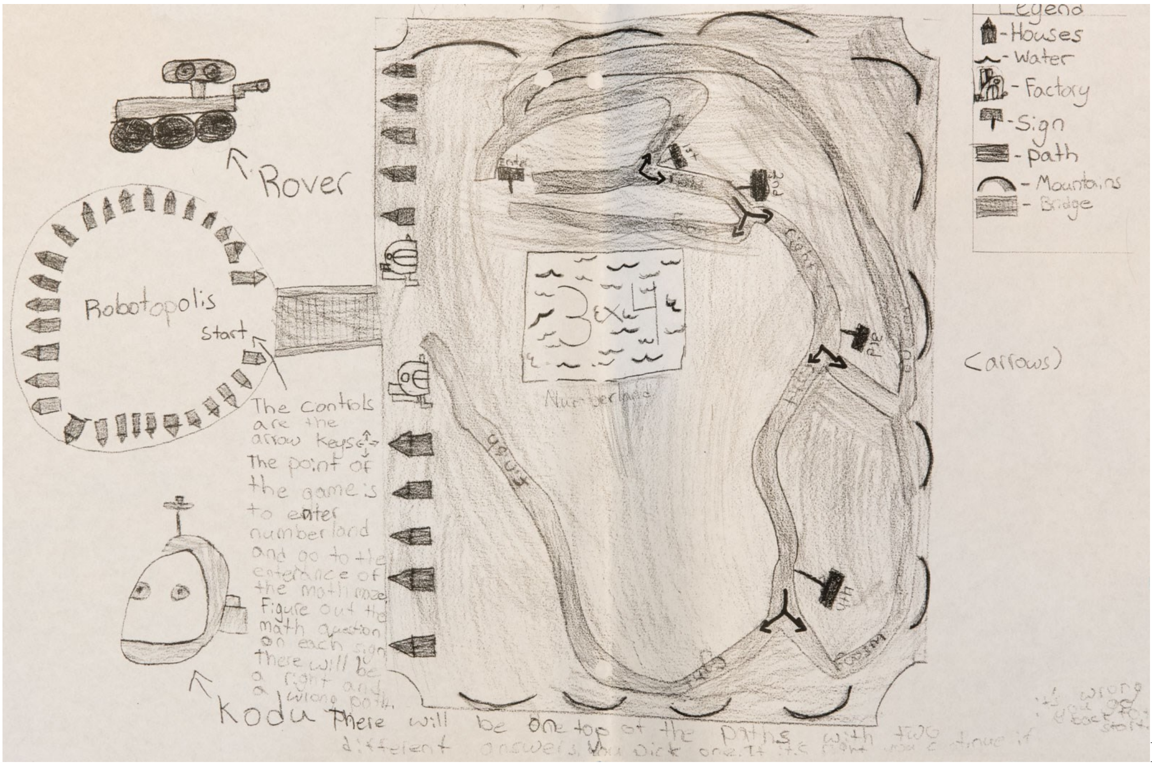


Figure 13. Student example of a game map.

Lesson 21.

Both classes integrated a tech ninja program, where the students elected an individual or individuals who might be able to assist their peers with the use of the technology. At the beginning of each class, the students elected a “tech ninja,” and the ninja wore a badge to represent their role.

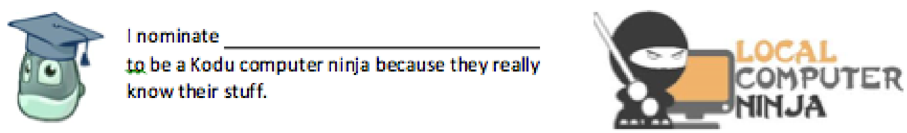


Figure 14. Example of the tech ninja program and nomination form.

Lesson 22.

The students began building their game. They often used the school's computer lab, but sometimes they used the cart of laptops. Unfortunately, the laptops were less reliable than the computers in the computer lab and the students were often not able to locate their games. The students were given a guide sheet (see Appendix G) to help them make connections with the characters found within the game. During the first video construction class, the students were asked to build the base of their game, the landforms. Students spent 80% of the time planning and writing to get ready using the technology and 20% of their time was dedicated to actually building video games. Many of the students found that they had run out of resources by the end of the first day of building the landforms and, as a result, their games became slow. Many had to start over, or cut out a considerable amount of the land, to make the game run faster. (one and a half hours)

Lesson 23.

The students continued to work on their video games. They utilized the tech ninjas to support them as they built and constructed their games. Both teachers provided the students with large blocks of time, at least one and half hours each day, to build their games. After four building days, 80% of the students finished their games. At this point, the students were reminded to add in more specific details, such as an opening cut scene. The teachers found that the mechanics of the game, such as the landforms and the play components, were included, but a running description was often missing. To provide context, the students were shown how to add an introductory cut scene to the beginning of their game. As students finished building their games, they were asked to have at least three other students play their game and provide feedback based on the following criteria:

- Retell the story
- Was it too hard—or too easy?
- Any advice on how you might make the game better (6 hours)

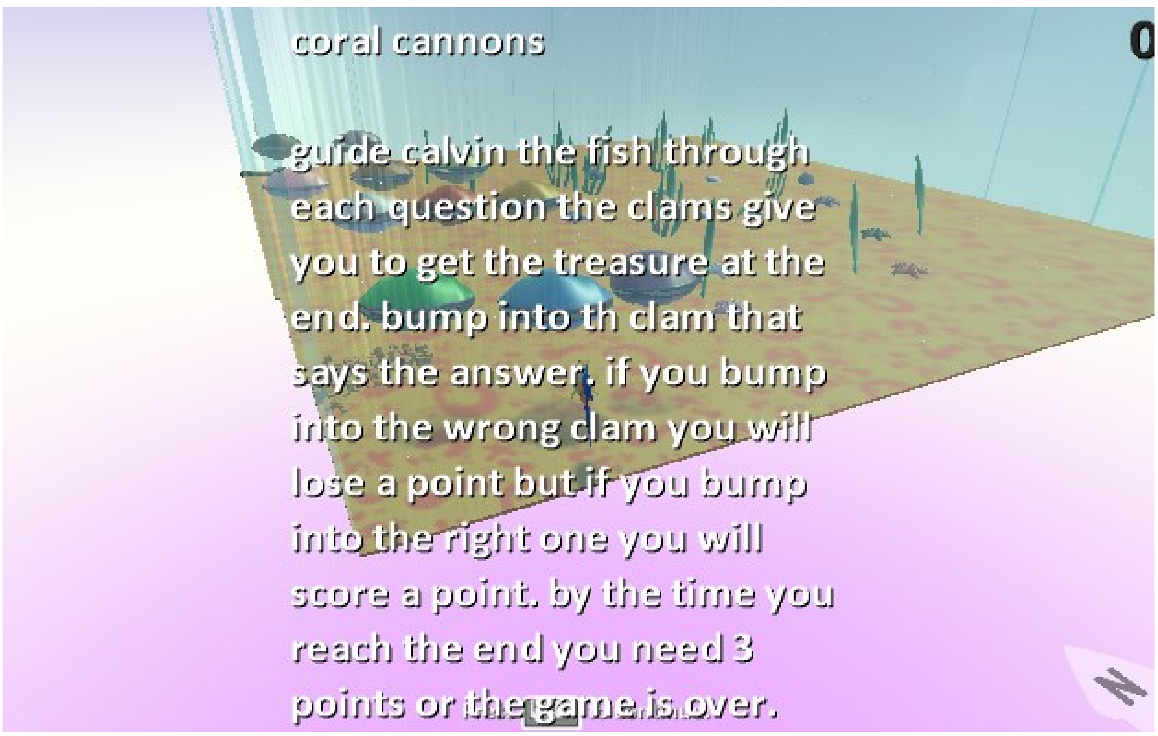


Figure 15. Beth's initial cut scene.

Lesson 24.

The students exported their games into a shared drive so that other students could access them. They were provided with an entire afternoon to play each other's games. They worked collaboratively in groups of two or three to play each other's games, either in the computer lab or on the laptops. Some students had issues accessing each other's games on the laptops, which created frustration. On the computers that worked, the students had the opportunity to play over 40 games. Although there were significant issues with the technology, all the grade 6 students suggested that they would like to construct a game in the future, and most of the students thought it was extremely important to play each other's games. (two hours)

Lesson 25.

Although Patrick's class finished the project with the completion of the game construction, Angela's class created a persuasive piece of writing in the format of a video game jacket cover, brochure, or poster (see Appendix H). This was meant to be a promotional piece to advertise the merits of the video game they had constructed. (one and half hours)

Lesson 26.

The students showcased their video games at the school's demonstration of learning event. A demonstration of learning showcases what the students have accomplished over a particular term, and they show their parents particular pieces of work and discuss what went well and areas to work on. The video games were included in the demonstration of learning, and the students had to answer several predetermined questions when they showed their games to their parents.

Grade 6 November 2014 Demonstration of Learning: Language Arts

***Schooled* Read Aloud:**

a) Talk to you parents about the book Schooled, by Gordon Korman.
b) Do a retell for what it was about. Be sure to include some of the most important events in it.
c) Tell them 2 things you liked about it and 2 connections you made to it.

Kodu:

a) Go through our project with your parents.
b) What is Kodu?
c) What makes a good game?
d) Explain at least 1 of the games we played at the beginning and how it helped you.
e) Explain how you made your game.
f) Show your parents your game.

Figure 16. Video game construction questions for the demonstration of learning.

Lesson 27.

To reflect on the video game construction project for himself, Patrick created a curricular guide that connected to the content areas of math, language arts, and health (see Appendix I). Patrick provided a detailed account of what had been accomplished in the game construction unit and different things to consider in future game units.

Grade 4.

Time duration: October 14th – November 27th (20 hours)

Table 5: Grade 4 Lesson Descriptions

Grade 4 Lessons	Brief Description of Lesson
Lesson 1	Kodu was introduced to the students.
Lesson 2	The teacher split the students up into group and assigned research tasks to each of the students about the regions of Alberta.
Lesson 3	The students played good video games.
Lesson 4	The students and teacher discussed the characteristics of a good video game.
Lesson 5	The students created flipbooks to organize their information about their region of Alberta.
Lesson 6	The students created true and false questions for their video game.
Lesson 7	The students drew a map of their region and indicated where the true and false questions would take place on the map.
Lesson 8	The students utilized the Somebody Somewhere…planning tool to craft a story for their game.
Lesson 9	The teacher assigned specific tasks to the students while building their games, half were builders while the other half were problem solvers.
Lesson 10	The teacher reorganized the groups, creating smaller groups, to ensure each student is participating in the constructing a video game. Students add in land, huts, paths and trees to their games.
Lesson 11	Students construct and finish their games.
Lesson 12	The teacher provides time for the students to play each other's games.
Lesson 13	The students independently reflect on the game they constructed by writing what they liked and disliked about the game construction process.
Lesson 14	The teacher uses a rubric to assess the students overall understanding of the regions of Alberta.

Lesson 1.

The teacher and teacher researcher introduced Kodu Game Lab to the grade 4 classes, working together to deliver this introductory lesson to the students. See Appendix C for more information. (one and half hours)

Lesson 2.

Heather introduced the project, which was meant to explore the regions of Alberta, to the students. She split her class into groups of four and five, with one student leader in each group. She classified a student leader as someone who would be able to guide the group to collect information about their designated region. She wrote four topics on the board (see Figure 17) that each group had to explore as part of their research. She mentioned to the students that they were individually responsible for researching one of the topics, such as natural resources and jobs. Then each of the students was asked to bring their research back to their group and share what they had found.

Heather added links about each of the regions to her virtual classroom, which allowed the students to access information more easily. She also allowed the students to explore beyond the links she provided. The students worked both at school and at home to gather this information. Heather also told the students that after they researched their regions, they would be building a video game based on their new knowledge. (four hours)

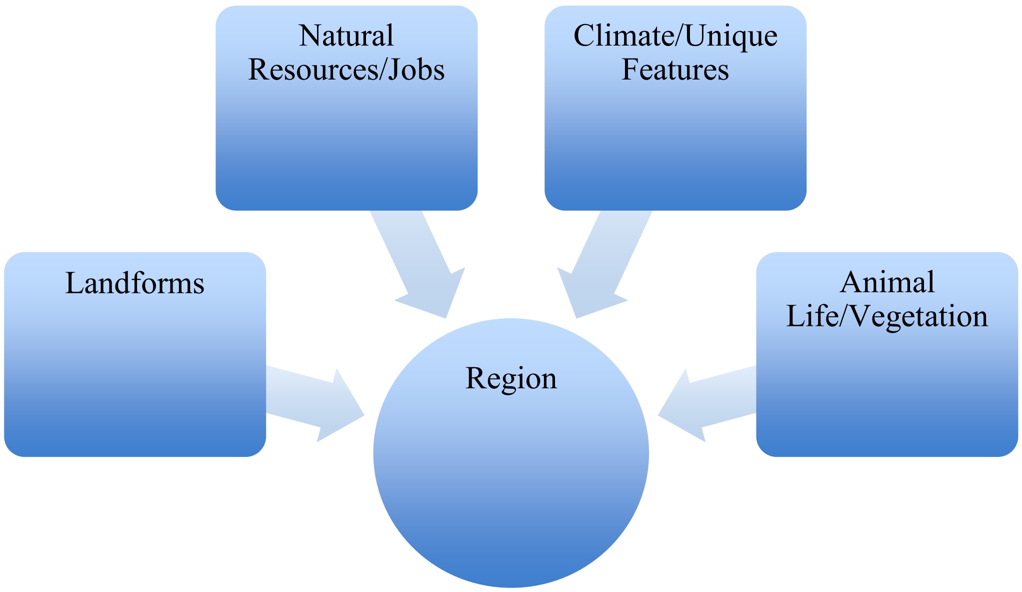


Figure 17. Four areas of focus for each of the regions of Alberta.

Lesson 3.

After a conversation with Patrick, Heather decided to pause her social studies unit and have her students play a few good video games. In small groups of three or four, the students played the following games:

a) Icarus Needs (http://bartbonte.com/portal/icarusneeds.html)

b) Sprout (http://www.kongregate.com/games/customlogic/sprout)

c) 40 Times Escape (http://bartbonte.com/40xescape/)

d) Piggy Bank Adventure (http://piggybank.disney.go.com/game/)

The first three games were the same games that were played in the grade 6 classes, but Heather added Piggy Bank Adventure, which was part of the Games for Change website (www.gamesforchange.org). It received high ratings (a 9.0/10.0 score) from the community that supports this website. For most of the students in this class, Piggy Bank Adventure was their favourite game because it allowed them to customize their characters and make personal choices that ultimately won the game. (two hours)

Lesson 4.

After playing the video games, the students discussed what makes a good video game. Heather limited the criteria to four elements and emphasized that these elements should be part of their own video games. (one hour)

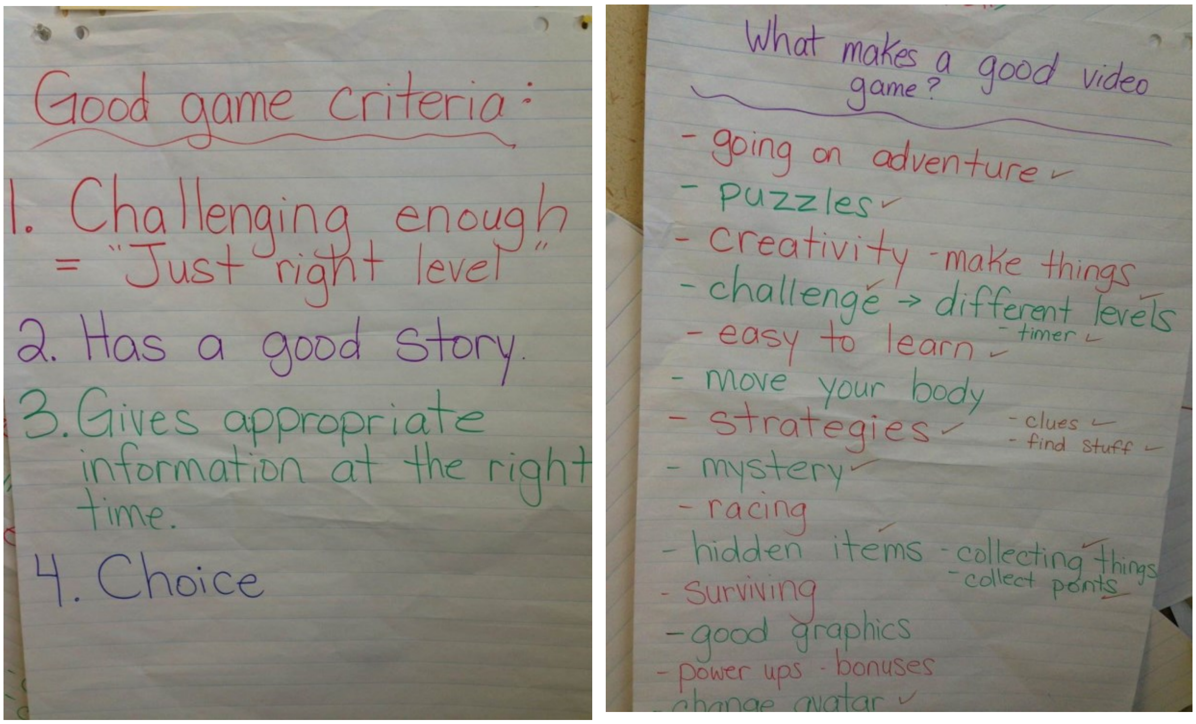


Figure 18. Brainstorming lists of what makes a good game.

Lesson 5.

Heather resumed the research project regarding the regions of Alberta, but found the students were struggling to record both their own information and their group members' information in their notebooks. Some of the students found a lot of information, while other students did not record any information, creating an imbalance in the groups. Heather changed the structure of this part of the project and asked the students to record their information using a flipbook format. A flipbook helps students organize their work. In this case, each tab in the book represented a particular feature in the students' region. Heather found this process to be more effective for the students, who were then able to collect and organize more information about their region (see example in Figure 19). Heather also noted that the flipbook seemed to be a less intimidating process for the students, who felt they were not writing as much.

Although not all the students completed their flipbook, they had the opportunity to talk with each other about each of the topics in the region, which created a foundational understanding of the main features of their chosen region. (two and half hours)

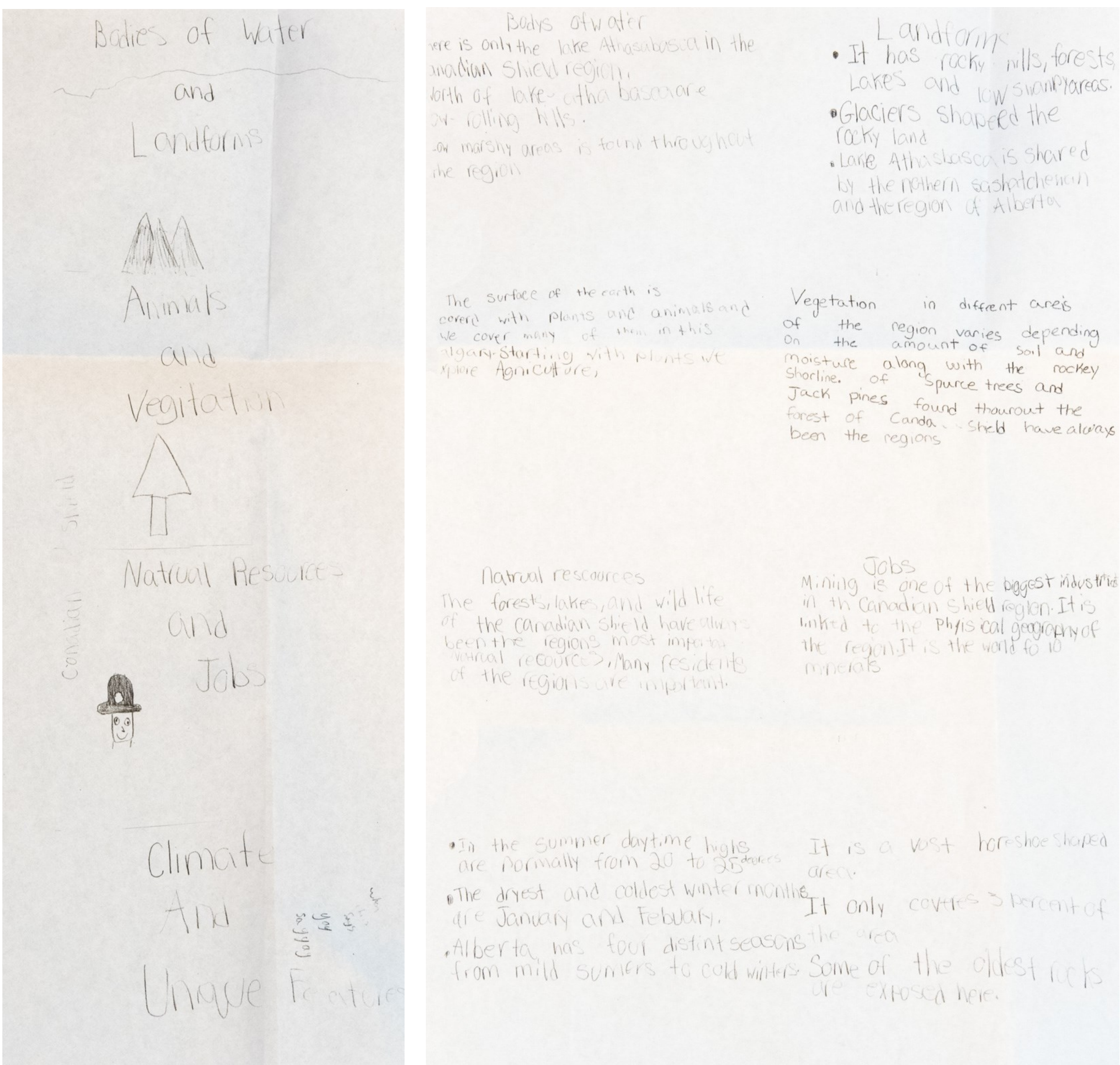
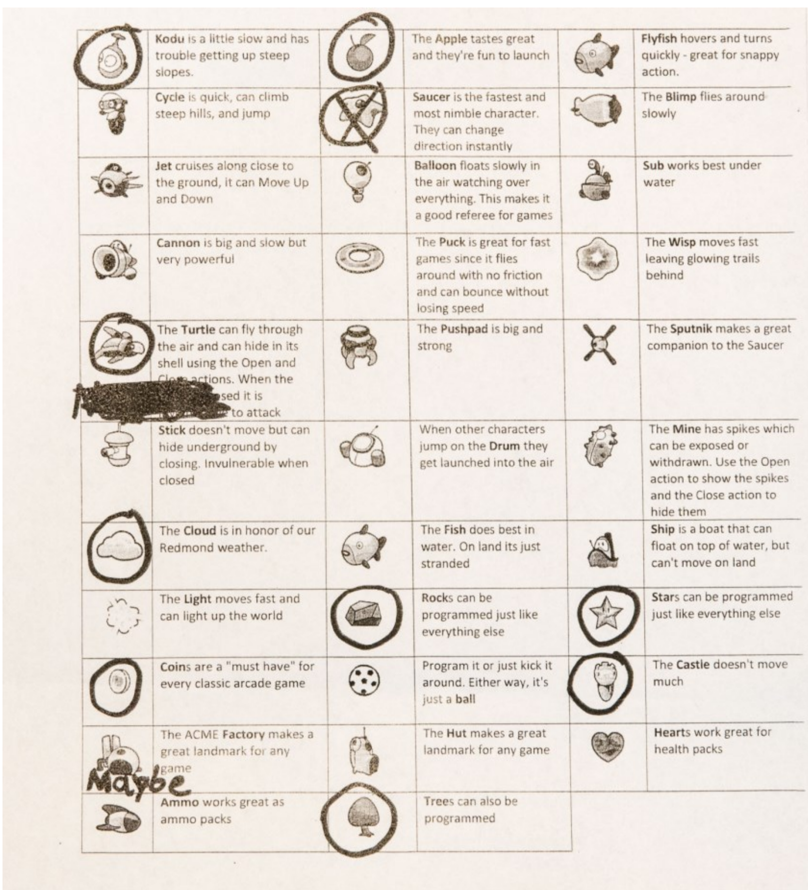


Figure 19. Colin's flipbook.

Lesson 6.

After the students finished their flipbooks, Heather asked them to create true and false or multiple-choice questions to add to their games. Each group had to have at least eight questions. Heather reminded the students that the overall purpose of constructing a video game was to teach other grade 4 students about the regions of Alberta. As a group, the students thought about the kinds of questions that would best teach other students about their region. Heather also provided each group with a guide sheet that reminded them of the characters that were available in Kodu and what they do. (one hour)



Kodu is a little slow and has trouble getting up steep slopes.	The **Apple** tastes great and they're fun to launch	**Flyfish** hovers and turns quickly - great for snappy action.
Cycle is quick, can climb steep hills, and jump	**Saucer** is the fastest and most nimble character. They can change direction instantly	The **Blimp** flies around slowly
Jet cruises along close to the ground, it can Move Up and Down	**Balloon** floats slowly in the air watching over everything. This makes it a good referee for games	**Sub** works best under water
Cannon is big and slow but very powerful	The **Puck** is great for fast games since it flies around with no friction and can bounce without losing speed	The **Wisp** moves fast leaving glowing trails behind
The **Turtle** can fly through the air and can hide in its shell using the Open and [redacted]ions. When the [redacted]sed it is [redacted] to attack	The **Pushpad** is big and strong	The **Sputnik** makes a great companion to the Saucer
Stick doesn't move but can hide underground by closing. Invulnerable when closed	When other characters jump on the **Drum** they get launched into the air	The **Mine** has spikes which can be exposed or withdrawn. Use the Open action to show the spikes and the Close action to hide them
The **Cloud** is in honor of our Redmond weather.	The **Fish** does best in water. On land its just stranded	**Ship** is a boat that can float on top of water, but can't move on land
The **Light** moves fast and can light up the world	**Rocks** can be programmed just like everything else	**Stars** can be programmed just like everything else
Coins are a "must have" for every classic arcade game	Program it or just kick it around. Either way, it's just a **ball**	The **Castle** doesn't move much
The ACME **Factory** makes a great landmark for any game Maybe	The **Hut** makes a great landmark for any game	**Hearts** work great for health packs
Ammo works great as ammo packs	Trees can also be programmed	

Figure 20. Caleb's Kodu guide sheet.

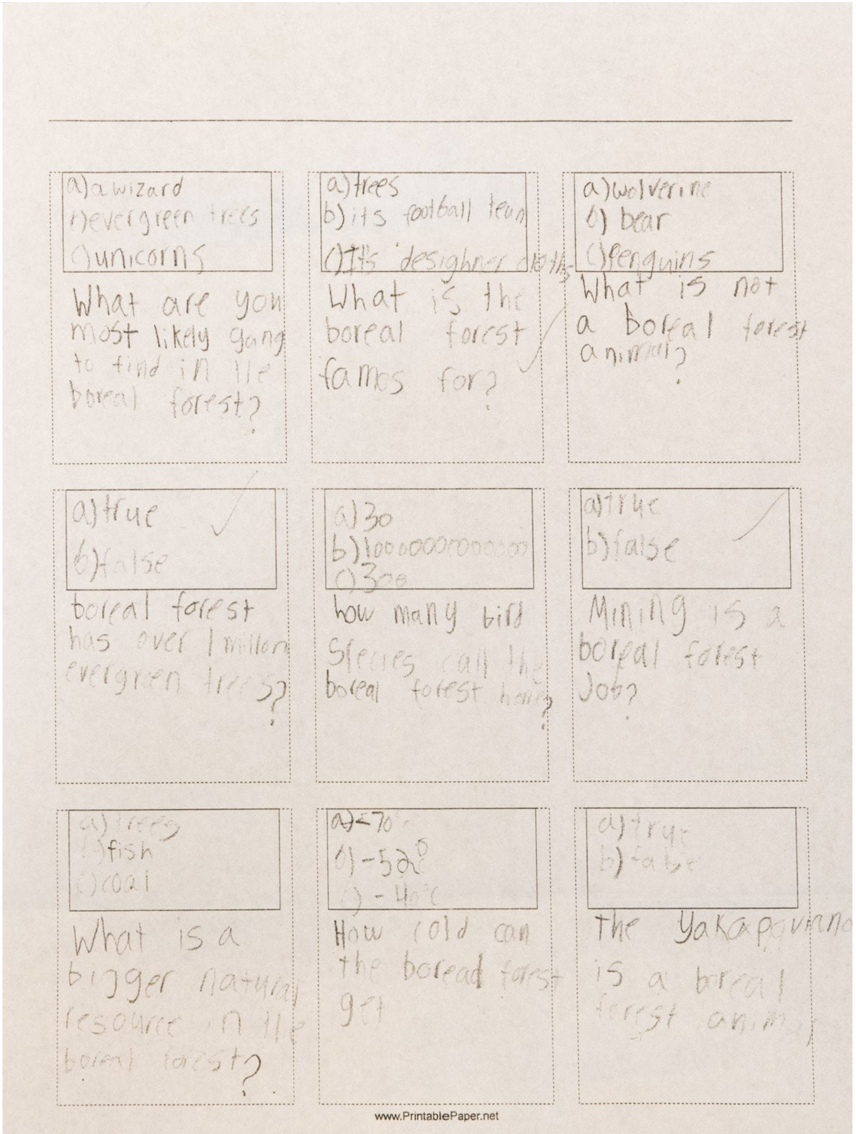


Figure 21. Caleb's true and false questions.

Lesson 7.

After the students finished writing their questions, Heather had them create maps of their region, including particular elements. The students drew their map on a large piece of paper and Heather asked them to make sure they included the following elements in their map:

a) legend

b) compass

c) the land forms

d) animals

e) vegetation

f) water forms

g) interesting facts

Heather also suggested that the students mark on their map where the particular questions were going to take place. (one and a half hours)

Figure 22. Caleb's map of the boreal forest region.

Lesson 8.

Heather was hesitant to give the students the "Somebody Somewhere…" story planning tool that both Patrick and Angela had used in their game planning process; however, she felt it might be helpful for the students to add more detail in their stories. Her hesitation came from the fact that she did not want her students to get wrapped up in the details of a story rather than focusing on the details from their maps and questions. As a compromise, the entire class went through the process together and developed an example of what a story plan might look like. Heather emphasized that the story plan did not need to be too specific, but it had to give an idea of what the game story was about. (1 hour)

Table 6: "Somebody, Somewhere…" Student Planning

Somebody	Somewhere	Wanted	But	So	Then	Finally
Bob	Boreal forest	To collect coins	Too many obstacles got in his way	Bob has to answer questions of the region	He answers them wrong and has to back to the start	He got all the questions correct and scared away all the animals

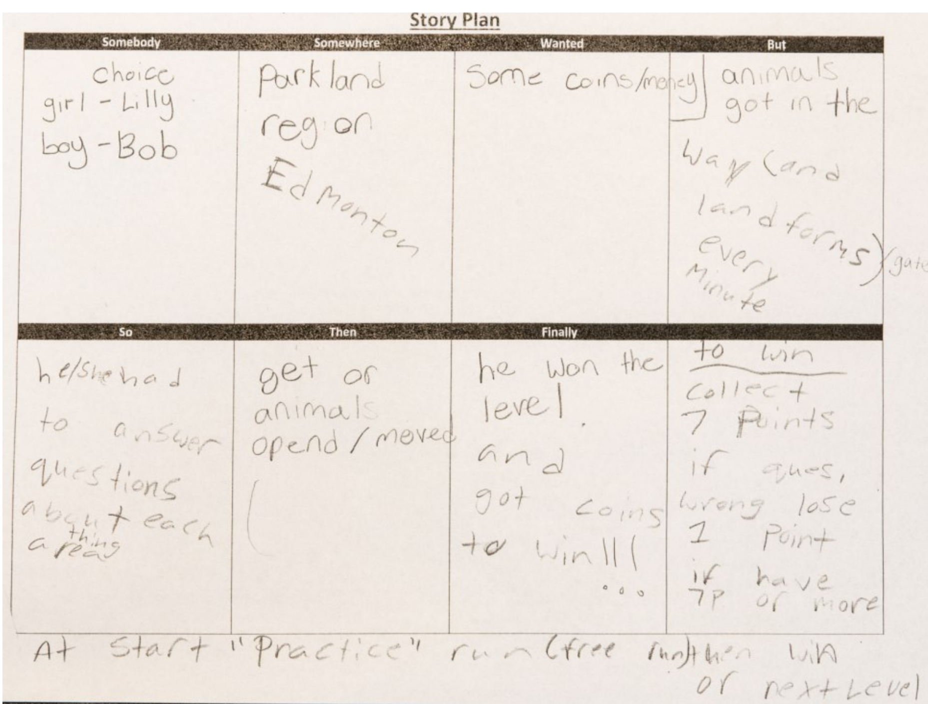


Figure 23. Meghan's parkland story plan.

Lesson 9.

Heather created groups with five or six students in each group. She decided to keep the groups together but gave group members specific tasks. One half of the group worked on building the video game, while the other half played around with the tutorials and tried to solve any problems that arose while constructing their game. Heather used this process for one class. Not all of her students were building games at this point, because over half the class was still finishing their maps, story plan, or true and false questions. (one hour)

About seven of the students spent some time at home learning about Kodu.

Lesson 10.

Heather reorganized the groups. She created new, smaller groups for video game construction, which allowed the students more time to learn about the program and apply their game design. The smaller groups used the same story maps and plans, but created their own interpretations of the game. The students spent about an hour and a half building their land and adding in varying elements, such as huts, paths, and trees. Heather made sure the students had the compass turned on in Kodu so that they were building with the correct orientation. (one and half hours)

Lesson 11.

The next classes focused on the students building and constructing their games, while Heather reminded them to move beyond simply building land in their game. The students were collectively trying to figure out how to create "when" and "do" sentences, particularly in collecting or subtracting points. The students worked together. Heather did not utilize the tech ninja program in her class. Instead, the students asked for help from someone who was working near their workstation. Heather also continually circulated throughout her class as the students built their games.

As the students built their games, they were also discussing how to change some of the characters in Kodu to match their game plans. For example, some of the students wanted to have a bear in their game to represent a prominent feature in the Rocky Mountain region; however, Kodu does not have a bear. The students discussed some of the options of how to create a bear, such as making Kodu brown and having him growl when another character got close. Students who finished their video games early played each other's games and provided feedback to one another using the same guiding questions that Patrick and Angela used:

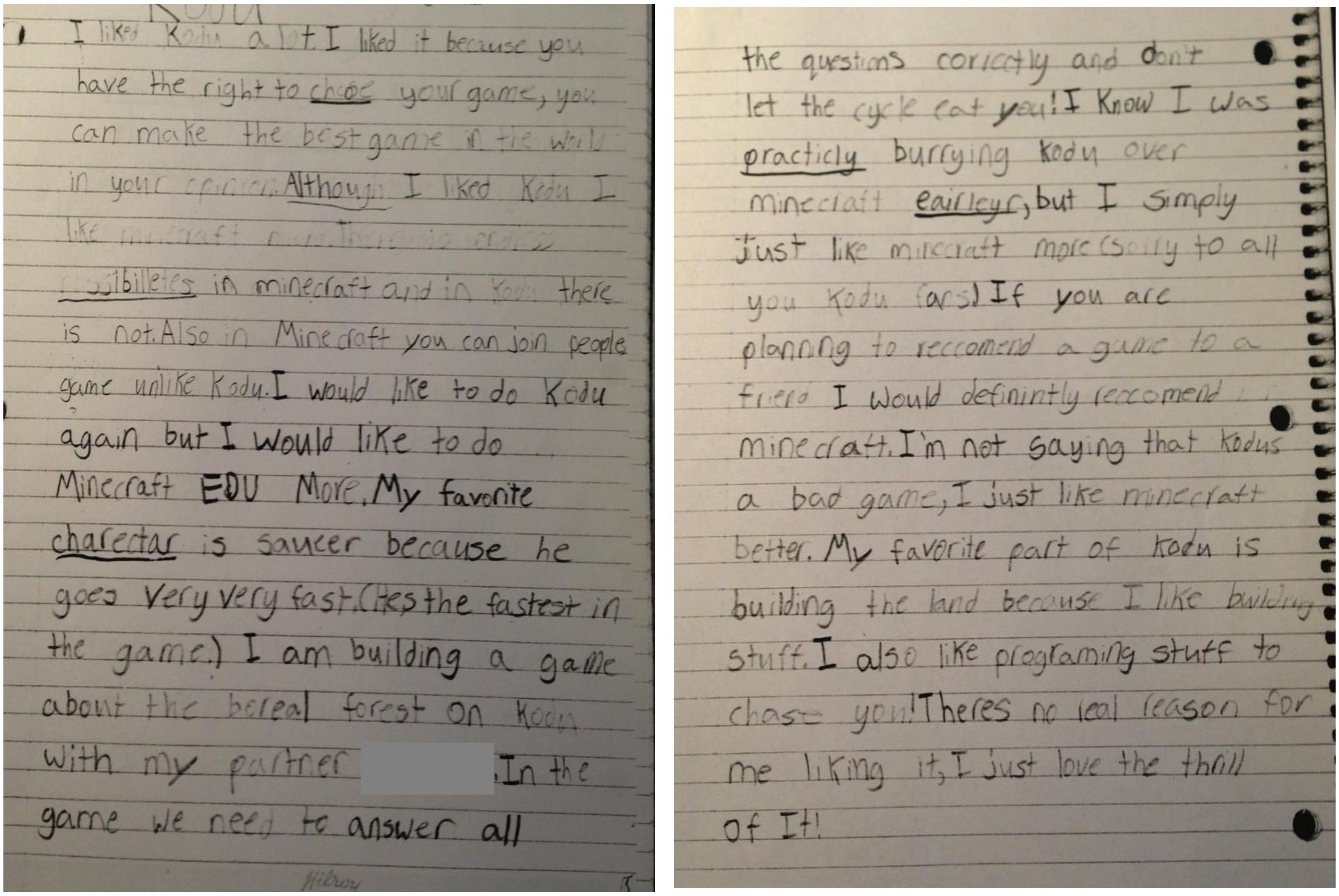
a) Retell the story
b) Was it too hard—or too easy?
c) Any advice on how you might make the game better (4 hours)

Lesson 12.

Heather provided a celebration day for the students to play each other's video games. The students exported their games into a shared drive that they could access. Not all the students had completely finished their games, so there were some students who were playing each other's games while others were finishing their own games. As the students played each other's games, there were often large groups of students gathered around a particular computer watching someone play. (one and a half hours)

Lesson 13.

The students spent an afternoon writing a reflection of their experience with video game construction. Heather provided some guiding questions for them to answer, including what they liked and what they disliked about the process. (one and half hours)



I liked Kodu a lot. I liked it because you have the right to choos your game, you can make the best game in the world in your opinion. Although I liked Kodu I like minecraft more. There is more possibilleties in minecraft and in Kodu there is not. Also in Minecraft you can join people game unlike Kodu. I would like to do Kodu again but I would like to do Minecraft EDU More. My favorite charectar is saucer because he goes very very fast. (Hes the fastest in the game.) I am building a game about the bereal forest on Kodu with my partner [redacted]. In the game we need to answer all

the questions correctly and don't let the cycle eat you! I know I was practicly burrying Kodu over minecraft eairleyr, but I simply just like minecraft more (sorry to all you Kodu fans) If you are planning to reccomend a game to a friend I would definintly reccomend minecraft. I'm not saying that Kodus a bad game, I just like minecraft better. My favorite part of Kodu is building the land because I like building stuff. I also like programing stuff to chase you! Theres no real reason for me liking it, I just love the thrill of It!

Figure 24. Caleb's Kodu reflection.

Lesson 14.

Although Heather did not collect any of the student's work while the game construction unit was going on, she did note that she planned on using Patrick and Angela's rubric to assess the students' work and their overall understanding of the regions of Alberta. Heather took a more holistic approach to assessment in the game construction unit than her colleagues.

Table 7: Assessment Rubric for Teacher-Generated Reflective Questions

4 - Exemplary	3 - Proficient	2 - Progressing	1 - Beginning
Thorough, in-depth, with precise details	Good understanding, detailed and accurate	Progressing understanding, general, with some accuracy and details	Limited understanding, little comprehension, vague
Accurate events or ideas, well sequenced; comprehensive	Events or ideas well sequenced; detailed	Events or ideas generally correct; general	Events may be partially in sequence; very little or no accuracy
Recalls all main facts/ideas and includes detailed and specific supporting details	Recalls most main ideas/facts and has many supporting details	Recalls some main ideas/facts with some supporting details	Recalls few ideas/facts with limited or no supporting details
Includes personal and consistent inferences; Includes elaboration	General inferences; some elaboration included	Starting to make inferences and may need further prompting to elaborate	Few/no inferences No elaboration
Uses appropriate vocabulary/ specialized vocabulary for the topic, enhances with effective word choice	Uses some appropriate vocabulary/specialized vocabulary and phrases	Uses general vocabulary and phrases	Little or no use of contextual or specific vocabulary or phrases

This section detailed the lessons that took place in both the grade 4 and grade 6 classrooms. For the grade 6 teachers, the most time and attention was spent in the planning process, where the students played games, discussed games, and subsequently planned and wrote game stories. Traditional planning and writing tools were used to support the students in the planning and writing process. For example, the teachers used the "Somebody, Somewhere…"

planning tool, which had been used for previous writing projects, to support the students in their writing.

There were moments in the planning and writing process that were unique and new to the teachers, and subsequently new to the students. The discussion centred on what makes good video games was certainly a new point of conversation. In addition, the students' highlighting of the parts of their story that would likely be included in their video game and the maps they drew to detail their game were also unique and new elements. These new pedagogies were significant; however, they didn't alter the basic structure found in the grade 6 classes. Rather, it remained relatively consistent to how planning and writing in language arts is often experienced. The teachers would often begin with reading a story to tweak the students' interest, then they would plan for a story, then they would write the story, and finally they might create some form of visual aid, such as a book cover.

Although the grade 6 teachers remained relatively consistent in their pedagogy regarding story writing, the second half of the game construction unit, which was centred on game construction, strayed from what was normal in the teachers' pedagogy. In fact, as the lessons indicate, the teachers allowed the students to construct their games with little structure. This starkly contrasts with the planning and writing experiences that took place at the beginning of the unit. It is possible that because game construction was a relatively new experience, the grade 6 teachers did not entirely know what the students could do while constructing a game, thus they trusted the students to construct a game based on their written story.

For the grade 4 teacher, the planning and writing process parallels the grade 6 teachers in some regards. For example, there was greater emphasis on the planning process at the beginning of the unit as compared to the game construction process. However, the grade 4 teacher spent less time on the planning and writing process, likely because she was connecting with the social studies curriculum rather than the language arts curriculum. However, much like the grade 6 teachers, her pedagogy remained relatively consistent with how a project might be experienced in class, where the students first begin by gathering information regarding a topic, then plan and design the project, and finally construct an end product, which in this case was a video game.

Although as the lessons indicate, more emphasis and direction was provided during the first half of the unit, the grade 4 teacher did provide some direction while the students were constructing their game, particularly regarding how the groups were formed and how the students were sharing information among themselves.

It is interesting and important to detail how the teachers implemented the game construction unit, because it provides context to the experiences of the students and teachers. This exploration into the game construction lessons also begins to answer why certain experiences took place in the unit. For example, the detailed writing process experienced in the grade 6 classroom influenced how the students experienced constructing their video game, as they had a relatively detailed story which they wanted to translate into a video game. The translation created both positive experiences for the students, as they were readily prepared to construct their game, but also some setbacks, where they struggled to translate the detailed story elements into game elements. The experiences of both the students and teachers will be further explored in the forthcoming questions regarding how first the teachers and then the students experienced game construction.

Question 2: How may elementary teachers experience video game construction in the classroom?

This section presents the themes that were constructed from the analysis of observations, artifacts, and interviews with the three teachers. These findings were collected over the duration of the game construction unit, and they begin to provide clarity regarding the pedagogical choices the teachers made in their design of the game construction unit. This question is divided into five sections: teacher pedagogy, collaboration, planning, writing and gaming, time, and assessment.

Theme 1: Teacher pedagogy.

Instructionism and constructionism.

Teacher pedagogy played an important role in how the teachers experienced game construction in the classroom. Their own interpretation of learning and how students come to understand and experience learning played a role in how video game construction was integrated in the classroom. It was interesting to see that each of the three teachers discussed the game construction project differently. Patrick's pedagogy aligned with a constructionist paradigm. He stated:

> I am a big believer in the process . . . they are going to learn as much from each other as they would from me. But the process—it comes back to the whole—the 21st century is not just technology, it's a way of learning and thinking and working with each other. And thinking about information and using the information. We are teaching them to be information connoisseurs, and so okay, if that is a word, where you are going to go and find out who you are going to trust or even listen to. And a lot of times when we do stuff—as teachers we have an

> end product in mind, so we tend to be the gatekeepers of information and process because we want the end product to look like this. And it becomes more of the craft and art you know. When I say we do projects—like that we want them turned out this way, and inquiry should be more of an art. Everybody's expression will come out differently. If we structure the inquiry project you should get a variety of different things. Not a craft where they are all cookie-cutter, and so too often we like to be in control. Part of being in control of our classroom is being in control of information. From where you find it and use this, and so we become the gatekeepers of tools, technology, and information, product, and art, supplies and such.

Patrick's connection to constructionism, as he understood the process, was more important than the final product, and his use of the analogy of art and craft provided an interesting representation of his own pedagogical practice.

For Angela, her teaching practice was defined through a more instructionist paradigm. This was demonstrated through her emphasis on showing the students how to complete tasks. She reflected on the experience as follows:

> So I think I need to do all that modeling and teaching of all these things, and then let's go into the Kodu. And now that we've learned how to reflect on various things, we've learned the story writing. And we've learned whatever we've done. Again, for me it's that modelling aspect I found that I lost in this project, that I wasn't able to model as much as I would've liked, and for them to really have that opportunity to practice it before they actually did their part. I would just add –it being at the end I would add all the modelling, because I was a little disappointed

> in the reflection questions in that way. Because I didn't get what I wanted. The higher level thinking and the reasoning behind and the support.

In choosing to model information to her students, Angela suggested that there was a specific way to come to an idea, and it was through her direct support and guidance that her students would come to better understanding of the concept.

Heather's pedagogical practice was similar to Patrick's, as it connected to the values of constructionism. She explained:

> I'm thinking I know we did a lot of the regions where I'm sure traditionally you could have done in a week or two, like just boom, boom, boom, right? But not having the kids really understand what it is and the higher level thinking process. So, no, I think just because that's the kind of thinker I am. I just see lots of potential and I just see—and maybe because my background is primary and I taught kindergarten for five years and all that. So, I see how everything kind of works together. Just 'cause we're not covering it for this assessment or this term or, know what I mean?

Heather provided space for the students to make decisions about the kind of game they constructed. However, beyond the content, Heather's demeanour in the class provided space for students to ask questions openly and with confidence, to work collaboratively, and to readily make mistakes.

Each teacher's pedagogy influenced how they integrated video game construction into the classroom. Patrick and Heather, who are more constructionist teachers, chose strategies that were more focused on student choice, while Angela, a more instructionist teacher, placed more focus on teacher direction. Interestingly, each of the three teachers, regardless of pedagogical stance, had a relatively positive approach to technology in the classroom. The following subsection further details each teacher's pedagogical stance, while also suggesting that there is fluidity in how a teacher approaches their own pedagogy, meaning that a pedagogical stance might fluctuate depending on the needs found in the classroom.

Fluidity between pedagogies.

In coming to understand where each of the three teachers was situated on a sliding scale of pedagogical practice between instructionist and constructionist, it became apparent that certain tensions existed. Patrick was perhaps the most clear about these tensions when he stated,

> This is 21st-century learning with a 20th-century/19th-century reporting process. And so by trying to make sure—I'm doing fantastic great stuff, but at some point having to justify and make sure it works with the reporting process we're obliged to use right now.

This tension between 21st-century and 20th-century learning was apparent in Patrick's own use of the story-writing form, because it not only provided the opportunity for the student to plan and write their video games, it also provided the opportunity to assess the students.

Patrick also used the word "frontloading," which contrasts with the very foundation of constructionism. By frontloading information, Patrick was able to quickly provide information to the students to ensure they understood the content. He stated, "At the moment we are focusing on frontloading in terms of looking at other games, figuring out the driving force behind it and analyzing the thought process that went into the game." Patrick used frontloading to potentially save time and to ensure the students were able to collectively understand the topic. However, at the end of the game unit, Patrick realized that he would have done things differently. He noted: "In the future, I would not baby step them through the game construction project. I would break it into smaller chunks and then have the game kind of evolve that way." Certainly Patrick's final reflection on the game construction project suggested that frontloading knowledge may not have been necessary; however, he came to this realization through designing and teaching the unit with his students. Patrick's own desire to allow the students to come to an idea through building and learning was juxtaposed with the need for concrete student assessment. Patrick also realized after the project was complete that he could have allowed for more student independence, but at the time he did not fully trust in his own pedagogy.

The tensions that existed between Patrick's pedagogical practice and the integration of emerging technologies in his classroom illustrated that it was difficult for Patrick to integrate constructionism into the class. Patrick carried the heavy burden of barriers, such as assessment and time, while also wading through the murky waters of how to integrate a new technology into the classroom. Video game construction was new to Patrick and he needed to work through the intricacies of game construction at least once in order to have both understanding and confidence in the process.

Heather also noted that the barriers posed by the curriculum created tension; however, she did not experience these barriers to the same extent as Patrick. She had some previous experience with student programming in classrooms, particularly through LEGO Robotics. This experience provided her with the opportunity to understand how to navigate some of the external barriers in the classroom, including content, time, and assessment, and to allow the students to work through and build the technology in a relatively constructionist manner. She reflected, "It has to have a little bit of a story to give appropriate information, the time and the hour or manner, be cyclical. If you get this wrong, guess what? You've got to go back to the start." This statement suggests that experience with video game construction programs or design programs provides a teacher with the confidence to understand not only how students can use game construction programs but also how video games can function in the greater school context.

Even with repeated experience with programming in her classroom and supporting other teachers through the integration process, Heather still implemented more traditionalist, formal structures as many of her students struggled to gather data about their region. She found that the data collection took a considerable amount of time, and stated:

> I'm thinking that I'll just have sheets already photocopied and I'll get them to highlight. I know that it is a lot of paper wasted, but maybe they need to actually highlight. I think that's a step I missed out on because I don't think they got that in grade 3.

Like Patrick and Angela, Heather found that she needed to depend on a structured approach to ensure that the students were able to construct a game. She had the students create yes/no questions for their games to structure the overall experience of the game. Heather's use of structure also connected to her understanding of the maturity of the students. She found that the students were not always focused enough to complete the research task without some formal structure, and therefore it was possible that Heather's structure was not necessarily a direct attempt to define what the students should think, but more an attempt to scaffold the experience for the students.

Angela also experienced tension with her own pedagogical paradigm, perhaps most notably with the technology. She reflected: "I am trying to take the video game and put it into language arts class rather than taking the language arts and putting it into the video game. Because I don't have that background information of video games." Angela experienced tension between how she would like to use the technology and the kind of experience the technology provided. In this way, Angela's own pedagogy was a force that worked against the effectiveness of the technology. This dynamic was noticeable when the students tried to fit their game construction story into the video game program. Because their game stories often called for a particular design, the students asked Angela many questions surrounding the potential of Kodu. Angela was unsure of how to answer these questions. She used a relatively tried and true technique of story writing, but the story didn't translate into a video game story. The students found this to be a frustrating experience.

Everything Angela knew about a good story and story writing seemed wrong in this situation. This experience, combined with her lack of confidence with video games and video game construction, caused tension in her pedagogical practice. She reflected, "I'm finding it a little difficult because I'm not a gamer and I don't play games and I don't know that background of games that they do have a story to it." A greater exposure to video games would have been helpful for Angela, to build her confidence with the technology and to further support her students, particularly while they constructed their games.

A teacher's pedagogical stance can play an important role in how they experience video game construction. A teacher with a constructionist stance may be more able to integrate new technologies into their classroom than an instructionist teacher who prefers to use technology in more teacher-centred ways. However, as this section has indicated, a constructionist teacher might have to implement certain experiences that do not align with how they would like their students to experience learning.

Theme 2: Teacher collaboration.

Collaboration occurred in the game construction unit in a variety of different ways, including teacher-to-teacher, teacher-to-student, teacher-to-principal, teacher-to-professional, and teacher-to-technology. Each of these collaborative experiences was interwoven in a dynamic manner, and none can be fully explored in isolation. In addition, the experiences of the teachers and their subsequent pedagogical approaches suggest that collaboration played a role for each of the teachers throughout this process.

Teacher-to-teacher.

Collaboration between the teachers was often dependent on each teacher's knowledge base and confidence. Both Heather and Patrick were more experienced and comfortable with technology, particularly the Kodu program, and were willing to share and collaborate with others. Patrick certainly took the lead in the process, given that he was the first teacher to explore and implement video game construction in his classroom. His experiences created a ripple effect among the other teachers, with whom he eagerly shared his enthusiasm about the project. The other teachers often used his ideas in their own classrooms. Patrick did not spend much time in the interviews discussing his collaborative relationship with the other teachers; however, he did express that his was

> sort of the class that is quite a bit out in the lead. So we're definitely breaking trail and you know in a way that's good. Although it is a bit lonely, but also depends on whom you are working with.

The following list represents the main contributing points that Patrick shared with both Heather and Angela:

- *Definition of a good game*
- *Video games played*
- *Story planning*
- *Story writing*

- *Map development*
- *Assessment/rubric*
- *Technology ninja program*

Personal connections.

For Patrick, the game construction process did not allow for many opportunities to share resources or discuss ideas because he was the first teacher to integrate game construction into the classroom. With a lack of support from a knowledgeable community, Patrick felt that in order to tackle game construction in the future, it would depend on working with someone with a similar pedagogical understanding. He suggested that it would be interesting to work with another school or another teacher, to not only have the opportunity to collaborate and share ideas, but also to share his own experiences with game construction.

Angela felt a similar tension in terms of her collaboration with Patrick. However, she identified that Patrick had played a central role in her ability to work through the game construction unit:

> I think it is really helpful because he plays games. He’s got that technology aspect of if. And he’s doing it first, so he can say, okay, like today don’t do that game. It’s too late. So I think that is great. It saves me a lot of time doing that. And next year I think it will be a bit easier.

Patrick provided the overarching structure for Angela to allow her to work through the unit, particularly given that she felt overwhelmed by her limited understanding of video games. However, Angela also had areas that she would have liked to alter during the unit. She recalled, for example,

> I didn't feel I had time to sit down with Patrick and plan through the unit completely. As were walking between classes, we might quickly suggest something. We'll do the reflection. Yes, we're going to do with writing and we're going to do it with maps. But we never really sat down for like a half a day or a couple of hours and said, Okay, what's our process? What are we going to do? What parts of the curriculum does this project meet?

Angela needed time to work through the unit, to consider the other elements and to plan accordingly; however, she felt that she never had the opportunity or the time to plan for the game unit. She stated:

> To be able to, I think, to sit down and plan our year, and say okay, during this time we're going to do Kodu because we're going to take these knowledge learning outcomes to implement it. Or have taught them how to do the process of a good story. And do it as a culminating activity.

This reflection demonstrates the competing demands that face the classroom teacher, and the limited amount of time teachers have to plan in a collaborative manner.

Although time was certainly a factor that restricted Angela's feelings of confidence, she also identified differences in pedagogical approaches as being a barrier to her teacher-to-teacher collaboration: "Patrick and I are such different thinkers. Like, I'm very linear. I need to know where I'm going. You know, what are my assessments going to be." On the other hand, Patrick was comfortable to plan as the unit unfolded. This comfort might have been because he had taught grade 6 for many years, and this was Angela's first year as a grade 6 teacher. Angela indicated that her own planning style and the newness of the curriculum meant that she needed more structure to her unit plan and more opportunities to contribute to the game construction unit.

While Angela's lack of confidence with technology and understanding of video games limited her ability to join in the planning unit, Heather felt included in the process, and contributed to the unit planning because of her understanding of video games and programming. She mentioned that

> Patrick shared some of the ideas of what makes a good video game, and lots of other ideas, and he gave me some rubrics and some planning documents. It's hard enough being a teacher on your own, if you're in your own grade, but having your partners there to bounce ideas off is awesome. If I didn't have Patrick there and he wasn't on the ball to give me some ideas and say, oh I'm going to try that, or oh I never thought of that, it would be much harder.

Heather felt confident and comfortable working with Patrick, and she was also able to make decisions about how her own game construction unit might be designed. In essence, she was able to personalize the unit to her own pedagogical practice and the needs of her students, while also making use of Patrick's expertise and knowledge. On the other hand, Angela didn't feel like she had the knowledge or space to share her own ideas when working with her teaching colleagues. This was particularly true regarding Angela's focus on the story-writing elements, where she felt she could have had a strong voice in guiding the students as they wrote their game narrative. She commented:

> So teaching something, a concept or a knowledge learning outcome, and then bringing it into that as their final kind of project. I think I was just doing 20 things at the same time, and trying to teach a story, which I really didn't feel like I was

> really teaching them a story. I was just basically going okay, they've had experience with this story in the past and the years ahead. But how is it that I should be teaching them more about adding details and different sentence structure, how to build up a character, doing all that where I didn't really have that opportunity with them.

Collaboration helped the teachers to implement a video game construction unit. For both Heather and Patrick, their own confidence with the technology and the autonomy they experienced in developing and teaching the unit allowed them to think beyond the school and begin to seek other collaborators to work with. Heather emphasized,

> I think being in my role as a technology coach and being able to try out these technologies, I can now say to other classes, you know what? I tried it out and I think it would be great for you at your level. Let's try this out together. Or if they come to me and say, well I have an idea but I don't know what kind of program, so maybe this is something that I can bring up.

Collaboration supported the teachers in finding ways to integrate game construction into the classroom. Similarities in the teachers' pedagogy also played an important role, where there was a greater exchange of knowledge and collaboration between teachers who shared a similar pedagogical practice and confidence with technology.

Teacher-to-student.

Collaboration between the teachers in this study and their students took place primarily while the students were building their video games. Each of the teachers utilized student expertise with Kodu to help make the unit successful. Although this was a new program for most of the students, many of them downloaded the program and tinkered around with it at home, which allowed them to become expert users. For example, in identifying his students' expertise, Patrick developed a tech ninja program in which expert students were identified to support other students during the game-building process. For Patrick, collaborating with the students in this way was a survival tactic. He explained,

> I won't make it, but these kids are naturally far more intuitive with this stuff than we are and there's so much out there, like going onto YouTube, or going to the Kodu site and looking information up. My students who were really eager went home and figured things out, like Aiden figured out teleportation, I didn't have to, and I had no idea that it was possible in Kodu.

Student leaders.

Student leaders played an important, if not pivotal, role in supporting the teachers through the use of Kodu. In general, Patrick believes in providing opportunities for students to support each other in his class. He noted, "I'm not an expert in this. For me, they know more than I do and I'm okay with that." Patrick indicated that it is simply impossible to be the expert in all areas, particularly when considering digital technologies. His confidence and pedagogical stance allowed the students to carry the expert role in the classroom.

In facilitating opportunities for technology ninjas in the class, Patrick also recognized the importance of student leadership opportunities, particularly for students who are not always provided the opportunity to showcase their knowledge. In fact, many of the game construction experts were not high-achieving students.

Heather also identified the valuable role her students played in the game construction unit, particularly in building capacity for successfully using Kodu. She stated: "Kids get ideas from others kids. We bounce ideas off of each other." In understanding the value that collaboration serves between her students and herself, Heather chose to not utilize the tech ninja program that both Patrick and Angela used in their classes. Instead, Heather focused on organizing her entire unit around group work, which contrasted with both Patrick's and Angela's classes. Patrick allowed his students to work in small groups, but he also had them write their own stories, while Angela had her students work on independent games. Heather selected groups based on each student's skill level and ability to work in groups, and, as a result, she had relatively balanced groups within her class. Heather was also responsive to students' needs, and after finding that the groups were too large and there was too much idle time, she split the groups in half and each smaller group created a game based on the region. In these rearranged groups, Heather found that the students naturally helped each other and rarely sought outside help. Heather was more hands-on with the students, and helpful when solving some of the problems the students encountered. She reflected:

> It depends, I think on what the issue was. But I think for the most part they all figured it out. There were a couple of things where I thought, oh I should check out that tutorial, right? But I think for the most part they could pretty much figure it out.

Moments of frustration.

In Angela's case, her class relied solely on student expertise to support their development of programming and Kodu. Because Angela was not able to help the students beyond the story-writing and reflection aspects of the unit, when a problem arose, she felt frustrated that she could not help them, which also resulted in an increased sense of anxiety among her students. Angela noted, Like Clara, she said it didn't work, and the program kept crashing. And she asked the tech ninja for help, but the tech ninja had no idea of how to help her. And I have no idea. So I just feel dumb when it comes to this.

In all three classes, it seemed as though student collaboration worked to a certain extent, but there were moments when the teacher was required to jump in and support the students in their gaming problems and game design. Although Patrick was not an expert in Kodu, he had a base knowledge that allowed him to navigate through the program. Angela, however, did not feel like she had this base knowledge, which created some tension for her students.

Teacher-to-principal.

While the teachers did not identify the role of the principal in the game construction project, Patrick understood that the principal's support principal was pivotal to allow such a project in the classroom. He reflected:

> The support of the principal was fantastic in terms of being able to say we're taking too much time in the lab and if you don't like it, go talk to the boss. But we could have worked around that. And I think we linked this to the curriculum so tightly, I wasn't worried about justifying this, but it always helps when you have a principal that is backing you.

During the course of the project, it was helpful for the teachers to have this support, because each of the teachers involved in the project was given more freedom to use the computer lab and laptops in the school, particularly given that the school followed a scheduled lab time. The three teachers in this study were able to use more computer lab time than other teachers in the school. This extra time was vital in allowing the students to work on their games for extended periods of time.

Angela knew that this support was partially driven by the connection the game construction project had with the school district's Transform initiative. She commented, "We did have the support of the administrator because of its transform-[ness]." Each of the teachers understood that the game construction project met the requirements defined by the Transform initiative (see Figure 25), which in turn fulfilled their own commitment to the initiative for the year. This was certainly one of the initial benefits of the game project for the teachers, and the project was advertised on the Transform bulletin board located outside the office.

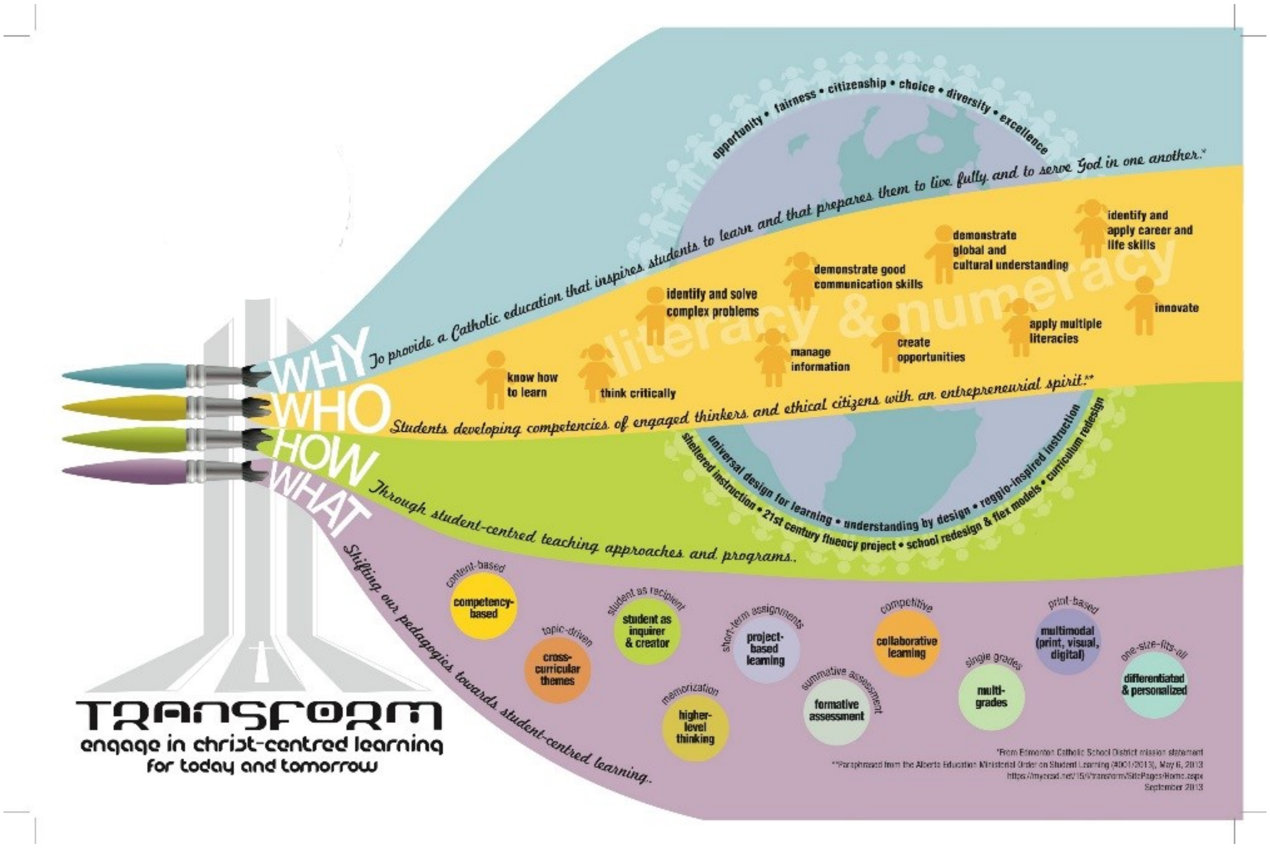


Figure 25. Transform initiative.

Although Angela identified the role the project played in meeting the expectations of the Transform initiative, she was not convinced that it served the best interests of her students. She stated:

> I think because it's Transform and we have to do a project we're trying to find something that we can show. That we have done. Rather than say, okay, is it really beneficial to my kids? What are they really getting out of it? Or is just because we're on the bandwagon and we have to do this?

For her part, Heather did not mention the role of the principal; however, she did express that she values the interconnected role the game construction project had with the Transform initiative.

Principal-to-teacher.

It is important to note the principal's perspective regarding collaboration and how she fostered it in the school environment. Natalia, the school principal, stated,

> I am a strong believer in empowering teachers to take the lead. Technically, in a school like mine with over 500 students, I cannot do it. Even other things that I'm an expert, like I could teach French, but I can't. It's impossible with 500 students.

Natalia valued distributed leadership, saying, "I prefer to get my own people to lead something, like Patrick can lead technology integration, and somebody can lead literacy." She also notes that this distributed leadership will inevitably be more successful and accepted by the other teachers than a top-down type of leadership. These specialized teacher leaders have a greater sense of credibility than Natalia does in these particular areas. Natalia explained,

> They are using it in their own classroom and then they have things to talk about. Well, this really worked or this didn't work. Patrick's experience, or Angela's experience, or Heather's experience with the gaming, this worked but this didn't work. And then they can share this with the staff.

Principal support was essential to allow the game construction project to take place in the school and to ensure access to needed resources, such as the computer lab.

Teacher-to-technology.

The game construction technology played a pivotal role in this study, which consequently impacted each of the teachers and how they designed and implemented the game construction unit. This role was particularly important because Kodu was a new technology to each of the teachers, which meant that each teacher had a unique collaborative relationship with the technology.

Confidence and a basic understanding of how to access and use technology to locate information seemed to play an important part in how the teachers experienced the technology. In addition, it was important to each of the teachers that they had continuous access to the technology when it best suited their own time, as compared to booking the computer lab on a schedule. Lack of just-in-time access to technology was a problem for all teachers in the study, particularly because the schedule limited their use of the technology for extended periods of time.

Accessibility.

Accessing the technology proved to be a challenge for most of the teachers in their ability to collaborate and use technology easily. For example, Patrick identified the computer schedule as challenging, but he also found the amount of technology available, and its speed, were challenging for him and the students. He commented:

> It would be ideal to have one tablet device for every four kids in our school. And reliable Internet speed that is fast, efficient, and works consistently. And while I like the tablets, at some point you need a keyboard, and you need a dedicated

input device. And whichever device it is, I think we need at least double or triple bandwidth with what we have in the building right now.

Patrick also highlighted the inequity in an elementary school, as compared to a high school. This was particularly true for bandwidth, because his younger students might not be as patient as older students. He stated, "Elementary schools have slower bandwidth than high schools, which sometimes makes it difficult to use technology in the class." Slow bandwidth may be a significant barrier to the ongoing success of technology-related projects in an elementary school.

Angela also highlighted the importance of having access to more technology in the school, particularly due to the size of the school community: "We're a big school, it is the timetabling that is a factor. And it is difficult to be organized all the time and book the lab and the laptops. It is a big factor." Angela would have preferred to have opportunities to be more spontaneous with technology, so that, for example, if "someone in the class asks quickly, like let's look it up or let's do something, and having that technology in the classroom is important to answer those questions, and that is how the school system is going." Angela believed that technology should always be available in the classroom for all students to allow for greater accessibility.

Curricular connections.

Each of the teachers felt that it was important, if not vital, to connect the use of technology with the curriculum. The value of the technology increased for the teachers when they felt they were connecting to a curricular outcome. Both Heather and Patrick believed that it was important to allow the students to explore through the use of the technology and to tinker with the tools. They also expressed that this free exploration should not be the sole use of the technology in a classroom and suggested that tinkering or playing with technology could also be experienced after school. Perhaps one of Angela's greatest hesitations regarding the use of the technology was that she worried that the game construction experience would not address the various knowledge and skill outcomes in the curriculum. She reflected on this concern, stating, "I think that as long as it's not just, here's Kodu and it's a fun game, but how do I implement it, and how does it correlate to the curriculum?" This connection to curricular outcomes was crucial for the teachers, and was one of the reasons they combined subjects within the project, to ensure that not just one subject was addressed. This combination was particularly important because of the amount of time the project required.

Patrick saw the connection to the curriculum in a slightly different way. He understood the integration of technology into the curriculum as a way to fill gaps in his own professional practice, "because in some places technology does a better job." He referred specifically to the Khan Academy and the use of Barbara Reid's YouTube videos on how to create varying forms of art: "That's more than I could ever hope to do. And I mean she teaches the lesson and then I'm here to steer them in the right direction. There's some stuff that technology does and will do better." (see https://www.youtube.com/watch?v=F4aOMVZLEpw for an example of Barbara Reid's videos)

For Patrick, therefore, technology was critical, not only to support his students' participatory needs, but also to support him in meeting the curricular demands of being a grade 6 teacher.

Repeat experience.

Each of the teachers suggested that a repeat experience with the technology was essential for them and their students to use the tool more effectively in the future. The three teachers understood that they and their students were not very effective with Kodu during the game construction unit because it was the first time any of them had built video games in class. However, they also realized that with repeated use, their students would not only become less distracted with the nonessential details in the game, but that the overall quality of the games would also improve as they all became more familiar and comfortable with the process. For example, Patrick believed he would need to provide a repeat experience for both himself and his students because it was easy to get lost in the details of these technologies. He explained, "Sometimes you get lost in the digital world, you lose sight of where you are and where you're going, or you get caught up in all the bells and whistles again." Heather had a similar perception, particularly for the grade level she was teaching. She commented, "Because the way these kids are, they'd just be stuck on choosing icons and whatever. And that's not the process I want to be learning. I want them to learn the regions of Alberta."

Similarly, each of these teachers understood the important role that all technology, not just Kodu, played in their lives and in the lives of their students. Patrick noted that developing lifelong skills was important, stating:

> The end of this project is that my students can use it as a presentation tool for future years. The biggest thing is that they are more critical users of technology, even the websites they look at. I feel that the games that they will now look at, or play, they will be more critical of them, considering if [the games] are pleasantly frustrating, or if they are well designed.

The teachers' use of technology and their ability to collaborate and interact with teachers, students, the principal, and the technology demonstrates the complexity that is associated with integrating video game construction into the classroom. Each of the teachers sought the support and guidance of others, which indicates that collaboration is essential when integrating video game construction into the classroom.

Theme 3: The process of planning, writing, and gaming.

The three teachers who participated in this study came to the video game construction project with a unique perception of planning and writing and how those processes might look in a game construction unit. They all believed that it was important for the students to have some kind of plan and/or story in mind prior to constructing the video game, and that the story needed to be complete prior to building a game with Kodu. All three of the teachers believed that video games have a story, particularly given that both they and their students experienced an underlying game narrative located in games such as Icarus Needs and Sprout. The differences in the teachers' approaches to planning, writing, and gaming is another significant theme that were constructed from the data.

Both of the grade 6 teachers, Patrick and Angela, felt they needed to emphasize an in-depth game story with their students because the game unit was connected to the language arts curriculum; however, they varied in their perception of the knowledge and skills the students required to construct a game story. Angela, for example, felt that the students required more formal learning experiences, particularly lessons focused on the mechanics of writing. She stated,

> To me it would have been better to let me teach them how to write a proper story, making sure that they have developed all that. Because I'm just assuming that they learned story writing in the past, which they have.

However, Angela discovered throughout the unit that her students had not learned enough about the basic components of writing a story, reflecting, "so I think I need to do all that modelling and teaching of all these things, then let's go into the Kodu. And that we've learned how to reflect on various things, and we've learned story writing."

On the other hand, Patrick and Heather focused less on the mechanical requirements of a story and more on exploring ways in which a game story can be planned and implemented. However, Patrick did lean more on his previous knowledge of story writing, particularly by integrating the "Somebody, Somewhere…" planning tool, which had been introduced at a district-wide language arts session.

> The reason I keep this planning method for game construction is because I think it is something we can carry on throughout the whole year. And I'm a bit of a linear thinker myself, but I find the nice thing about that is you get the cause and effect action happening and I find that's really hard for kids to wrap their heads around, as at least there's something where they can look and when it does this, that causes this, and the chain reaction flows well with that.

Although both Angela and Patrick utilized the "Somebody, Somewhere…" planning method, Heather was apprehensive about integrating it into her classroom, because not only did she believe her students were too young to go into that much detail, she was unsure about having her students write a story for the game construction unit.

> Do they really need the story? I don't know. It sort of got some of them on track, then some, I notice a couple of groups, maybe it was Colin's group, was focusing way too much on the story and that got them off track. So that was what I was worried about. So maybe that part, because it's the social aspect, trying to get the questions and trying to get the information versus an actual storyline. So that threw me off a little.

Heather used other forms of planning and writing, including maps, flip books, and yes/no question to help the students plan their video game stories. Reflecting on the future of video game construction, she noted that she would continue to do the planning she had implemented, particularly the maps the students had constructed, because

> I really liked that visual we used for the map of Alberta. So, I think even just to get their mind on how they're going to put the shape and what's the pathway? I really like that. And the discussion we had was trying to figure out where we're going to start, where are we going to end, and what icons to put in.

She also noted that another time she might use a storyboard instead of the yes/no questions or the "Somebody, Somewhere…" plan that was used prominently in the grade 6 class. She explained, "Those storyboards might be less intimidating than writing a boring story." However, she noted, "I'm thinking of my struggling readers and writers who, if I told them to write a regular story, would look at me like, seriously?" For Heather, the intrinsic motivation that was derived from creating a game might be diminished if the students had to enter into writing a traditional story, and she was not convinced that writing a story was the best way for her students to experience game construction.

Patrick and Angela also reflected on the planning and writing process they entered into, and highlighted some of the areas that did not work. Upon reflection, Patrick, for example, said that he would have done things differently:

> I would have done two games, I would have done a mini version first, like mini tasks. Build a game where your character solves one problem. Now build a game where there is two problems and there's a difference between how to solve the first problem and how to solve the second problem. And sort of built it up in level.

> So the first one would be focusing on some landscape, where you moved into the landscapes and then discuss what's too much. And then add in a new problem, okay what's too much? And then sort of work our way in levels, 'cause we just sort of did stories and jumped into a game and just sort of let them go with it and that was fine. But in the future I would break it into smaller chunks and then have the game kind of evolve that way.

Patrick's focus on scaffolding suggests that there was too great a leap between the students' stories and their video games. Next time, Patrick said that he would have the students write in small sections, then have them translate the individual sections into the game to make more sense. Patrick also found that the traditional writing process was difficult for the students to translate into a video game. He noted that another time he "would focus less on the traditional story and I might have done something more along the lines of storyboarding, rather than just taking a story and pulling the pieces out." Patrick further emphasized that

> game construction is a visual medium and the storyboarding, even if it's just stick figures, here's four panels, what do you want your story to look like . . . or you know what do you want this problem to look like, 'cause they have to think graphically, and so that would be something that might help make the transfer go better.

In referencing a storyboard, Patrick identified that he needed to provide different kinds of opportunities for his students in preparing for their video games, particularly because constructing a video game not only is a visual medium, but is also experienced differently.

From the outset, Angela struggled to make a connection between story writing and the video game. She commented:

> So I'm trying to use, I guess the video game as a tool to, instead of a picture book. I use it that way. Which I'm finding it a little difficult because I'm not a gamer and I don't play video games and I don't know the background of games that the kind of story they have.

It was Angela's lack of understanding that fuelled not only her collaborative relationship with Patrick, but also her dependence on story-writing instruction that she had used in the past. She noted:

> I'm comfortable with a chapter or a novel, or whatever I can find that I can build comprehension, and I am thinking I don't know if I am getting the gist of video games and video game stories. It's a little bit tough doing the video game.

Although Angela struggled to work through the game construction unit, she reflected on the process and recommended a few changes to it, particularly after all the formal content was taught to the students.

> I would create a storyboard, having each square represent something. So my first square is going to be my introduction. The next one is going to be this is what I am going to program because it's going to represent this. So this leads me to quickly assess what the students need to do in Kodu.

Similar to Patrick's recommendation to write small chunks of a story at a time, Angela also noted that it would helpful to scaffold a story together. She explained, "I think it would be an easier transition for the students, because then you can say, well, this is what Kodu can do, and the students understand how they can implement that into their game."

Both Patrick and Angela also noted that some of their students got lost in the game construction experience, and Angela found that some of her students struggled, not only to make the connections between their stories and their video games, but also with how to implement some of their story components into their games. This was particularly true if Kodu was unable to do a certain task or command. She said: “I think this threw them off. Because they had written this story and had this idea about what the character does in the story. But putting it into Kodu, well it simply couldn’t do that.”

Patrick also found that students got lost in the game construction process, particularly with the varying tools situated in Kodu. He said, “Sometimes you get lost in the digital world, you lose sight of where you are and where you’re going or you get caught up in all the bells and whistles again.” Patrick suggested that this is a natural part of using technology in the classroom. He recalled when PowerPoint was first introduced into the classroom; his students had a similar experience, where they needed to play around with the customization features, such as making a slide transition in a certain way. However, Patrick has found that when a technology is used repeatedly, it becomes easier to use and more connected with the content.

One of the last concerns that both Angela and Patrick brought forth was the integration of the math content and the math questions into the students’ video games. Initially, both Patrick and Angela felt that it would be useful to integrate both language arts and mathematics in the project, because doing so was a recommended process to create cross-curricular connections, particularly when working through a project. However, both teachers felt that adding in the math questions imposed a barrier on the creativity and quality of the game stories and video games that were constructed. The games became solely focused on answering the math questions, rather than allowing the students’ creative stories to come forth, which resulted in a relatively formulaic video game experience for many of the students. Angela reflected, “I wonder if you write the story, just write the story, don’t even think about the math. It’s interesting, as I’m reading through the stories, some of the students don't even have the correct answer to their math questions." Both Angela and Patrick were looking for a greater variety in the problems the students created, but because there was such consistency among the students' questions, it is possible that adding in more complex questions was too difficult. Both Patrick and Angela suggested that in the future they will likely just have the students create a video game based on the language arts curriculum, rather than combining the two subjects.

Each of the teachers, particularly the grade 6 teachers, found it difficult to connect the planning and writing process to the game-making process. This difficulty created a sense of tension, not only for the teachers but also for the students. This tension exemplifies the disconnect that can exist between well-formed pedagogical practices, such as the story writing the teachers had experienced in previous years, and aligning these preestablished experiences with new ones, particularly constructing a video game.

Theme 4: Time.

Video game construction can take a considerable amount of time, particularly when one is immersed in the game-making process. Each teacher noted that the video game construction unit took more time than the traditional curricular equivalent, such as writing a story or creating a PowerPoint of the regions of Alberta. In order to learn more about integrating video game construction, each of the teachers had to invest time throughout the unit to learn the program, to create lesson plans, and to collaborate with each other, particularly because it was a brand new experience. In addition, the teachers had to invest additional class time to ensure that each of the students understood how to build in Kodu Game Lab and how to write a game story or plan a game story, because this was also a brand new experience for the students. Although extra time was needed, each teacher found it worthwhile to provide this extra time because it allowed them to go deeper into the design and structure of the game.

Classroom time.

Patrick, for example, felt that he needed to dedicate more class time to ensure his students had the opportunity to plan, write, and construct their video game. He also understood that extra time was required when integrating emerging technologies into the classroom. He mentioned that, throughout the project,

> if you want to try a new, something new, you have to give something up. I think it is worthwhile, and it took me a long time to figure this out, for whatever, you take on something new, you have to be willing to let go of something.

Patrick highlighted the realities of technology integration when he stated, “Five years from now this version of Kodu will not look like this,” which means we might have to create a very different kind of learning experience.

Heather also suggested that the game construction unit took more time than other projects; however, she felt that the time dedicated to this project was worthwhile. She reflected:

> I’m thinking I know we did a lot of regions where I’m sure traditionally you could have done in a week or two, like boom, boom, boom, right? But not having the kids really understand what it is and the higher level thinking process. . . . Sure it takes a long time, but I think it’s going really well, especially with their discussions. They’re really getting into it. They’re thinking about the steps where I don’t think if it was a paper/pencil test they would have been like, well, whatever—they’re getting into it. But I bet you in a couple of months they’ll still talk about this project. Hopefully, that is.

This meaningful experience is important because, as Heather suggested, it will hopefully be something that the students will remember in the future.

Patrick also found that the time dedicated to the game unit was worthwhile, particularly because his students were able to acquire a unique skill set. He explained:

> They understood why we took apart games, and the planning and all that. And if nothing else, even if that's all they get out of it, that's a hugely worthwhile thing.... They had to take the abstract to make it concrete, which will improve their writing later on.

Patrick suggested that his students were able to develop a more reflective stance on the video games they played and the role that game construction might have in other subjects, in other schools, and in other disciplines:

> My thoughts are if I'm going to invest this much time in something, I want it to be a scalable thing that they could take with them beyond just now, because for me to invest a lot of time and effort in an activity that you can do one year and it's done, doesn't make sense. And it doesn't benefit them. So previously when we were using Prezi, before we carefully investigated the terms and conditions, for me that was a great tool because it was a tool that my students could use all the way through their education. So I try to invest my time and effort in stuff that is more that just a one-year product.

Heather also suggested that her students might not remember everything about their region in ten years, but she believes they will continue to remember that they had this opportunity to build a video game, an experience that they might carry with them in the future. She reflected:

> Really, in ten years are they going to remember regions of Alberta? Probably not, even if you got them to memorize it, but they're going to remember this experience, they're going to remember, wow you know what? We built a video game. We worked together really well.

For Heather, the time spent on the project went beyond the curricular applications of learning the regions of Alberta. It was also connected to developing important social skills, such as collaborating and sharing in a group. Heather believed that this was an additional benefit of such a motivating and engaging project, because the students would carry these social skills with them throughout their lives.

Patrick expressed that it was important to spend time to ensure his students felt confident with the technology so they could use it in the future. For example, it would be incredibly rewarding for Patrick to see his students return in future years and tell him that they had built a video game in their grade seven social studies class. Patrick also found that the game construction project could extend to other projects in his class: He noted, "This is process work and it should be good for other projects down the road. Even if it's not, they still work through the portal, gathering information, expressing ideas, presenting it in a variety of formats." Thus, it was not simply the time spent learning how to build a video game that was worthwhile to Patrick, it was also the skills the students learned through the game construction unit.

Angela had a different perception than Patrick and Heather of the amount of time spent on the game construction project. Angela used words such as time consuming, lingering, and choppy to describe the process. She found the use of time throughout the project to be disjointed. The students would begin writing their story, then there would be a day or two when they would leave their game story and work on something else in language arts or math, then they would return to game story or the video game. Angela suggested that in the future,

> I would have done all the teaching components first and the language arts and then the math theory. And then I would have done the final project. Because I would have liked to spend a bit more time in the writing process of it and how to write a proper reflection question. And how to get them to think deeper in their answer in that way. And then spending two days solid on building a video game.

Angela found that the project did not dedicate enough time to teaching the skills to complete the tasks that were required of the students in the unit. She felt that the students' reflections, their stories, their math problems, and their maps were missing details that would likely have been rectified if a greater amount of time had been spent teaching the students these skills. In addition, Angela felt that the time dedicated to the unit could have been utilized more effectively if the actual video game construction had taken place over an entire day, rather than in one- or two-hour sessions.

Angela also connected the amount of time the game unit took with the deficiencies of the school's technology. She explained:

> Because they spent all this time. And then they lose their world. Though it's not there because they had saved it on a USB and now it's not there and that's so it was. It was very frustrating because they know they put all that time in there and then to have to rebuild it. And then thinking, okay, what did I put in there?

Angela's students experienced many issues with the Kodu program, particularly when they worked on the school's laptop computers. This led Angela to question whether the time spent using the technology was valuable or worthwhile, particularly because the technology did not work smoothly and there was a lack of expertise to solve the problems.

Angela also felt that there was not enough time in the game construction unit for herself and the students to collaborate. She would have liked the opportunity to have time to plan and develop the unit with Patrick. She reflected:

> We never really sat down for like a half a day or a couple of hours and say, okay. What's our process? What are we going to do? What parts of the knowledge learning outcomes does it meet?

Each of the teachers felt that the video game construction project took more time than a traditional learning experience; however, they felt the additional time was an essential component of video game building.

Longer periods of time.

None of the teachers noted any complaints from parents about the time spent playing and building video games; however, there was some tension in the school community regarding the amount of time the "gamers" spent in the computer lab. St. Luigi School has a predetermined computer lab schedule, but the teachers involved in the game construction project were provided freedom to use some of the time that might normally be dedicated to other classes for their projects. Some of the other staff felt that there was an inequity, even though the time was well spent and generally required by the students. Patrick emphasized, "I don't like a booked time in the lab, because I'm a big believer you go in with a purpose and if there's not a purpose you shouldn't be on there." These large units of time did impact the school computer schedule; however, Patrick felt justified in adjusting the computer schedule, because he was able to prove that the project was connecting with the curriculum in numerous ways.

Each of the teachers found it beneficial to provide their students with large amounts of time when building the video games. Anything less than an hour to work on the video game was not useful to either the students or the teachers, because by the time they logged in and got themselves organized, the period was over. At least two-hour periods were required, if not full-day game construction sessions. Heather suggests that it would have been helpful to have more time in the lab to potentially add in more details, to play each other's games, and to edit the overarching content of the game. She reflected, "If we had more time I think we would have edited, like, oh let's go back. Were there capital letters in the description? Were there question marks?" However, these are more surface details to the game that would generally not detract from the overall learning experience and gaming experience of the players.

In considering the varying pressures a teacher must balance in their practice, time is certainly one of the main pressures that can affect the kind of experiences that transpire in the classroom. Although each of the teachers felt that it was important to provide additional time to this project, and in longer chunks than was often scheduled in the classroom, it is also important to note that this kind of learning experience might be difficult to replicate throughout the year. There simply is not enough time in the year or enough space in the Alberta curriculum to allow for this kind of experience to happen repeatedly, particularly because each teacher had to take certain topics out of their plan while the game construction experience took place. It would be almost impossible to build video games throughout the year with the same intensity the teachers and students put forth and meet all the curricular outcomes. In essence, video game construction is time consuming and competes with the other curricular demands defined by the Program of Studies.

Theme 5: Assessment.

Assessment is an important factor that describes the learning that takes place in the classroom. Assessment-based practices, such as tests, notes, and rubrics, all contribute to the learning experience, because often the teacher will define how the student will be assessed at the onset of the unit. In addition, teachers generally need to collect three or four forms of evidence to assess a specific curricular outcome. And considering that an elementary teacher usually must report on 21 curricular outcomes over one school year just for language arts, this represents a considerable amount of pressure to both identify and collect varying forms of assessment.

Each of the three teachers who participated in the study identified the importance of assessment in the game construction unit, where they felt accountable to the amount of time allocated for the project. Although game construction was a new experience for each of the teachers, they each utilized their previous understanding of assessment to inform how the video games would be marked and integrated into the students' report cards. For example, Patrick recognized that his assessment practices are confined to the demands placed on him by the curriculum. He felt caught in a confounding situation: he felt the need to continually reel in his own practice to meet the demands found in both the Program of Studies and the district-wide assessment practices. He commented, "I'm doing fantastic great stuff, but at some point having to justify and make it work with the reporting process we're obliged to use right now."

Traditional and non-traditional forms of assessment.

This connection with the curriculum and preestablished assessment practices was seen clearly in each of the teacher's choice of assessment, particularly regarding the students' stories and planning documents. Angela and Patrick both used a variety of assessment techniques to grade the students' planning documents, reflections, and stories, including observations, notes, checklists, and rubrics. In general, their overall assessment of the unit focused on the story writing, because both teachers found it difficult to assess the students' final video games. Angela cited not having enough time to assess the games, particularly because she wanted the students to assess each other's games, which again emphasized her reliance on her students' game construction expertise. She commented, "I would have liked the students to assess each other's games. But again, time is a factor in all the problems that we had, we didn't do that."

Patrick also found it difficult to assess the final video games, particularly because he feared that assigning a particular grade would limit the students' creative process:

> The students are enthralled in the process right now that they haven't asked about their mark. I think they just figure that the game is going to be the mark. I don't know if they realize that I'm watching them through the process and taking mental and physical notes.

Both Patrick and Angela lacked the understanding and resources to feel equipped to accurately and fairly assess the students' final video games, even though both teachers collected, albeit mentally, non-text-based assessments throughout the game construction process. They also didn't want to derail the students in their holistic gaming experience, because they were both innately aware that game construction was a different kind of experience than the more traditional writing experience, and thus it demanded a different kind of assessment. The kind of assessments that Patrick and Angela relied on throughout the planning process, in using rubrics and checklists to assess their students' stories and reflections, were simply not appropriate for a video game; however, they did not know what to do with their observations once they were collected. This finding suggests that teachers need more support and examples of how other teachers have assessed video game construction. Each of the teachers was successful in situating the game construction unit in the Program of Studies, but assessing the games was a far greater challenge for them.

Although Heather did not align her focus on assessing the students' video games, she seemed less concerned about locating forms of assessment to validate the students' work and knowledge. One contributing factor was certainly the difference in grade levels, because grade 6 has traditionally been framed around a more standardized form of assessment. However, it might also have been because of her own pedagogical practice and how she perceived the game construction unit. Throughout the process she developed a rubric that focused on three areas: game building, group work, and content knowledge. Although the content area of the regions of Alberta was a driving point for the project, Heather also emphasized the importance of group work and collaboration:

> So we have our rubric. Just more of the game-building group work, collaboration wise, and the kind of information they have put in. I think those were the basic three that we're going to assess. The group work one is very interesting. I can really see who's not going to work well with that.

Although these process skills are in the curriculum, some teachers find it difficult to assess them and they are rarely included on report cards.

Provincial achievement tests.

As noted above, grade 6 curriculum usually culminates with a set of standardized province-wide tests, which impacts the structure and timing of the entire grade 6 year. The grade 6 provincial achievement test (PAT) was cited as one potential reason why there might not be enough time to include video game construction in grade 6 classes. At the time of the research study, the grade 6 PATs had been removed; however, the provincial government has since reinstated the testing for the 2014/2015 academic year.

Because Patrick had been a grade 6 teacher for most of his career, he understood the pressures that are placed on him, from both the school and parent communities, for his students to perform well on these standardized exams. However, Patrick felt that he had more time to explore this kind of project, because the pressures of the PATs had been removed. He stated: "We don't have the same pressures as with the PAT, as we did in previous years; however, I'm still moving at that pace because you always find you are scrambling for time at the end of the year." Patrick suggested that even if his students had had to write the PATs, he still would have tried to integrate the game construction unit because he values the importance of students learning new skills and developing new ideas through a hand-on learning approach.

Angela, on the other hand, strongly stated that this kind of learning experience would not have been integrated into her year if she had had to prepare her students for the PATs. She stated, "I thank God we don't have PATs because really I don't think this would have happened. . . . This game unit would not have happened if we have PATs, just because I'm already feeling like I'm falling behind in everything. And I'm thinking language arts, what have I covered? A story." Angela felt like she was behind in her curriculum, which reflects her earlier statement that the game construction unit was time consuming, particularly when she felt that at the end of the first term, she had only covered story writing.

The future of assessment.

Heather identified the importance of information and communication technology (ICT) outcomes in aligning the video game construction project with non-content-area outcomes. For her, this alignment validated the introduction of the new technology. Although Heather seemed to demonstrate the least amount of struggle with regards to how game construction could be assessed, each of the teachers indicated that their next game construction unit would be easier to assess because they could use their new understanding. This second chance would align their focus with video game construction, as compared to primarily focusing on story writing and planning. Each teacher realized that game construction requires a different kind of assessment, one that encompasses a more holistic approach. In the future, it is possible that rubrics and checklists might not be sufficient to understand the learning that transpires through game construction. This might indicate that video games and the video game construction process are difficult to assess, particularly in assigning a grade to the product.

These findings begin to identify the concurrent themes that represent the teachers' experiences in the video game construction unit. There was juxtaposition in regards to the teachers' experiences, where on one hand there was an excitement, because the teachers understood that integrating these kinds of experiences was good for learning and good for their students. However, on the other hand, each of the teachers experienced tension, whether it was the amount of time they had to dedicate to game construction, how they assessed their students regarding the non-traditional video game, or how their students planned for their video game.

These findings indicate that game construction is difficult to integrate into the classroom because it is different from what is considered normal. However, in considering that each of the teachers indicated that they would be interested in participating and integrating video game construction in the future, the positive experiences must outweigh the negative ones.

Question 3: How may elementary students experience video game construction in the classroom?

This section presents the themes that were constructed from the analysis of observations, artifacts, and interviews with the 11 students. The themes include problem solving, use of video game construction technology, playing, planning and writing, and student collaboration.

Theme 1: Problem solving.

The first theme related to this research question has to do with the problem solving students were required to do throughout the unit. Each of the students experienced an array of problems as they built their video games, and each student used a variety of strategies to overcome these roadblocks. Each of the students worked hard to overcome the hurdles they experienced while building their video games, suggesting that video game construction is a motivating experience. Motivation played a significant role in allowing the students to overcome the hurdles of game construction.

The following sections describe some of the problem-solving strategies the students used while building their games.

Forwards and backwards.

Each of the students in the game construction unit integrated a forward and backwards problem-solving strategy, where they would program, play, and then debug if the game did not match their expectations. Some of the students identified this strategy as guess and testing, while others referred to it as tweaking their games. This was the most common strategy used by the students, and although some of the students used this strategy less than others, it seemed like an intuitive way to ensure the game would work. John noted,

> I tested it. It didn't work, I went back, tweaked it a bit, went back, tested it. Oh, it didn't work. I have to change it 'cause it didn't work. I just kept going back and forth until I got what I wanted, until I was happy and satisfied with what I had.

Robert employed a similar strategy. He explained, "like every time like I did a little section, like where I had to get past the gates, I like played just to make sure that it worked and like that's what I did like throughout all the programming."

Guess and testing, or tweaking, was used with less frequency at the beginning of the game construction unit because each of the students had to come to the understanding that building in large chunks of program made it much more difficult to debug as compared to smaller, more concise sections. Stella came to this realization after the first day of game construction. She said:

> It was definitely a lot of guess and testing. I think we played it a lot. Almost every time we changed something we would play it. Because if we changed a bunch of things at once, then if something didn't work, we didn't know what wasn't working. So we tried to change one thing and then play it, and then another thing and play it. Just so it would be easier in the end.

Beth described a similar experience: "Probably when something wouldn't work and then you don't know where you made your error. So you have to keep trying—going back and making changes."

As the students went back and forth constructing their video games, some of the students had to revise their initial idea of what was going to take place in their game. For Clara, this was particularly true in her complex vision for her underwater game. She stated:

> I wasn't going to freak out or get mad, but I sort of tried different ways in doing it, because in one of my worlds they are supposed to collect all five of the apples, but they kept moving around and shifting because the wave height was too high and too strong. So I kind of lowered it a bit and put them on places where they

> wouldn't move, and for the rock problem I sort of kind of added it in the pipes, because they're solid and they don't sink.

Clara struggled with this sinking problem for well over a class, and decided to revise the overall plan for her game in order for it to work.

For some of the students, their revisions were driven by the availability of certain elements in Kodu. Meghan, for example, wanted to incorporate certain animals and houses into her game, but they were not available in Kodu.

> For if there was no animals, we took a brown Kodu for a bear—or a house or something, we took a hut for the building and we put in the small screen we made it say 'I'm a house' so that people would think that it's a house.

Many of the students had to initially problem-solve or tweak their game stories, even prior to building their games in Kodu, to match the features available in Kodu.

Some of the students also found that they needed to delete certain parts of their games. Aiden, for example, deleted large sections of his game after he played it, as opposed to revising the game. He explained, "Like if I get one part of the programming wrong I always swoop back and delete everything to find out what I did wrong. So it's kind of hard with the program." Aiden also noted, "It took me like a thousand tries just to get them right. I had to delete and put it back. Delete, delete, and put it back." Aiden wasn't able to come to an appropriate revision plan for the problems in his game, and thus he found the easiest strategy was to delete large parts of his game and start over. However, this also slowed his own process and limited the content located in his game. Patrick, his teacher, mentioned that Aiden was hung up on the small details located in Kodu and wasn't able to demonstrate his understanding of the content because of the process he was using to build his game.

On the other hand, there were other students who found that tweaking their games provided excellent opportunities to learn more about Kodu. For example, Caleb found that if his initial game construction strategy didn't work, then he had to explore a slightly different strategy. Similarly, Stella found that by guessing and testing she was able to identify new possibilities in the game program. She explained:

> Because there are so many different things you could do. Like just with making the land you can do like different elevations, you could do like hills, you could do like with your different colour lens or whatever. So there's lots of different things that you can do, lots of different possibilities, so you definitely have to guess and test and see what works.

The students also incorporated the guess and test strategy when trying to solve common issues with Kodu. Beth had to continually go back and forth to try to limit the number of points that were collected for a certain task. Setting limits to the amount of points collected was a common problem experienced by all the students. Beth said,

> I just went back and I played my game first to see what was wrong and then I looked at the programming. Most of it was the programming. When I bumped into or climbed the fish it wouldn't move or anything and I kept stacking up the points.

Ellen also encountered a common problem with a character not vanishing after a message had been delivered. She stated, "When we were programming we couldn't have 'vanished' on the same line as when he says something. So, we had to go to the next line of program and tab it over and then it vanished me once." For all the students, guess and test or a backwards and forward process was critical to their success throughout the unit and was one example of how they used problem-solving strategies to create their video games.

Expert support.

For many of the students it was not enough to simply go back and forth in the program to explore how to solve the problems they encountered. Some students also required the support of an expert or a tech ninja to solve some of the problems they encountered in building their games. For example, while Beth was able to solve her problem with the score stacking up through simply tweaking her own game, many of the students sought out an expert to solve this issue. This was the second problem-solving technique the students utilized, where they would first explore by tweaking their game, and then they would ask for help. John described this process, stating,

> I went into the programming and checked it out, like, oh I can do this maybe, or this is an option to do with Kodu, this is an option. And then I got help from the ninjas. I said I want to do this; how would I do this?

Interestingly, John was a tech ninja and still felt comfortable seeking the support of others, even when he was identified as an expert by his peers.

Many of the students in all three classes utilized an expert as a secondary support due to the amount of time it took to access help, because sometimes the game expert was not available or didn't understand how to solve the problem. Stella suggested,

> So then we got one of the tech ninjas—they were helpful but sometimes they didn't know what to do either, so then I would have to get another one. I know at one time, we had all four—when we were in the lab, and then someone else, who wasn't even a tech ninja who was sitting next to us ended up figuring it out.

Each of the grade 6 students identified the tech ninjas as their primary expert support. The grade 4 students, on the other hand, identified their teacher as their primary expert support. For example, Caleb noted, "First I trying going, programming it again, try a different way, slightly different and then I just ask a teacher if it didn't work." Colin also mentioned that his first resource would be the teacher: "Well, we asked our teacher but our teacher was very busy so if we were about to show her but she would wait and go to a next student and then she wouldn't come back to us." The reason the grade 4 students relied on their teacher for tech support might be related to their own personal maturity, the lack of a tech ninja, or the fact that their teacher was quite knowledgeable about programming, in general and with Kodu in particular.

For the students, the expert was the first person they sought help from to problem solve. If the expert was not available, the students would seek support from a partner or an individual who sat close by. Stella worked collaboratively with her partner. She recalled:

> Because I know when we were designing some of it, I didn't know what to do. I don't know what colour, and you know she kind of helped me. And she's like oh you know we have to think about having different lands. So yeah, I like having communication and sharing ideas, and I like working with my friends as well.

Ellen also described how she was able to problem solve with her partner:

> We tried to do different things. And to try and if something didn't work we would try it the other way. So, if I had an idea and then Ethan had a different one then we would try mine out and see if that would work and then we would go to his idea and see if that would work.

Colin also discussed his collaboration with his partner as a process for sharing some of the frustration that comes along with building a video game. He stated:

> The first time we played it I wasn't really mad, but after the tenth time we played it, I got frustrated. So I just handed the mouse over to Daniel for ten minutes and walked around. That's when I got the help from my friend.

For both the grade 4 and the grade 6 students, the expert support was an essential element that kept the game construction process moving and alleviated a considerable amount of frustration.

Playing around.

Another strategy used by some of the students was playing around with the program to solve their own problems in the game. For the most part, it seemed that this kind of problem-solving strategy was more accidental and less planned. Some of the students came to a solution unexpectedly when they were solving a problem for a separate issue. For example, Colin and his partner were able to solve the problem with the points stacking up by playing around. Colin explained:

> So me and Daniel, we just started looking at the programming and all of that and at the very beginning it was giving us too many points. Then we figured out you had to move the point system to the next bar and move that bar over so you could do once and then it'd have to be vanished.

The boys did not guess and test this strategy; they simply played around with moving objects with no expected end result.

Aiden also discussed his experiences with playing around, saying, "I did learn a few things. Like, how to make a mine explode and your character can go 'boom.' I didn't make that." Although Aiden had no intention of using a mine in his game, he was able to learn how to solve a future problem by playing around with the Kodu program. Clara described a similar experience:

> It sort of kind of helped me a bit, because I got extra practice, like I could do whatever I wanted, so I explored with the programming and figuring out things and that's where I figured out that you can choose a different avatar for different purposes.

John talked about being inspired by one of his classmates who was able to make walls without having to raise the land: "I wanted to do this, but I couldn't figure it out. So I just explored in Kodu." Stella also said that it would have been helpful to incorporate more playing around experiences. She suggested:

> I think that what would have helped me. Let's say I play someone else's game and then going and making how they would program it. So thinking about what they were thinking. So I think that would help me. And watching videos would help too. Just like playing around would probably help too.

The students who identified the importance of playing around did not think of it as being off task or a waste of time. In fact they realized the importance of being off task in order to develop a more in-depth understanding of the program.

Thinking out loud.

Although not all the students mentioned the importance of thinking and problem solving out loud, both John and Stella identified this as a pivotal problem-solving process. Stella suggested, "Well some problems, after you just think about—like blah, blah, blah, blah, do, blah, blah, blah—if you actually read it and then think about it in your head, then sometimes you can solve it." Stella found that talking out loud was a helpful process for both herself and her partner and inevitably prevented needless clicking of buttons. She stated:

> So me and Natalie, we thought what we wanted to do, so just something like when for like moving. So we thought when you click the arrow, then what will Kodu do, and he will move. And then we looked at our options, like what we could do to make that into the little sentence, and then we just kind of converted what we had thought into what we can do.

John described a similar experience, stating, "I would definitely say it out loud, when I do this I want this done. But most of my programming was the same." For John, once he verbalized the first few program lines, he was able to apply this knowledge to other components in his game.

Problem solving through demonstrating.

As each of the students completed their games, they played them for the teacher researcher. For each of the students they located at least one problem they did not realize was present prior to playing their game. This finding suggests that the simple act of playing a game may be one method of solving problems in the game, particularly once the game is finished. It also suggests that an audience may have provided the students with opportunities to be more reflective of what was actually taking place in their game. This was particularly true given that the students could generally only visualize their own perceptions of how the game should be played. Even when other students played their game, provided some feedback, and answered the reflective questions the teacher provided, the students still missed certain elements in their game. The conversations between the students and the teacher researcher were similar to the following example with Stella, John, and Beth:

Stella: Yeah. So next question, you made it to the third problem. This question is, what are the first three common factors of 4 and 6? So the first one is—the answer is 1620, 120, or 180 and this one is—the answer is 24, 48, and 72? Oh, that one didn't vanish—and then you bump into this guy. This is your last question, pick which path you think the right answer is. Your final question is 4x7+(34-10)? The answer is 26—this answer is—oops, where is his answer?

John: So when you start, you would go—you go across the bridge to the left. And this is just saying, 'cause when you go here, you come back to the start, come down that pathway there. You go this way. It tells you to come down here. When you get to here, it's kind of—the first question is, what is the answer to 4 times 4 plus 3 minus 5? It says pick an answer. The answer's 12; the answer's 14. Oh, it didn't work there, but the answer would be this way because it's 14.

Beth: Okay. See? That's what I was having problems with. It wouldn't go with the time. When it bumps into the right clam it should say speech bubble. When they hear the fish say that, the next problem comes up, but this one kept going back and forth.

Each of these conversations demonstrates that the students came across problems they could not solve, even with the support of experts.

Problem solving was an important experience for each of the students as they learned to use the game construction program and as they translated their game story into a video game. Some of the students changed their problem-solving strategy as they became more comfortable and confident with the technology, for example, they began by randomly testing whether a program line was correct, and then moved on to generating a more sophisticated strategy in debugging their game.

Some of the students' strategies included moving forwards and backwards throughout the game, seeking expert student support, playing and tinkering around with the technology, thinking out loud, and solving problems through demonstration. Interestingly, each of these strategies was experienced relatively independent of the teacher, where the students generated these strategies while they built their games. It seems as though the game construction technology afforded an experience that allowed the students to learn with and through the technology, similar to Papert's (1980) statement that constructionist technologies are 'objects to think with.'

Theme 2: Use of video game construction technology.

The video game construction technology Kodu Game Lab facilitated a certain kind of experience in which the tools situated in the program led the students to craft a tale-based game. It is important to understand how the students used this game construction technology because it shaped the students' experience. Generally, the program was relatively easy to use, and provided the students with enough internal scaffolds to allow them to construct a game that met many of their expectations. Certainly, students who were avid gamers or students who wrote a complex story experienced some disappointment with regards to the possibilities Kodu offered; however, many of the students were able to overcome this disappointment. These ideas are explored in this section.

Student experiences with Kodu.

Each of the students were provided an introductory Kodu lesson at the beginning of the game construction unit. However, this lesson did not entirely meet the students' needs because many students planned and wrote a story with the expectation that certain objects and tasks would be available in the game program. For many of the grade 6 students, this was an area of struggle because they wanted to match their game story with the available tools in Kodu. They asked many questions about Kodu while they were writing their game stories, particularly whether a certain character existed in the game and if it could do a certain task, such as collecting points, speaking, or teleporting to a different land. This was particularly true for students who played Minecraft at home, because they often wanted to use the features they understood in Minecraft and apply them in Kodu, including creating doors and building tunnels. These two features were not easy to build in Kodu.

Although many of the grade 6 students asked questions about the tools available in Kodu at the beginning of the game construction unit, very few of the students critiqued Kodu, either at the end of the game construction unit or while they were building their video games. They were often content with the tools available and what they could do with the tools. However, the opposite effect happened with the grade 4 students, who had fewer questions while they were planning their games, but asked many questions while they were building in Kodu and critiqued the program at the end of the game construction unit. Many of the grade 4 students struggled to revise their plan to match the tools available in Kodu. Colin, in particular, found this to be true in his own video game. He explained,

> Well, you're trying to make something and then it's so hard to get the little details in there, so there's like no animals for that. For animals we just cut that whole thing out. We just did trees, mountains, and the lake, or river. That's what we did.

Colin's group did not feel confident about reinventing certain tools located in Kodu, so they consequently took them out. The lack of tools in the Kodu program seemed to be more pronounced for the grade 4 students because they were expected to represent both the animals and the vegetation of the regions of Alberta. Although Colin's group could not look past the concrete nature of the tools found in Kodu, some of the other students were able to reinvent the tools and use them for their own desired purposes. For example, Meghan's group used the colours located in Kodu to define certain animals, such as using Kodu and turning him brown to represent a bear.

> We added some things to make it look like animals. We made the colour of the flora look like grass. We made a little lake that we researched and then we added some animals where they would go in the Parkland.

Although Meghan's group made some creative revisions to the tools in Kodu, they still felt it was important to make a concrete connection to what they were trying to represent. The speech bubbles were an additional connection that satisfied their own vision of their game. This concrete connection with the characters and the objects suggests that their games were more representative of expository, factual ideas, as compared to the grade 6 students, who wrote more fantasy-based stories.

Caleb's group made specific decisions in their game based on their gaming ability and their understanding of Kodu. Their game was an open game that did not follow a path, while each of the other grade 4 games had some form of a path to follow to answer the questions. Caleb and his group created a game where you could choose where you would start; there was no definitive flow to the game. He made this choice based on two reasons: "First, because our group isn't really good at doing that, making the paths. And we want it to be an open road game, like they can go wherever." Although Caleb was motivated to make a game that was more open than those of his peers, his choices were limited by his lack of understanding of how to use the path function in the game program. Interestingly, none of the other grade 4 students used the path function, which allows characters to follow a path without having to control it in their game. Instead, most students simply drew a path with a different colour land brush. Caleb likely perceived that in order to create a path within Kodu, he needed to use the path function. The tools influenced his decisions in his game; the path function was not discussed in the initial game construction tutorial.

It is also important to highlight that some of the students, particularly in the grade 6 classes, found the tools overwhelming. Clara, for example, created a complex underwater sea adventure; however, she experienced an array of issues as she was building her game, not because she didn't understand how to use the program, but because she was trying to integrate too much into her game. She explained:

> It has this weird shield effect and sometimes it will make you slip off, because you can turn shield effects on, but it only gets rid of the glowing part and see it just disappear that way. So it doesn't work as I want it to because they just disappear and you know what the answer is and you can just cross the lava. So it was kind of harder, like if I do a next game, I'd probably do something like simpler.

Aiden had a similar experience. He added so many details that he lost track of the overall purpose of his game. Patrick highlights this, saying,

> I think Aiden got caught up like a lot of the details. It is like an action movie in that there's lots of cool effects, but the main story got lost. So he has some cool things happening, but the structure . . . the story element is not strong.

The students experienced a mixed perspective, where some were satisfied with the number of possibilities Kodu offered, while others found the program restrictive, which inevitably limited their video game. The following sections further discuss the students' experiences with Kodu*,* particularly focusing on the impact the Kodu tutorials had on the students, the ease of use the students experienced with the program, and the challenges they faced with the program.

Kodu tutorials.

For many of the students, the game construction tutorial that was provided at the beginning of the unit was an important component in learning about how to use Kodu. John highlighted the importance of this tutorial when he said:

> I would have had no clue what, well, I would guess what was possible or not, but I had no clue what kind of characters there are, what kind of setting you could make, what the programming type, like what you can do with the programming. I probably would have been even more lost if I never played.

Beth also found the tutorial helpful because "it got you on your way," and Stella stated, "Yeah, because when we played that first day, for however long—an hour or two hours or whatever—definitely helped. And thinking about that day definitely did help us just to get up get a feel for playing."

Colin, Robert, Stella, Aiden, and Beth downloaded Kodu at home to play and learn more about it. This at-home play experience allowed Stella to revise her game plan. She explained,

> Well, me and Natalie, she came to my house and we decided and we were planning out we were going to do it. I think that is in her book, but it was different—it was actually the circles and everything. So this—we did this one—we built our land, then she came over, then we restarted our land.

This at-home experience provided Stella with time to think deeply about her game and revise the direction she was heading in. John and Meghan tried to download Kodu at home but could not locate where to download it or had trouble downloading the program onto their computers. One student, Samantha, missed the tutorial but found the technology easy enough to use, even though she was not a gamer. Samantha did face some challenges and relied on the experts within the class, particularly the tech ninjas. It is difficult to know if she struggled with these more complex ideas because she missed the tutorial at the beginning of the unit, because she was not a gamer, or because the tasks were simply more challenging. However, other students who attended the tutorial also struggled with more complex programming sequences. Robert had mixed feelings about the game tutorials, saying,

> I think the game tutorials were kind of both because you know like some things you can't do and some things you can do. Such as you can't really take apart your animal. Well like maybe say like if we should've maybe brought in—like say one of the teachers had an Xbox or something. Like one of the kids' Xboxes. We could've brought in one of those and like we could've like showed them the set-up and different kinds of games on there.

Robert was referring to the restrictions that are found in Kodu. Although the students were shown how to do certain tasks in the game construction tutorial, there were still restrictions to the program. Robert noted that a more mainstream technology, such as an Xbox and Xbox controllers, might be easier to use and would connect to his own gaming interests. Doing so would be possible because Kodu works with Xbox technology.

The tutorials were an important experience for many of the students because they created a sense of awareness of what Kodu looks like and the game construction possibilities it offered to the students. Other students did not require the tutorial and were able to construct a game with relative ease. This difference brings us to the next section, which highlights the ease of use that Kodu offers to users.

Ease of use.

Although all of the students came across some problems while building their games, students found Kodu easy to use. Aiden noted, “I think the Kodu game is pretty cool. Like, I actually get to make my own game and play others that have been made. So it’s basically like a terminal for games.” Stella also found Kodu easy to use, stating,

> Well, I was scared it was going to be—because everybody always told me, you know when you are programming things and put something in there, is that the zillion numbers and letters and spaces and dashes and all that. And I thought it was going to be like that. I had no clue what to expect, so at first I’m like oh my gosh, this is not going to go well, but then—so yeah I thought it was going to be way harder. It actually is pretty kid friendly.

Clara echoed these thoughts, saying,

> I think it’s nice that it is easy to do, because like some other programs could be like very complex and not like someone who just got on it would know a lot, so for Kodu it like explains on the top of the corner.

Clara was making reference to the instructions Kodu provides at the top left corner of the screen, where it shows how to perform each of the functions through both text and pictures (see Figure 26).

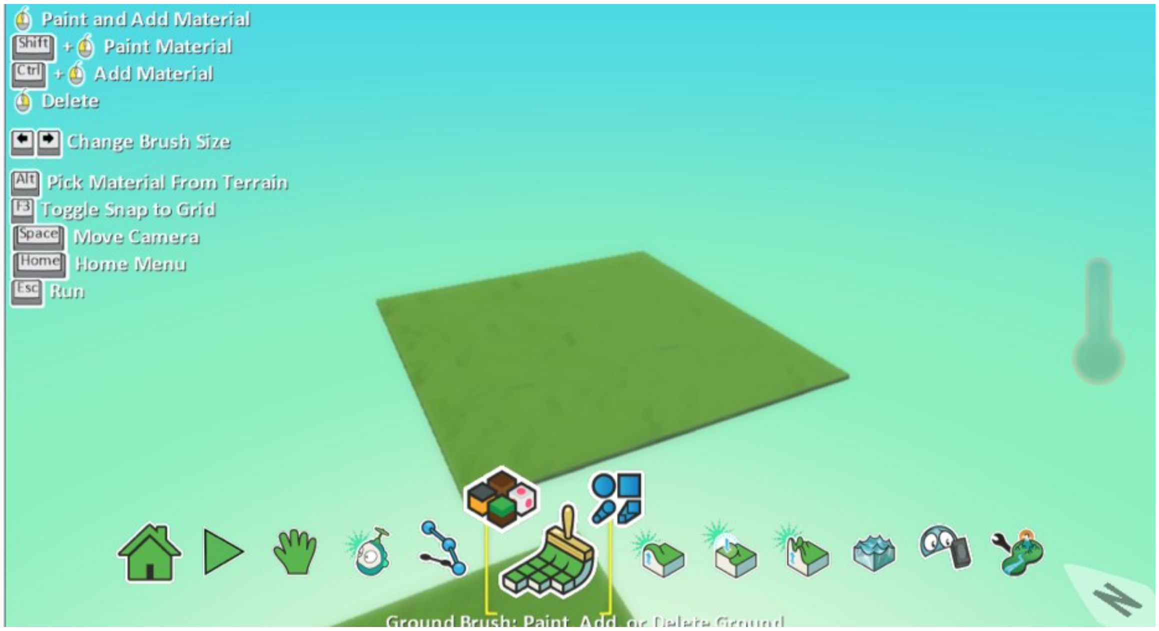


Figure 26. Kodu directions in top left corner.

Students found Kodu easy to use because of the wheel that is located in the program (see Figure 27). They found it easy to program by simply looking at the pictures. For example, Ellen found the program wheel very helpful as she built the game. She explained, “It was easier to program the rover to say different things because we could find it. So it’s helpful when everything is in front of you.” Aiden similarly noted that when he was programming his game he would look at the pictures as opposed to reading the text. This made the game-building process faster for him.

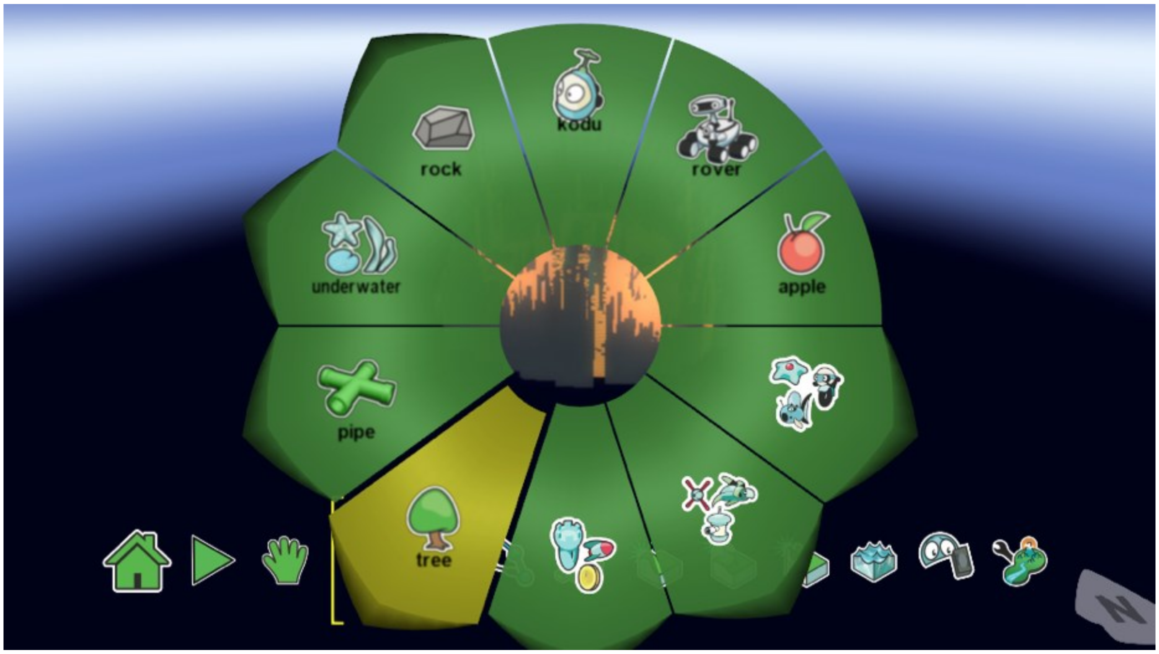


Figure 27. Kodu game wheel.

For each of the students, the easiest part of using Kodu was when they were building their land. This was often the first task they completed, but they would continually revise their land throughout the process. John liked

> creating the land because you can do whatever you want, like change colour to the land, to make hills or make big mountains, spiked things. And you can go as high as you want. You can do anything with the land.

Colin also highlighted the ease of building land, saying, “Making the land was the easiest. Well you basically just need a brush and you start building.” Colin also suggested that it was easier to build land in Kodu than in Minecraft, particularly because you do not have to make as many clicks. Ellen also highlighted the ease of changing the land if you made a mistake. She noted, “When you build the mountains, if they’re too high then it’s easy because there’s that thing where it makes the mountains lower.”

The wheel situated in Kodu*,* and the graphics it presented, provided a relatively simple process for the students as they constructed the game. For most students, basic elements such as painting the land, adding in objects, and simple programming were incredibly easy to use, and they often did so independently and rather quickly. For most students, Kodu was an easy program to use.

Challenges with Kodu.

Although the students found Kodu relatively easy to use, particularly when building and changing the land, they did encounter problems as they were building other parts of their games. Most of the challenges related to debugging, particularly as their games increased in complexity. For example, the more content and programming Clara added to her game, the more issues she experienced. When she changed one thing, often something else was affected. She explained:

> My least favourite part was trying in the lava world, trying to program it, because I was trying to figure out—make the rocks float in the lava, but you can't do that in the programming. And I tried the pipes, when my character on another pipe, she would be killed because that black line is still touching the lava, so I had to turn the lava [brain off] and the pies they sort kind of [caused like lots of problems].

Certainly the level of complexity created a 'cause and effect' situation, where more detail inevitably created more issues in the game. For Beth, these difficulties took place in her underwater world, where her fish had to bump into the correct clam to answer the question, and then her next question would pop up. She explained, "When it bumps into the right clam it should say speech bubble. When they hear the fish say that, the next problem comes up, but this one kept going back and forth." Caleb had issues with timing objects in his game, where he would have a new question pop up every five seconds; however, he based this on his own game play, as compared to the ability and knowledge of others. Caleb discovered that the questions were timed to appear too quickly, making the game too challenging for his peers.

Another common challenge among many of the students was having an object vanish after it said something. Often a message would keep appearing on the screen until you were able to manoeuvre away from the object or character that was providing the message. This was a challenge for Colin, who stated,

> We know what the question and answer would be but, like I said, the star wasn't working well and it was hard to get away from the jet once you've touched it for the question because when you touched it I had the once on but you had to back away from it really quickly so it wouldn't say it again.

Other common challenges in using Kodu included making sure the colour of the Kodu character was identified in the program, controlling and manoeuvring characters, and creating signs and speech bubbles. These more common issues were not necessarily associated with increased complexity, but resulted from a lack of understanding of the program itself. Most of the students needed to be shown how to make a message vanish or how to change the size of the text. Some of the features located in Kodu are not intuitive or easy to use. However, many of the students, including Aiden and Stella, found that through increased experience with Kodu they were able to solve many of these challenges. Stella noted, "It would be a lot easier, because now I know how to do more things and I know what I want and what I don't want."

One of the last challenges the students experienced was saving their games. Some of the students forgot to save their games at the end of a class; however, more commonly the students, particularly Robert and Samantha, found their games could not be recovered even after they had saved them. This was particularly true when they would work on different computers where, rather than the games being saved on the school's server, they were being saved on the specific computer's hard drive. The games were then difficult to retrieve if another student was using that specific computer. This situation led to a great deal of frustration among the students; for example, both Robert and Samantha had to start over at least once. Although these problems were the result of the school's technology rather than the Kodu program, they did create challenges for some students.

In addition, the Kodu version that the school used was older and did not match up with the version students downloaded at home. This meant that the games many of the students built and worked on at home did not load at school. This was frustrating for students who were motivated by the video game construction project and worked at home on parts of their games.

In choosing Kodu Game Lab*,* the teachers, perhaps inadvertently, shaped the kind of game construction experience the students would encounter. Kodu allowed the students to construct a particular kind of video game based on the tools and features located in the program. This can be referred to as a tale-based game.

Certainly there were some students who would have liked to have more control of the program, or to have access to more features, but this was a small portion of the class population. Although some students encountered some challenges with the program, these challenges did not necessarily negatively impact the learning experienced in the game construction unit, because the students implemented problem-solving strategies to overcome these challenges. Most of the students and teachers noted that they would like to use Kodu Game Lab again in the future.

Theme 3: Playing, planning, and the process of game construction.

This section explores the experiences of students before they began constructing their video game using Kodu. The students took part in three kinds of experiences to prepare for their video game project. The first was playing video games and determining the features that make up a video game, the second was planning and writing a video game story, and the third was creating visual maps of their game worlds. This section explores each of these experiences in turn.

Playing video games.

The students enjoyed playing the video games that were introduced at the beginning of the unit, with the exception of the game Muck and Brass because of the lack of challenge and choice in the game. Some of the students compared Muck and Brass to a 'choose your own adventure' story, but with less choice regarding how the game would end. John found that there was "too much reading in the game, where I would have someone talking instead. And at the end I would let the players make up a conclusion for the story instead of the game doing it for you." Although the students were relatively dissatisfied with Muck and Brass, Patrick found that the students provided the most passionate game reflections because they had a strong understanding of the elements that make a good video game.

Each of the teachers felt that it was important to provide the students with the opportunity to play video games; however, the students rarely made reference to these video games or the qualities that comprise a good video game while they were constructing their own games. It is possible that the students embodied the elements that comprise a good video game while they were constructing their games; however, it is also possible that there was too much time between playing these games and building their own games.

It is also possible that the four video games were contextually different from the students' video games and that it was difficult for them to make connections to the features situated in these games. John made reference to this idea, stating,

> I didn't really like, at the start, when we played all these other games because it had nothing to do with Kodu. Maybe if we could play games that had to do with this program, because when you go to the main menu you don't see some fortress or whatever games some people made it. It's on the main menu part. If we could play some of those games and then talk about those to get a better idea of what makes a game good.

John is referring to the games that were found in the download section of Kodu, where students could play other games that have been made with Kodu. Playing these games might have allowed the students to make more concrete connections to the attributes that make a good game and to generate ideas of how to program in Kodu.

Playing games was an important introduction for the students to begin thinking about video games. Although the students did not mention these games while they were building and reflecting on their own game, playing the games did facilitate focused conversation around what makes a good video game.

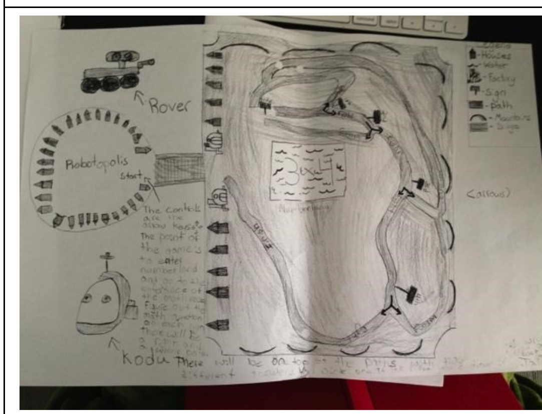
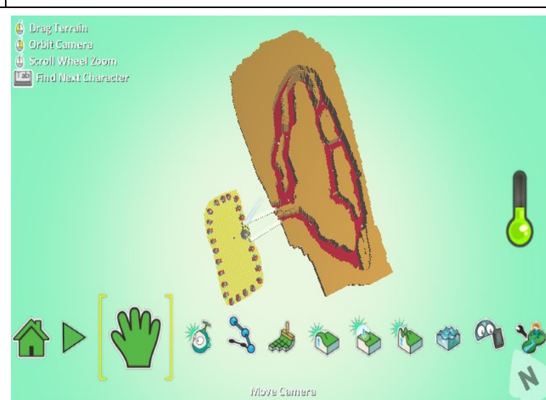
Planning (story writing, mapping, math problems).

Once the students finished playing the sample games, their teachers prepared them to construct a video game by having them write stories and create maps. Table 8 compares one of the student's initial story and their final game story. It also compares one student's drawn map with an aerial screenshot of their final video game. The rest of the students' stories and maps are located in Appendices I and J.

Table 8. Comparison of Stella's Initial Story and Final Game Story (Grade 6)

Stella's story changed completely, from the main character to the setting of the story. Stella made significant changes when she played Kodu at home and reworked both her story and her partner's story to construct a video game.	
Initial Story Idea	**Final Game Story**
So my story so it is about Claire—Claire Delamoon and some Sun Delasun. So the whole idea of it is clear—it is a nice one peaceful calm and then the sun is like the crazy one, the evil one and the one that does all that stuff. So there's like two worlds and there's a path in the middle. And it's the mysterious mountain mesmerizing math problems. So in order to get to the other one because there's Mooresville and Sun City and so in order to get to the other one, you have to cross this math path. So Sun is trying to invade Boonville and then here's what here's. What's going on, so than the game will start out—it's at the beginning of the past and then you have to get to the path.	Hello, Dean. Welcome to the mysterious, magical path of math problems. The princess has set up this path to keep you from taking her. At the end of this pass is the Crazy Castle where the princess lives. Your goal is to kidnap the princess by correctly answering each math problem in order to reach the end. For every right answer, you get a point, but if you get a question wrong, you lose a point. In order to get the questions, bump into me every time you see me at each path. Use the arrows to move and click when you want to exit a speech. Your first questions is, what are the first three common multiples of two, three, and six?

Table 9: Comparison of John's Initial Map and Final Game View (Grade 6)

John's initial map and video game are relatively consistent. John crafted a beginning space, Robotopolis, for Kodu to explore, which then led to the math questions. Once the questions were answered correctly, players would return to Robotopolis.	
Intial Map	**Final Game View**
	

For some of the students, their game stories changed considerably from their initial work to their final version, mainly because of the finite tools located in Kodu and the relative shifts caused by adding in the math questions. It seemed as though the math questions located in the game took over the grade 6 games, altering or eliminating many of the details the students had written in their game stories.

However, some of the students' games remained relatively consistent with the initial story, where the game story was written in manner that was easily translatable into a video game. Interestingly, some of the students' stories lived in their heads when they transfered them into a video game: they constructed a game that was similar to their story, but missed including some of the pivotal markers that described the backstory of their game, including the setting of the game world, the names of the characters, and, at times, the purpose of the game.

Examining the students' aerial maps and final video games shows a greater consistency between the two, because most of the students had a more defined vision of their game by the time they drew their map. Some students had more detail listed on their map, as compared to the detailed located in their game, but few students made any drastic changes to the look and feel of their game once they had drawn their map.

Because many of the students' final video game resembles their aerial drawing, it seems possible that many of the students utilized this drawing to support the construction of their game. In understanding the similarities between the two, it seems as though the map drawing is an important tool situated in the game construction process, and that students have a fairly solidified vision of their game once they draw their game maps.

Story plan.

Many of the students found the planning and writing process helpful to their game construction process, particularly because it kept them focused and on track. John felt that the "Somebody, Somewhere…" story tool was useful because it allowed him to organize his thoughts and ideas and cover more of the story in his video game. He explained:

> The story plan helped me describe what's going to happen in my story because right here we wrote our pointers. I wrote what's going to happen in the game and it helped me define what was going to happen, it helped me to make the game step by step.

The entire planning process was beneficial for John, because it allowed him to establish a place to save his ideas and story elements. He stated:

> It was good because if we didn't plan and write, we would have—we wouldn't remember what to put in our game. We would kind of just would go blank—it would be impossible but we wouldn't know that, so then our story couldn't relate to the stuff in here at all.

Much like John, Clara also found that each of the activities were vital elements to the success of the project. She reflected,

> Playing video games was a good thing, because they help figure out what a video game should have and the planning, so it got us organized and helped our ideas and that practicing story maps helped students who really didn't know about story maps, so I couldn't take anything out, because it was very helpful.

For both John and Clara, the planning and writing process was important. However, because this was their first video game construction experience, they might have a more critical perspective if they experience game construction again.

Stella also had a positive perspective regarding the planning process. She felt prepared and ready to build her video game after her own story-writing and mapping process.

> So definitely by looking at other games, planning and writing a story, the end product will be better, because for example, I know there are a few kids in our class, they don't really like to play video games that often, they have other things. They just don't like it, so they didn't really have common sense of games. They didn't know exactly that there should be directions, there should be easy controls, and maybe some other stuff, you know, like a playable land, you know.

Stella was empathetic towards her peers, particularly those who were not gamers.

Samantha also found the planning and writing process to be an effective method to store ideas and concepts, and identified the "Somebody, Somewhere…" story plan as beneficial: "Well, I like the fact that it's more organized. So it is more beginning, middle, and end rather than [a story] web because it just becomes so scattered. And then it tends to get a bit more out of place." Samantha benefitted from an organized and concise learning space, thus the "Somebody, Somewhere…" story plan was helpful to her game design.

Stella also found the "Somebody, Somewhere…" story plan to be beneficial compared to the use of a story web. She stated, "I never really liked doing webs or any other way because it wouldn't really help me separate my ideas." Meghan also attested to the importance of being organized, because it allowed her to understand what kind of details were required in her video game, and "it showed us where to write and what to write, so you could put in the description.

This 'Somebody, Somewhere…' has introduced me to creating a beginning, middle, and end, where there is a problem and a solution."

For many of the students, the "Somebody, Somewhere…" story plan was a useful tool to craft their story. Although only a few of the students discussed the benefits this plan had in writing their story, none of the students identified this story plan as a deterring factor in their planning and writing process.

Samantha suggested that if she had not taken part in the planning and writing process, she would have likely been ill prepared when it came to constructing a video game. She felt that "the planning allowed you to be ready and you already knew what your game would be about, rather than just kind of sitting at your computer and thinking, okay, what is this going to be about?" Stella suggested something similar, saying,

> I think if I just sat down in front of the computer and I wanted to build a video game, without a plan, it really wouldn't make any sense because you would just have random ideas and you really wouldn't think about all the important stuff that you needed and all the things to make sense. I mean, you could do it, but it wouldn't be very good.

For these students, the planning and writing process allowed them to feel well prepared to build a video game.

Visualization.

Many of the students found it beneficial to visualize what their game was going to look like in the end as they were planning and writing. Samantha, who missed the initial Kodu game tutorial, simply used her background gaming experiences and visualized her game as a "regular video game." She explained: "Well, it just all comes to life. Like you can imagine it, and see it like when it's in a game instead of just imagining it in your head as a book." Samantha's distinction between a book and a video game was similar to Beth's description of her experiences. Beth said, "Well, when I think of a game story, I think of the game in my mind. In a regular story I think of a story in a book." Although Samantha used previous games for her own visualization, Beth used the characters and details found in Kodu to help her imagine her own video game, explaining, "I imagine the octopus that's purple and shooting out ink." Interestingly, neither Beth nor Samantha spent a considerable amount of time playing video games, but from their limited experiences, they still understood that they needed to craft a different kind of story. The differences between a video game and a story were not formally discussed in their class, only as part of the discussion that centred on the elements that comprise a good video game.

Robert also found it valuable to visualize a video game as he was writing his story. He explained, "So you kind of just have to think that it's going to be a video game as you are writing the story." Similarly, Clara utilized Kodu as a foundation to visualize her own game, but she also used comics and movies. She explained,

> My ideas came from Kodu, and something else, like in Kodu you can program the water orange and have it actually burn something and make it explode. And I thought of some movies and some comics where they have to jump on the right rocks and stuff and if they stepped on the wrong one, they would slip, but they would grab onto a ledge or they would fall.

Aiden also made outside connections in visualizing his own video game, saying, "I've played Assassins Creed so there's lots of adventure in that game and that help me and clicked with the adventure part of my game." Aiden's game also was well aligned with Civilization, a game he plays at home.

Story exemplar.

Both John and Stella found the game story that Patrick wrote helpful in visualizing their own stories. Stella noted that Patrick's "Marvin the Martian" story helped her get started in visualizing her own story, saying, "The story that Mr. Patrick wrote, I kind of got the little path, I kind of got inspiration from there and everything else I just made up as I went along." For John, Patrick's story was also an important point of inspiration. He said, "Mr. Patrick's story was so good, if I didn't have that, I would have been confused. His plan really helped me as well." Patrick's story was an important starting point for John, and in reading John's story you can easily identify the similarities between the two ideas. It is very possible that John's story might have been entirely different had Patrick not crafted a game story example and shared it with the students. John struggled to begin the writing process because he was focused on writing a story that included the elements located in Kodu. Patrick encouraged John to simply write his ideas. John explained,

> I was told to simply write my story, and then make it work after. So, I just went all out and wrote what I had in mind. And then when I was programming I took out the parts that wouldn't work, trying to make it kind of similar to my story.

Although John had to make changes to his story, he was still satisfied with the overall writing and planning process.

For Stella, visualizing her story as a video game was a motivating factor, because "when I was planning my story, I just thought of my character." This visualization was particularly effective for Stella because it provided her the motivation to write a story, something that she does not particularly enjoy. Aiden also found the planning and writing process motivating, particularly because it related to his strong interest in video games. He stated, "Because I am going to make a video game out of this story, I want it to be really good, because I really like video games." Not only was Aiden more motivated to write this story, he also found it easier to write because he could make connections with his strong understanding of video games. He said, "I have only been able to write stories that are two pages long before, but now I have finally been able to write a six-page story." Although Aiden struggled to recreate these detailed ideas in his video game, his background knowledge and his ability to visualize a video game were helpful in the planning and writing process of the game construction unit.

Mapping.

For many of the students, the planning and writing process allowed them to become organized and to visualize the end product of the video game. The hand-drawn maps were a useful planning tool that many students used as they were constructing their video games. For John, Beth, Samantha, Clara, Robert, Meghan, Ellen, Caleb, and Colin, their video games strongly represented the details defined within their maps. Stella made dramatic changes after her map was drawn, particularly in the time she spent exploring Kodu at home, thus her map did not align with her video game. For Aiden and Clara, their games changed because of the available tools in Kodu and some of the struggles they had in using the program.

Colin was one of the students who found the map an important tool as he built his video game. He stated, "The map helped to let me know where to place all the stuff and it was really, really helpful that we had that, because without the map we wouldn't be able to get the shape of it." Robert had a similar experience in that his map helped him construct a visual interpretation of his ideas. He explained, "It was helpful because you had to show what your land looked like and then you had a copy of that when you built your game." Aiden also found the map helpful, particularly because he had so many ideas of how his video game should look. He reflected:

> I use my map a lot while I'm building the landscape. Because my landscape was, it wasn't very big, but I didn't want it to be too big. So I had to take a few things out from Kodu. Like, I was going to build, like, some skyscrapers but [Kodu] didn't have skyscrapers or spaceports.

Aiden often brought his map with him when he was on the computer, and he used it as a reference point when he was building his game. Meghan also found the map useful, because it allowed her group to create a game that connected to her group's vision of their region. She explained, "I think it looks just like—almost how I saw it on pictures, and I think our group worked hard on it and it looks as we expected it to look like." Clara also highlighted the importance of the map, noting that "the map was helpful because they showed me where things go, because sometimes I do something different in my head and that will shift the whole game to something else." Recording her ideas on a map allowed Clara not only to make a concrete connection with her story, but also to finalize some of the ideas she had in her head.

It would have been interesting to see students working through the video game construction process without a map. Stella is the closest example of this, because her map did not match her game, but she was still able to construct a well-organized and concise video game. However, for Stella the overall look and feel of her game was of utmost importance. She stated, "The look was really important because me and Natalie like everything to be perfect." Stella discussed the differences between what girls and boys perceived to be important in their games, saying:

> Some girls care and some girls don't care, but I know I was helping a few of the boys because they didn't know what to do, or I was walking past the games and I noticed they were a lot—not as polished or looked good, they didn't really care.

> They were just like whatever. Some boys care about it, like some of them, they were like perfectly straight and some of them it was just whatever.

For Stella, the aesthetics of her game were not based on gender, but more on interest; both boys and girls might be interested in creating a game that was visually appealing.

Some of the other students discussed their lack of interest in drawing a map, particularly Caleb, Colin, Ellen, and Samantha. Although each of these students' maps shared a strong resemblance to their final video game, the students said they would prefer not to use a map in the future. Caleb stated,

> The map wasn't that good. We had different kind of ideas, and I'm more of a person that just does things off the top of my head. I just think it up. I've actually gone up in school assemblies and just thought up what I was going to say.

Caleb saw his learning style as being fluid, and felt he didn't need to use a map to ready himself for his game. The overall design of his game lived within his head. However, the map was helpful to communicate with his group, to share what Caleb visualized the game to look like. Although Caleb did not need the map to feel successful, he did feel that the true and false planning questions were important in preparing for their video game.

Colin shared Caleb's sentiments regarding the map, stating,

> The one thing for me that I didn't think we needed was all that stuff on the map, like I like the base of how we drew out land but I didn't think we needed anything on the land. My game didn't turn out anything like the land.

While Colin's map and his final video game looked very similar, his initial game description was also very similar to his video game.

Ellen, Colin, and Caleb all found the map ineffective because they couldn't clearly represent the kind of characters and objects, such as animals and houses, they would have liked in their game. Although the map made an impact on their final game product, because their map looked very similar to their video game, they found the lack of available characters a debilitating factor to the success of their map, because the items in the map did not completely match their final game. Although Meghan had a similar experience regarding the lack of animals in Kodu, she found the map to be an effective tool because it helped her to reconstruct her interpretation of the region.

Samantha and Beth also found it difficult to transfer their ideas from their maps to their video games; both of them wanted their games to look the same as their maps. Beth explained, "I had the map and I can't really make it from the game. I can't really translate it like that. I had different levels than the map but I can't really do that in the game." Samantha reflected, "I found that it was difficult to transfer back and forth, and you had to put in a lot of detail to make sure you can include that into your game." The mapping experience was useful for most of the students, although for the grade 4 students who were doing regions of Alberta, the lack of some characters and tools created some challenges to the game construction experience.

Math questions.

It is important to discuss the math questions that were part of the video game project for the grade 6 classes, because they played a pivotal role in the overarching design of these students' video games. Both Angela and Patrick wanted to develop a cross-curricular project that achieved an array of curricular outcomes, which is a significant feature defined through the district-wide Transform initiative. However, the students inadvertently used the math questions rather than the game story as their prime focus. In essence, the math questions took centre stage in the video game, with each of the students' video games carrying a relatively consistent narrative: you bump into a character, the character provides you with the question, and then you have to bump into another object to answer the question. This narrative pattern can be seen in the students' maps and story descriptions in Appendices I and J.

This consistent narrative was also situated in the grade 4 video games, where the students' stories were defined through yes and no questions. The difference between the grade 4 and the grade 6 students was that the grade 4 students firmly established their games around the purpose of displaying facts about their region, whereas the grade 6 students were primarily provided the task of writing a story.

Some of the grade 6 students were critical about integrating math questions into their video game. Clara provided an interesting perspective, saying,

> I don't really like math games, 'cause they are boring. Games without math would be more fun and entertaining and they would be more difficult, because I had to change my own video game around to add in the math questions, and it would have been something completely different if I didn't put the math questions in.

It would have been interesting to see the kind of game Clara would have crafted, because her initial story ideas were complex and intriguing. The math games Clara has played, such as Math Blaster, provide a drill and practice kind of experience, which Clara did not enjoy. She felt that she had to devise a game that was similar to the games she would rather not play. Interestingly, the students were designing and building through a constructionist experience; however, the video games they constructed were more aligned with an instructionist final product. Even though Clara was critical of the overall structure of the video game, she was enthusiastic to build another video game in the future. Adding in the math questions was a deterrent for Clara, but not enough to take away from her enjoyment of the process.

Other students, including Samantha, Beth, and Stella, also discussed the difficulties they experienced with adding in the math questions. These students were critical of the struggles they had adding them into their story. Samantha noted that “sometimes it’s hard to incorporate the math problems, even like you have them inside your head, I wanted to be sure that I add them in properly and not just kind of sloppy.” Samantha wanted the math questions to be integrated into her game in a fluid manner, where the questions were not experienced as an afterthought. Stella had a similar experience, where she found that it was important to put the math questions in as she was writing, as opposed to putting the questions in as an afterthought. She thought that if the math questions were put in at the end of the story-writing process, it would have been much more difficult.

Many of the students also thought it was important to make sure the questions would be challenging for those who would play their game. Aiden and Stella were satisfied when their game proved challenging to other students. However, Angela found that some of the questions were too difficult, making it nearly impossible to win the game. This difficulty could relate to the idea that the game lived inside the student’s head, where it was a challenge for the students to gauge when their game was too difficult. Thus, if a time function were added to the game, the student designer could answer the question in a matter of seconds, where it might take much longer for another student to answer the question.

The math questions made an impact on both the kind of games the grade 6 students constructed and how the students experienced game construction in the classroom.

Without the constraint of adding math questions, what kind of games would the students have constructed? Would they have been consistent with question and answer games, or would they have been more open ended and exploratory? Would the students have felt successful in building their game without the structure of the math questions, or would they have struggled to maintain the focus of their game?

Process of game construction.

Each of the students reported an overwhelming desire to build another video game in the future. For example, John found the process to be extremely fun. He stated, “It’s different and you get to—it’s not writing a boring old report. You’re actually making the project fun.” John also found that building a video game took less time than writing a report. Although this conclusion might be questionable, because John likely spent at least seven hours building his video game, where writing a report would likely take less than four hours, John’s calculation demonstrates that he was clearly engaged and motivated in the process.

Ellen also enjoyed building a video game, suggesting that

> it’s more interesting to play the game and learn about it because kids love to play games instead of reading books and stuff. And if they have to, they will read the book but most kids would like to play the game.

Although Ellen is not an avid gamer, she found the process to be enjoyable and saw that many of her classmates were more engaged in building and playing a video game than they would have been reading a book. Clara also found building a video game more motivating than writing a story. She stated,

> I’d probably say that if we had to write a story, that the video game would be more motivating. Video games do have storylines and they basically tell you the

whole story, so you wouldn't have to read it and it's more exciting and the students wouldn't get bored. And it would boost up their creativity, because they get to create their game and show it in a way that's easy for them, because some students don't like writing or they just can't. And video games would be easier for them.

Aiden also highlighted his enjoyment in building a video game, saying, "I think it is easier to build a video game as I have more control over it and I won't have to fight with anybody to try to get my story into it." It is clear that Aiden has struggled with writing in the past, but working in Kodu was an important experience for him. Aiden also commented,

> I would make a game because, well, I'm not very good at writing, and I don't like it. But I like to program, and when I made my video game I felt proud of myself and I feel inspired to continue to work until I am finished. I have never worked like this before.

Stella found that game construction allowed her not only to feel motivated, but to create a meaningful connection with the content.

> Well, because for video games I think that you learn more, because for reports, all you're doing is writing it down, writing it down, and you don't, you don't have to in video games. If you program something, you have to go over it if something doesn't work and you have to problem solve. Reports you can't really do that, because you're not really—you're just writing stuff down.

Stella's constructionist perspective of gaming suggests that game construction is good for learning.

Many of the students found the visual re-creation of their design to be an important component of the game construction process. Colin suggested, “The difference is you actually get to kind of be in the world, see it and play it, but with reading, all you do is imagine it and you can’t see it or anything like that.” Being in this virtual world was significant for Colin because it allowed him to take action on his imagination and create with relative ease. Samantha had a similar experience, explaining, “Well, it just all kind of comes to life. Like you cannot imagine it, but see if like when it’s in a game instead of just imagining it in your head from a book.” For both Colin and Samantha, making this concrete, visual connection with their imaginations was significant, because it was likely one of the first opportunities they had had to not only create a concrete representation of their ideas, but also to play it.

Much like Colin and Samantha’s experiences with recreating their imagination, Meghan also found game construction to be satisfying, noting, “I liked that you could make it your own and put whatever you want that you thought would look more like Parkland or whatever we did.” Ellen also found the construction aspect a significant feature of her own enjoyment in the process. She stated:

> I would ask to do the video games again because it’s a lot more creative and you could make all your ideas in here, and in the story you can’t have so many ideas—because you have a main point in there. But in the Kodu game it doesn’t have to be based on one topic.

The overwhelmingly positive response regarding the students’ desire to construct a video game is important, because it indicates that they found the process satisfying and motivating, even through difficult challenges. The students do not share a united perspective regarding the process they went through to construct a video game, however. Some found the math questions helpful, while other found them hindering, and some found the map helpful, while others did not use the map.

These differences indicate the different kinds of learning preferences situated among the students. However, among these differences, the students all believed that some form of planning was important, and that they should be given continual game construction experiences. This finding suggests that students should be given choice in how they plan and design their video game, but at the same time, they need to be provided with some structure to ensure that they feel supported and safe in the game construction process.

Theme 4: Collaboration.

This section explores the collaboration that took place among the students and with their teacher. The students played an important role in supporting the development of video game construction, particularly in supporting other students using Kodu.

Student-to-teacher.

Many of the grade 4 students utilized the support of their teacher, Heather, while they were building their video game. Heather was able to provide this support because she had a strong background in programming as a result of her involvement with the LEGO robotics club. The grade 4 students tried to find answers to their questions from their group members, and if this wasn't possible they would seek the support of their teacher. Caleb described seeking Heather's support: "First I try going—programming it again, try a different way, slightly different and then I just ask a teacher if it didn't work." Meghan used a similar strategy, where she tried to solve the problem first on her own, then asked for help from a teacher. She explained,

> At one point it didn't move with the arrow keys, but then we played it for a longer time and then it started working. And then the points didn't work; it didn't give us points, but then the teacher helped us with that problem.

On the other hand, the grade 6 students relied on the expertise found within their class, which can be noted through the popularity of the tech ninja program. As a result, the collaborative relationship between the student and their teacher was more limited for the grade 6 classes when they were constructing their games.

Student-to-student.

Student experts.

Collaboration among the students played a pivotal role in the game construction project, especially when the students were constructing their own video games. This was particularly relevant for the grade 6 students, because both Patrick and Angela empowered the students to troubleshoot their own issues when using Kodu. As described above, Patrick and Angela integrated a tech ninja program where the students would nominate two or three of their peers who would be the experts for a particular game day. The tech ninja program also allowed expert students to showcase their knowledge and teach others about the program. For some students who were chosen to be tech ninjas it was a confidence-building experience. Aiden, for example, noted, "I feel proud of myself, because I know I can do this and I was chosen to be the tech ninja." Aiden also increased his understanding of the Kodu program when he helped others; however, this knowledge did not necessarily help him in staying focused on the story design he initially developed.

Other students, including John, did not appreciate being chosen as tech ninjas. John reflected:

> It didn't help me because it set me back. I could have been done my game problem by now, but I was down in the hallways and in the computer lab helping everybody for at least thirty minutes and I wasn't able to work on my own game. I don't want to be a tech ninja in the future.

Although John had more than enough time in the end to construct his game, as evidenced by the fact that he was one of the first students to finish, he felt that being a tech ninja put undue pressure on him to support other students.

Samantha also recognized this pressure, even though she was never chosen as tech ninja. She stated: "I think [the tech ninjas] were very helpful, but they just didn't get a lot of work done when they were the Kodu ninja because they were helping other students." Stella suggested that she was inwardly relieved that she wasn't chosen to be a tech ninja:

> I kept saying to myself, please not me. I don't want to be a tech ninja. Because if you are going to be a tech ninja then lots of people are going to be coming to you and if you don't know what to do, then you know I would feel kind of bad.

Stella had to ask more than one tech ninja for help, particularly when she experienced a new challenge in her video game. She recalled:

> At one time there were four tech ninjas and we had all them there to help figure it out. I think it was how to get a character bump into a character and make the other one vanish. We got it, but it took 20 minutes.

Some of the students found that the tech ninjas were not able to help them because the problem was too challenging. Beth emphasized, "The tech ninja showed me an idea of what to do, but it wouldn't work, but then eventually it would."

The use of student experts is a common reality in many classrooms today, particularly when emerging technologies are integrated, because often the teacher needs to lean on the technical expertise of students. When students support each other in using technology, they may be drawn away from their own learning. However, they build leadership, collaboration, and other skills, and they may deepen their own learning by explaining things to someone else.

The grade 4 students relied more heavily on their teacher for support and they did not have a structured tech ninja program set up in their classroom. However, they did rely on the collaborative support of their partner or someone who was nearby when problems arose during their project. Heather created groups to ensure that at least one expert gamer or knowledgeable user would be situated in each group. This provided an internal support system that the students used readily.

Group work.

Group work was another theme the students talked about in terms of collaboration throughout the project. The grade 6 students had mixed perspectives about group work. For Stella, it was a natural decision for her to work with a partner, and together they worked hard to make the partnership work. To work together, they had to rewrite their stories to combine details from both stories in their new draft. However, this extra work was worth it for Stella, who said, "I like working with partners because it helps you and you can bounce ideas off of each other, and if you're not sure of something they can help you out." Although Stella chose to work with a partner, very few of the students in Patrick's class decided to put in the extra work required to combine their stories. Angela did not provide her students with the option to work with a partner. However, given the opportunity, it is possible that both Robert and Clara (Angela's students) might have decided to work with a partner. Clara suggested,

> I would like to work with a group, but like with people who I work well with, because if I work with people I don't know or that don't pay attention or don't listen to people's ideas, I do get frustrated.

Similarly, Robert felt that working with a partner would have given him more ideas and details in the video game.

While working with a partner was appealing to some of the grade 6 students, not all of them shared the same positive attitude about the value of group work. John, for example, emphasized his lack of interest in group work, stating, "If I worked with a partner I would have to add two parts of the story together, and if I picked the wrong person, we wouldn't get anything done. And it sets people back because they fool around more than work, and talk too much." Samantha also mentioned that working with a partner might not be conducive to building a video game, noting, "I might think of something different than what they want and then I can't be as creative as I would have liked to be." A need for autonomy was a driving factor for these students, and although they collaborated with each other in solving problems with using Kodu, they felt it was important and motivating to construct a game that represented their own visions.

For the grade 4 class, Heather took a more active role in creating the groups and developing group work. The students were particularly grateful when Heather decided to make smaller groups for the game-making portion of the project. Ellen emphasized,

> I think groups of four or five are a bit much because then we can't include everyone's ideas. But groups of two or three are good because then we can definitely include all of the ideas that we want to and we should share them a lot better than just screaming at each other.

The grade 4 students found it easier to navigate through their problems and discuss their visions with a smaller group of their peers. Small groups also allowed each student to have the opportunity to program using the keyboard and mouse.

Some of the grade 4 students had an interesting collaborative approach. Caleb and his partner, for example, recognized and made use of their individual strengths. Caleb's partner was better at designing the land and adding in objects such as trees and buildings, and Caleb was more skilled at programming the objects. As a result, they took turns throughout their partnership and every few minutes they switched and continued to build or program. Caleb noted:

> You know, a partner's pretty good because let's say your fingers get sore of typing or moving or you're just tired, then it would be their turn. And If I would have done the landscape it wouldn't have been as good. And if my partner would have done the programming it wouldn't have been as good.

It is interesting to consider why so many of the grade 6 students chose to work by themselves while the grade 4 students enjoyed working collaboratively in small groups. This difference might be the result of the classroom culture in grade 4, where students are more comfortable and willing to work in groups. It might also be because the grade 6 students developed a more personalized, independent story, and they wanted to make that story come alive through their video game.

Collaboration was an important, if not pivotal, component to the success of the game construction unit: the students relied on each other in solving problems and learning more about the game construction program. Although there was little exchange between the students and the teacher regarding the use of the game construction technology, there was plenty of exchange among the students. However, many of the students did not like the tech ninja program, because it put them in a position that might not suit their needs, particularly if it took them away from constructing their own video game. This finding brings to focus the important role the teacher continues to play regarding technology integration. It is helpful for the teacher to understand the technology and support students in answering some of these questions.

However, it seems as though students are naturally prone to collaborate and support each other, although in an informal manner, which was seen in the grade 4 class. Finally, when students are working in groups, it was found that smaller groups of two or three are the optimal size for successful collaboration. Larger groups limit the amount of access the students have to the technology.

Summary

This study examined the following three questions: (1)What pedagogical approaches may upper elementary content-area teachers use to integrate game construction into teaching and learning? (2) How may upper elementary content-area teachers experience student-based game construction with their students? (3) How may students experience video game construction in a content-area classroom?

The general themes that were constructed from this study indicate the challenges presented to the teachers in integrating game construction into the classroom, such as locating ways to align current assessment practices with the finished video games, locating enough time to sufficiently work through the project, and developing writing and planning experiences that align with the development of a video game.

Although the teachers experienced varying tensions in the game construction unit, they also understood the importance of gaming in the classroom. This was affirmed in the positive responses from the students, where most of the students were enthusiastic collaborators, solved challenging problems with little complaint, and worked with the technology with relative ease. However, the students also experienced some tensions, for example, in locating solutions to their game bugs and in translating their game stories to their video games, where the traditional method of learning did not align with the game construction experience. This tension indicates that relative shifts may be required when integrating game construction into the classroom: traditional approaches are not necessarily the best fit for game construction. The discussion in the next chapter will further explore these tensions and what they might mean to both teachers and the research community.

Chapter 7: Discussion

This chapter connects the themes from the literature with the findings from this study. The study provides strong evidence that game construction can be integrated into the upper elementary curricular classroom. The discussion in this chapter brings forth these experiences and illuminates certain roadblocks that need to be addressed for both teachers and students.

The discussion is organized into seven sections: pedagogy and technology integration, time, assessment, teacher collaboration, student collaboration, problem solving, and planning and writing. Each section begins by discussing the literature that connects with the findings and concludes by highlighting specific reflections that connect with teacher pedagogy and questions for future research.

To reiterate, this research study was framed through the following three questions: (1)What pedagogical approaches may upper elementary content-area teachers use to integrate game construction into teaching and learning? (2) How may upper elementary content-area teachers experience student-based game construction with their students? (3) How may students experience video game construction in a content-area classroom?

Pedagogy and Technology Integration

The findings suggest a connection between teachers' pedagogical practice and how they integrate technology into their classroom. Patrick and Heather both integrated technology in a student-centred, constructionist manner, while Angela integrated technology in a more instructionist manner. These findings affirm the research of Andrew (2007), Ertmer et al. (2012), and Tondeur et al. (2008), all three of which identified a connection between a teacher's pedagogy and their use of technology.

Similarly, Evans-Andris's (1995) research suggests that student-centred teachers are more likely to embrace technology and devote more time and energy to technology. In this study, both Patrick and Heather spent more time immersed in learning about the game construction program and designing their unit. However, there are some inconsistencies with the connection between technology use and pedagogy in terms of Angela's pedagogical practice and how she integrated technology into her classroom. Certainly, Angela's lack of confidence with game construction connects with Evans-Andris's classification of distancing techniques, as Angela relied heavily on the expertise of her students and spent little time learning about the technology. However, in considering the experiences of Angela's students during the game construction unit, particularly during the times when they were immersed with Kodu, there were times when students were engaged in a constructionist experience. This finding suggests that constructionist technologies can inadvertently support constructionist experiences even when teachers are defined through a different pedagogical practice (Black et al., 2006; Kafai, 2006; Kafai & Ching, 2001; Papert, 1980; Robertson & Good, 2005).

Confidence and risk taking.

In addition, Angela's interactions with her students also affirm the research of Ertmer and Ottenbreit-Leftwich (2010) and Mueller et al. (2008), who suggest that working with students can positively impact the use of technology in the classroom and develop a sense of confidence in the teacher. Certainly the students' expertise created a sense of confidence for Angela to facilitate this kind of experience in the classroom. Moreover, student expertise had an impact on each of the teachers, as their observations of students working and building with Kodu created a greater understanding of game construction (Borko & Putman, 1995). These positive moments are important, because Mueller et al.'s (2008) research suggests there is a connection between having a positive experience with technology and using the technology repeatedly in the future.

It is possible that Angela will integrate this technology in the future. However the relative consistency in pedagogy affirms the work of Hayes (2007), Lovell (2014), and Smeets (2005), which suggests that teachers generally do not change their pedagogy when integrating technology into the classroom, or conversely, that technology is not a great enough force to alter a teacher's pedagogical practice. In this study, the students in Angela's class certainly had a constructionist-based experience, but they did so independently of Angela's pedagogy.

Agency and structure.

Each teacher in this study experienced a degree of tension regarding both the knowledge of how to integrate game construction into the classroom and the barriers that are present in facilitating a more constructionist experience. This finding is similar to Brennan's (2013) research about the balance between agency and structure: most school contexts tend toward a high structure / low agency paradigm. Brennan (2013) also suggests that teachers will rely on a greater degree of structure when dealing with complex situations. This dynamic was certainly present in how Patrick and Heather integrated game construction, where they relied on a greater degree of structure at the beginning of the unit, particularly during the planning and writing stages of the project. It also affirms the research of Sandford (2014), who suggests that when teachers are challenged with a new or difficult planning situation, they will inadvertently lean on traditionalist practices to support them through the process.

The complexity of the situation was also influenced by the lack of adequate training and support for the teachers in integrating game construction in the classroom. Besides the short tutorial session offered at the beginning of the game construction unit, the teachers were provided limited support and guidance in both designing and integrating the project. This finding affirms the research of Overbay et al. (2010) and Pelgrum (2001), who suggest that without adequate training, the use of technology will be limited, regardless of the teacher's pedagogical practice.

Reflections for teaching and research.

In considering the kind of constructionist experiences that were developed in relative independence from the teacher's pedagogy, particularly considering Angela's own instructionist pedagogy, it is important to consider future applications of constructionist technologies in the classroom. Technology rarely alters a teacher's own pedagogy, but technologies such as video game construction can transcend how a student comes to understand a particular idea, regardless of how they have learned in previous classrooms or how they learned in previous lessons. Constructionist technologies such as Lego Robotics and varying makerspace technologies can serve an important role in the classroom, while not only aligning themselves with the participatory needs of 21^{st}-century learners but also ensuring the needs of learners are met. If students can experience constructionist learning independent of the teacher's pedagogy, it is important, if not vital that these kind of technologies be made available in schools and become apart of the Alberta Program of Studies. In addition, these constructionist experiences might also account for some the resistance to using technology in the classroom.

Although this research affirms the lack of influence technology has on a teacher's pedagogy, it does present an interesting opportunity for teachers to learn from students. Students interacting with game construction programs can provide opportunities for teachers to observe and interact with students, which can subsequently provide the much needed time for teachers to learn more about the technology and potentially create a more positive relationship with emerging, constructionist technologies. This student-led constructionist experience suggests that if teachers are provided the time to observe and learn from their students, it is possible that their own pedagogy might change over time. This was particularly true in the Apple Classroom of Tomorrow and the research of Borko and Putnam (1995), who found that teachers learned the most about technology when observing their students. It seems possible that by spending time observing students engaged in using constructionist technologies, a teacher's pedagogy might change. Further research needs to investigate not only the role that constructionist technologies play for the digital learner, but the potential role they serve to the teacher and the teacher's pedagogy—and if in fact they can influence and alter a teacher's pedagogical practice.

This section discussed teacher pedagogy and technology integration, particularly aiming to understand the impact that game construction has on a teacher's pedagogy. This study found that a teacher's pedagogy remains relatively unchanged with regards to the experience of integrating game construction into the classroom, and constructionist teachers will likely experience a greater ease in integrating game construction into the class than will instructionist teachers. However, this study also shows that with greater exposure to and understanding of the technology, teachers will likely become more confident with it and lessen the amount of structure situated in the classroom.

Time

The amount of time available in a classroom is a constraining factor, particularly given that each of the teachers in this study found video game construction to take more time than a traditional project. This finding is consistent with Ertmer's (2005) and Carver's (2006) research, which indicate that constructivist applications of technology take more time because of their complexity and higher order learning experience. Although the video game construction project in this research spanned about five to six weeks, it took considerably less time than Harel and Papert's (1990) Instructional Software Design Project, which took about 15 weeks, and Kafai's (1995) game design project, which took about 20 weeks, and slightly more than Baytak and Land's (2011) Scratch project, which spanned 21 days, or about four weeks. This finding indicates that students can construct a video game in a shorter period of time than that required for the two earlier projects, which is likely due to the advancements in game construction technology since the 1990s. Programs such as Scratch and Kodu Game Lab offer a greater assortment of smart tools (Gee, 2007a) that help students navigate and build their games. As well, there is a greater collaborative agency (Kafai et al., 2012) in using these programs, where students can access various affinity spaces to problem solve and learn more about the program.

Although each teacher in this study found that it took more time to complete the game construction project than to do a traditional text-based project, they found that the additional time was beneficial. This finding is consistent with Robertson and Howells' (2008) research, which indicates the importance of providing additional time to allow students to work through problems while constructing a video game. In fact, each of the teachers in this study felt that anything less than a one-hour block was limiting due to the amount of time it took to log in and begin working on the game. The teachers indicated that longer periods of time (two- or three-hour blocks), particularly when building the video game, were essential.

This result counters the experience of Harel and Papert's (1990) Instructional Software Design Project and Kafai's (1995) game design project, which generally provided only one-hour blocks. Although these longer periods of time were essential to the students and teachers in this study when building and constructing a video game, they are not conducive to the structure situated in the school, particularly because the computer lab has fixed scheduling. Each of the teachers required more time than what was initially planned for, and oftentimes there were not enough computers when classes were combined to collaborate and work together. The regimented computer schedule suggests the destabilization that occurs when a new technology is introduced into a school (Smokeh, 2008) because it alters the preconceived application and use of older technologies. This finding is consistent with Baylor and Ritchie (2002), who suggested that teachers in their study were not provided enough time on the computer schedule, particularly when working through exploratory technology projects.

In addition, this finding contrasts with the research of Cuban et al. (2001), who suggest that schools are defined through a high access / low use paradigm; however, each of the teachers would have liked to have more access and time with the technology than were available. It is possible that emerging technologies such as game construction programs will begin to create greater demands on the accessibility of technology. This paradigm may be reversed, where there is high use but low access to technology in classroom and schools that are using constructionist technologies. Game construction technologies take more time, and more time with technology needs to be provided in order for students and teachers to fully experience the building of a video game.

Reflections for teaching and research.

Two key points are important to consider regarding video game construction. First, planning and building a video game can take a considerable amount of time, particularly when compared to a more traditional experience, such as writing a report or creating a poster. Second, not only does game construction take more time, it also requires longer periods of time, particularly especially when using the game construction technology. These two factors can be difficult to work with, particularly because upper elementary teachers in Alberta must teach a fairly comprehensive and detailed curriculum. In addition, it is not always easy to access technology for longer periods, particularly when schools follow a fixed computer schedule. Unquestionably, time is a factor that generally works against the relatively inherent demands that are situated in constructing a video game, and it requires thoughtful planning, organizing, and administrative support.

Certainly, it is important to consider the relative advancements that have been made regarding video game construction programs, which allow students to design and program with relative ease, making the amount of time required in the classroom less than earlier research studies indicated. This factor also leads to the question, if most elementary schools are subjected to a computer schedule, is there in fact enough technology within schools to enable these kinds of constructionist technologies? It is possible that the overall equation used to measure the acceptable access to technology per student no longer is sufficient to truly allow for experiences such as game construction to work effectively in the classroom. It is possible that we are quickly approaching an environment where students do not simply need access in the school, but instead need access at all times. As further research centres on video game construction is school settings, it will be important to consider time as a constraining factor for teachers and students.

This section discussed time, both the amount of time that video game construction takes in the classroom and the limited amount of time available in an upper elementary classroom. As video game construction technology becomes more advanced, it will likely take students less time to construct their games, due to their collective agency and the scaffolds situated in the tools. However, it is still important that students are provided long periods of time to construction their games.

This section also identified having adequate access to technology, given that constructionist technologies require more time than traditional projects, thus greater access to technology is needed, potentially meaning that schools will need to purchase more computers.

Assessment

The assessment situated in each of the teacher's classrooms was framed through a greater emphasis on formative sources of evidence, such as the students' game reflections, planning documents, and stories. No assessment of the final video games was done or provided to the students, which counters Tangdhandakanond, Pityanuwat, and Archwamety's (2006) research which suggests that instructionist-based classrooms are primarily driven through tests. Angela did not provide her students with any exam or quiz centred on the game construction experience, which may relate to the newness and unfamiliarity of the technology. She might have provided a more summative or instructionist-based assessment if she had had a greater understanding of the project and the technology; however, it is also possible that it may be difficult to create a more instructionist-based assessment of game construction, particularly because the final aspect of the unit was to build a video game.

The use of formative assessment in the video game projects described in this research is also aligned with Kafai and Burke's (2014) suggestion that authentic and translatable feedback is essential to support students through video game construction. Although each of the teachers provided written or verbal feedback to the students throughout the planning and writing process, only verbal feedback was provided to the students when they were actually building their games. At times, verbal feedback was provided to the students to solve a problem, but this feedback often came from the support of other students. Formative assessment seemed to be the most authentic form of feedback for the students as they solved problems throughout the process.

The relative absence of assessment regarding the students' video games aligns with the challenges Brennan (2013) identified in locating ways to assess Scratch games and simulations. Brennan (2013) found that the teachers were unable to assess the students' video games because they either lacked an appropriate assessment model to fully capture the students' work or they felt that providing a grade would undervalue the students' creative work. The grade 6 teachers in this research made similar comments, as they chose to not provide a mark for the final video game. Both grade 6 teachers found it exceptionally difficult to identify measures to validate the students' work. This difficulty was confirmed by the lack of discussion from each of the teachers regarding how they were going to assess the students' video games. Plenty of discussion centred on assessment practices prior to the game construction, such as writing and planning documents, but due to the complexity of assessing a video game, the subject was rarely mentioned or discussed.

Ching (2001) states that "providing sweeping statements about trends or progressions turns out to be more complicated given the complex nature of software design work" (pp. 358–359). The complexity associated with software design and game construction is not easy to assess, and thus it makes sense that teachers chose to focus their assessment practices on more common forms, such as stories and written reflections, because the teachers have assessed these products before.

Squire (2006) also identifies the complexities of assessing a video game, particularly when it is centred on a specific content area, because the kind of work produced in the game can vary considerably among students. Considering the association with a particular content area, both Ertmer and Ottenbreit-Leftwich (2010) and Hughes (2005) suggest that teachers are more successful integrating technology into the classroom when it connects to a specific content area.

However, in this study the teachers found it difficult to assess the students' knowledge of the content. Although it may have been easier to validate the use of time in the project when connecting to particular curricular outcomes, it also made it more complex to assess.

For these teachers, and for teachers new to game construction, it makes sense to centre their assessment of game construction on ICT competencies. This finding is particularly true for Heather, who seemed to find more success assessing the students based on ICT outcomes rather than content area outcomes. Kafai et al. (1997) similarly suggested that game construction provides opportunities to learn more about a certain technology, and assessing a student's technology use seems to be an appropriate way to measure their understanding.

Teacher concerns.

Considering the culture of the school in this research study, each of the teachers used assessment as a way to validate not only the work of the students, but also the video game construction project. Determining the assessment measures in advance helped the project feel more important and supported the amount of teacher and student time devoted to the project. Brennan (2013) found similar experiences among her teachers, who used varying forms of assessment, albeit not centrally situated around the video game, to validate game construction to the surrounding school community. This finding brings into focus why the teachers aligned their assessment practices around qualifying measures such as stories and reflections, because they can be easily measured and easily communicated to other teachers and parents regarding what the students were learning.

Although the teachers struggled to assess the video games, their focus on other components, such as story writing and reflections, was important. Baytak and Land (2011) found that when assessing student-constructed video games, it was important to assess not only the final artifact, but also the planning and writing documents. In this study, had time permitted, each of the teachers would also have liked the students to assess each other's video games, which aligns with Robertson and Howells (2008), who suggest the important role that peer assessment can have for understanding the work of the students.

Reflections for teaching and research.

Assessment is a particular area that requires further research, paying particular attention to examining whether and how student-constructed video games can be assessed in the upper elementary classroom. Certainly the complexities centred on software design and game construction are something to consider, because the summative product may look entirely different from one student to the next, making it difficult for the teacher to create an objective scale of student achievement. In addition, teacher concerns may centre on the idea of remixing, where game construction, particularly through programs such as Scratch, is deeply rooted in the notion of remixing products or tweaking certain elements of a preconstructed game.

Further research should also explore whether other forms of assessment, particularly formative assessment such as observations and discussions, provide a more effective means of student evaluation regarding the video game. This researcher wonders whether the methods used to assess the students' initial work, such as their planning and writing documents, were enough to provide the teachers with a clear indicator of student success and achievement, and for the students to understand their own learning. Certainly the teachers in this study felt confident and comfortable with the collected artifacts they assessed.

Do video game needs to be assessed? And if so, how does the expertise level of the teacher influence assessment? Is it imperative that teachers have a certain level of knowledge or experience with video game construction to effectively assess a video game? And is there any way to assess the quality of thinking that manifests itself in the final video game?

In addition, it is important to further investigate self- and peer assessments. Creating more opportunities for both personal and peer-to-peer assessment might create a more comprehensive picture of student knowledge and understanding of the content area through their video games.

Furthermore, it is important to investigate whether video game construction is best served as a focus on ICT competencies, where learning with and about technology in the digital age is an important area to report. The standards created by the International Society for Technology in Education (ISTE) could be one solution to how teachers could assess their students' work through game construction. Standards such as "use multiple processes and diverse perspective to explore alternative solutions" (International Society for Technology in Education, 2007) certainly address the kind of work the students in this study participated in while constructing their games, and this example represents a valuable understanding to communicate.

This section discussed assessment and the impact it had on both the teachers and students in this study. The teachers found assessment challenging and complex because video game construction is a relatively new learning experience, which makes it difficult to evaluate the learning of the students from a relatively unfamiliar artifact. Further research will help support teachers looking to understand how to assess their students' learning in regard to video game construction.

Teacher Collaboration

Video game construction was a relatively new experience for each of the teachers, and at first glance collaboration would present itself as a key opportunity for the teachers to become more knowledgeable and confident with the technology. However, collaboration was difficult to achieve between the teachers due to time constraints and their lack of knowledge regarding both the technology and collaboration. In considering Montiel-Overall's (2005) four levels of collaboration, including coordination, cooperation, integrated instruction, and integrated curriculum, the teachers generally experienced the first two levels of collaboration because there was a limited, mutual exchange regarding how the game construction should be experienced.

One of the reasons for this lower level of collaboration certainly relates to newness of the technology, where Patrick took the lead in 'breaking trail' to understand how game construction can be experienced in the classroom. The other teachers, particularly Angela, followed his lead and integrated Patrick's instruction into their own classrooms. This finding clearly indicates a one-way exchange of knowledge between the grade 6 teachers which necessitated a sense of coordination on Patrick's part, as compared to a sense of integrated instruction, which would have transpired if Angela had had a stronger voice in the game construction process.

In examining the collaboration that transpired between Heather and Patrick, the exchange between more dynamic, where Heather was able to use some of Patrick's ideas and shared her own with him. She recalled:

> Patrick shared some of the ideas of what makes a good video game, and lots of other ideas, and he gave me some rubrics and some planning documents. It's hard enough being a teacher on your own, if you're in your own grade, but having your partners there to bounce ideas off is awesome. If I didn't have Patrick there and he wasn't on the ball to give me some ideas and say, oh I'm going to try that, or oh I never thought of that, it would be much harder.

Confidence and knowledge with technology certainly seem to be important elements in levelling the playing field with regard to collaboration between teachers.

Although knowledge and time are important factors to consider, it is also important to suggest the possibility that the teachers may have lacked a strong sense of knowledge of how to collaborate, particularly considering the relative isolation many teachers work within. Welch (1998), Pugach and Johnson (1995), and Leonard and Leonard (2001) all suggest that collaboration in school settings is difficult to achieve because of a general lack of knowledge about how to collaborate or a lack of structure set up in the school to facilitate these opportunities. Interestingly, St. Luigi School did provide some time for the teachers to collaborate, particularly between grade partners, where Angela and Patrick and Heather and Patrick had time together during the week to collaborate. Although these teachers were provided with time to collaborate, it is possible that the amount of time provided was not sufficient, particularly given the general newness of the game construction technology and the fact that the teachers were often overloaded with other tasks to complete.

Leonard and Leonard (2001) suggests that one of the reasons for the lack of collaboration in schools is that "there needs to be a greater articulation of underlying values and beliefs about educational practice that is tempered with respect for diverse professional opinions and practices" (p. 9). Each of the three teachers in this study, particularly the grade 6 teachers, held a different philosophy of education and a different understanding of technology. It is possible that the very structure in a school works against effective levels of collaboration. Perhaps it is natural that one teacher takes over and the others follow, because this approach is easier and less time consuming than finding a common ground on which to share and exchange ideas.

Reflections for teaching and research.

When teachers share a common understanding or perspective, collaboration seems to happen more naturally. In considering this, it is easier to understand Angela's limited opportunity to effectively collaborate with either Patrick or Heather. Montiel-Overall (2005) and Leonard and Leonard (2001) suggest that it is important to develop a caring and respectful environment to facilitate these productive exchanges. However, if one teacher does not have knowledge of the topic, it may not be possible for them to become a collaborative member, even if a respectful and caring environment is established. Consider Angela's contribution regarding story-writing elements: the students struggled with making a connection between their game story and their video game, which suggests that even if Angela had had a stronger voice in the collaborative process she may not have been any better able to support her students. In essence, collaboration between teachers may be difficult to achieve, particularly if one teacher lacks a general understanding of game construction.

Thus, even if enough time is given to collaborate, if game construction is not understood, it is possible that lower levels of collaboration will be experienced. Conversely, if two teachers are knowledgeable about video game construction, it is possible that they won't require any additional planning time to collaborate because they will be motivated to exchange their ideas with each other. This was apparent between Heather and Patrick. Even though they didn't teach the same grade, they still found the time and energy to the share their knowledge with each other. It seems then that knowledge of the technology and the teachers' resulting confidence was the impetus for collaboration.

Further research needs to explore the role that collaboration can play in game construction, particularly because many elementary teachers do not play video games. Do teachers, in fact, need to collaborate? Or, perhaps a coaching approach is required to support non-gaming teachers. What kind of collaboration would transpire between two non-gamer teachers and how would they collaborate? What about two knowledgeable teachers who taught the same grade? Would they collaborate together?

This section discussed teacher collaboration and the positive and negative experiences that can occur when teachers collaborate while integrating video game construction into the classroom. Factors such as an understanding of the video game construction technology and a sense of confidence with technology were positive factors to facilitate effective collaboration between teachers, while teachers who struggled to collaborate generally lacked a sense of confidence with technology and a general knowledge of video game construction. In addition, a shared philosophy of education and learning were also found to be important factors in facilitating effective collaboration between teachers.

Student Collaboration

Student collaboration was an essential component to the success of the game construction unit, as the students supported each other in working with and through the game construction technology. In some regards the collaboration that transpired among the students can be attributed to the opportunities the teachers created for the students to work collaboratively, such as the tech ninja program. Students were willing to work with the teacher, or utilize the teacher's support when available, especially the grade 4 students, who were more dependent on Heather because she took a more hands-on approach to supporting the students during the game construction process. The grade 6 students received more support during the planning and writing aspect of the unit, while less support was available in the gaming component, and thus the students naturally helped each other when solving programming problems. This support went beyond the tech ninja program, because students who were not identified as experts still helped others.

In fact, most of the students were willing to help each other during game construction, which affirms the research of Robertson and Howells (2008), Brennan (2013), and Brennan, Monroy-Herendez, and Resnick (2010), who all suggest that students are natural collaborators and support each other when constructing games. For most of the students in this study, helping another student was like "paying it forward" because they knew that they would need help in the future, such as a bug they might encounter in their video game. It seemed as though there was a situated apprenticeship among the students, which affirms the work of Ching (2000) and Kafai et al. (2012), who suggest that students naturally organize and support each other through an old-timer/newcomer relationship. In this study, the students who were avid gamers, or who had a more advanced knowledge of Kodu*,* were willing and able to help more novice students in the class.

Collaborative agency.

It seemed as though the roles of newcomer and old-timer were continually evolving, depending on the knowledge of the students. For example, at one moment an old-timer supported a newcomer, while at the next moment the newcomer might support the old-timer. These titles, newcomer and old-timer, were only apparent in the amount of time spent with the game construction technology. Old-timers were often identified as tech ninjas, while newcomers were identified as students with limited knowledge of the program and often limited knowledge of video games. This finding is consistent with the work of Kafai et al. (2012), who suggest that collaborative agency is continually evolving because students are not always collaborating with the same experts. This collaborative agency was not as prominent when the students were planning and writing their stories, because there seemed to be a more ingrained understanding of who were the expert writers in the class. When it came to constructing games with Kodu, these collaborative boundaries were less rigid. This finding illuminates the redefined collaboration that transpires when students are using constructionist technologies (Papert, 1987).

Structured support.

However, there were students, particularly in grade 6, who were dissatisfied with being identified as an expert, or a tech ninja. Some students found that by being identified as an expert, they were not able to focus on their own work. This finding aligns with the work of Ching (2002), who found that structure, or direct instruction, created a reduced understanding in the collaborative relationship between students. Although Ching discusses the dynamic of older students supporting younger ones, the directive of being a tech ninja ties into the effect that structure can have on collaboration. In essence, students would rather organize themselves in their own collaborative roles than have the roles organized for them. This finding aligns with Gee's (2004) discussion surrounding affinity spaces, where the constitution of the group is more aligned to the activity than to the group members. The students would have been successful in creating their own affinity groups, particularly when a particular need was identified. This was seen with the grade 4 students, where no expert was identified by the teacher, but the experts were innately known among the students.

Sharing.

Although the students felt successful in collaborating together, many students did not have the opportunity to share their final games with the class community. This limited opportunity to share their games was primarily associated with an array of technical difficulties, but also occurred because Kodu does not provide simple ways to share games. Some students were able to share and play games during the final video game class and noted that this was one of the best experiences of the unit. However, those students who did not have the opportunity to share their game were deeply disappointed.

This finding attests not only to the importance that sharing and showcasing ideas has for digital learners, but also to the important role that deep shareability (Resnick, Kafai, & Maeda, 2004) plays in the process of creative production. It is not enough for digital learners to simply share their ideas while building and constructing; it is also important for learners to have opportunities to exchange ideas at the end of the project and beyond the project. Although Kodu provides some opportunities for sharing, it is not as conducive for sharing as other game construction programs, such as Scratch.

Reflections for teaching and research.

The relative newness of students constructing video games exemplifies the importance of both teachers and researchers learning about the kinds of collaboration that transpire when constructing video games. This requirement means that collaboration between students needs to look and feel different than the traditional classroom experience. Openness in the classroom and a fluidity among students is important; even a tech ninja program might not be helpful or necessary because collaboration will naturally transpire among students. This finding leads to questions about the role of the teacher in the game construction experience, where the teacher's role is not to instruct the students or demonstrate how to complete a task, but to act as more of a facilitator who initiates and supports fluid forms of peer collaboration.

How then do non-gamers, or students with a limited knowledge of video games, experience collaborative agency? Will they seek out more opportunities for this collaborative exchange in the future? Will they be more interested to build or play video games in the future?

Will they try to replicate this collaborative agency in other settings? And, once the game construction experience finishes, will they be motivated to replicate this experience in other ways, in other classrooms, and with other people?

As a teacher researcher, the collaborative agency of learners that was seen in this study is truly the utopia of collaboration, in which every student is engaged and a contributing member. Understanding the rareness of this collaboration leads to questions about how this kind of collaboration can be experienced in other areas of the classroom. Can it be recreated in more traditional experiences that involve collaboration, such as a group report or a class discussion, or is it the very nature of game construction that facilitates collaborative agency? The collaboration that takes place between students is an important if not vital area to investigate further. As technology continues to evolve, software designers can create technologies that follow the same principles of game construction, and it is possible that these experiences can be replicated in other ways to ensure that learners' participatory needs are repeatedly met in the classroom.

This section discussed student collaboration and the important, if not vital, role it served to the students and teachers in the game construction unit. This research suggests that students collaborate while constructing a video game and require little to no teacher intervention to support this collaboration. Although some students were able to provide more expertise than others, most if not all students were willing to help another at some point during the game construction unit. This section also highlighted the importance of students sharing their video game with others, and some of the challenges Kodu presents to gamers in allowing this sharing.

Problem Solving

Problem solving played an integral role in the game construction unit, particularly because the technology was generally experienced as a tutee, the third level of Taylor's (1980) technology hierarchy. In understanding the command the students had over Kodu*,* it makes sense that they had to employ a variety of problem-solving strategies while working on their video games. Each of the students experienced moments of flailing or fleeing, as Brennan (2013) describes when students feel overly challenged with the game-construction experience. However, none of the students remained in a state of fleeing or flailing for extended periods of time. In fact, each of the students located ways to fix their problems, whether it was collaborating with another student, thinking out loud, moving forwards and backwards through the problem, or playing other students' games. This finding suggests that learners engaged in game construction can develop a natural sense of perseverance in locating ways to not give up (Brennan, 2013).

Messing around.

Initially the students had a limited command over the technology, which resulted in less sophisticated strategies to debug their games. They generally relied more on a tinkering or bricolage (Papert, 1993) experience in which they utilized their limited understanding of the tool and experimented with it. This finding not only affirms Papert's (1980) idea that programs such as Kodu are objects to think with, but it also connects to Horst et al.'s (2010) discussion of creative production and messing around with technology. Digital learners are naturally prone to mess around with technology because they experience technology in this way outside of school and as a way to socially interact with their peers (Dougherty, 2013). This phenomenon was particularly true regarding the initial tutorials provided to the students. While the teachers required support to learn how to use the program, the students did not seem to need the direct instruction. In fact, some of the students who were not present for the tutorial were still able to learn about Kodu by simply tinkering with the program.

It is possible that kids are naturally inclined to mess around as a way of learning more generally, and messing around is generally aligned with technology than elsewhere because schools haven't yet figured out how to turn technology plan into 'school work'.

This initial tinkering or messing around strategy was a responsive way for the students to debug their games, but it also indicates the freedom the teachers provided to their students. As researchers (Brennan, 2013; Buckingham, 2007; Dougherty, 2013; Horst et al., 2010; Kafai et al., 2009) indicate, most teachers do not provide the freedom for students to tinker and mess around with technology during class time. This finding certainly confirms both the confidence the teachers had in their students' ability to learn the program and the teachers' understanding that the students required freedom to explore technology.

Remixing.

The students also solved their problems through playing other students' games. This finding connects to Kafai and Burke's (2014) discussion surrounding remixing or, more precisely, selective remixing, in which students participate in creative media production by altering or changing a part of a program or game to enhance their own product. Certainly the students remixed their own game, based on playing other students' games, because doing so not only solved problems in their own game, but it also gave them a different perspective on how to program in Kodu. Because the students were not simply copying and pasting ideas from one game to the next, their own remixing was framed with greater sophistication, as they were selective in what they were adding or subtracting from their games. Although this form of remixing was not specifically mentioned by the teachers in this study, it may have added to the complexity of assessing the students' video games. How does a teacher assess individual learning outcomes when the students readily share their ideas with each other and when a product is not an individual representation of the student's own work?

Iterative problem solving.

Some students utilized a tinkering strategy throughout the game construction experience, and they were generally successful in completing their game. This finding connects to Turkle and Papert's (1990) epistemological pluralism, suggesting there is more than one way to experience learning. Kafai (2006) emphasizes that "concrete thought can be just as advanced as formal thought" (p. 39). Tinkering with Kodu represents a more concrete form of understanding, in which some students developed more abstract forms of understanding by moving forwards and backwards to solve problems, or thinking the problem out loud. These more abstract problem-solving techniques were developed over time and as the students developed more confidence with the program (Kalelioyu & Gulbahar, 2014).

Brennan (2013) also found that students are naturally able to develop more complex and systematic ways to solve problems in their video games, particularly through the support of diagrams and sketches. Although some of the students utilized their maps as a reference point, many of the students problem solved either through talking problems out loud with an expert or moving forwards and backwards through the program, adding in more complex applications throughout the process. For example, as the students became more aware of Kodu, they would not simply have Kodu vanish, but they would have Kodu vanish AND advance to the next level.

This finding connects with Salen's (2007) reference to iterative design and Ito's (2005) understanding that technologies provide opportunities for continual revision. The teachers did not provide any formalized instruction regarding moving back and forth between the play and edit screens; however, for many of the students, this forwards-backwards technique was a natural problem-solving solution. It seems as though Kodu was designed to facilitate iterative design, because it naturally provides the opportunity for students to move between the edit and play screens to solve problems.

The students became more skilled with the iterative design as they progressed through the game. At the beginning of the unit they would remain in the edit screen for the entire class and only play the game at the end of the class. However, after a few classes, they realized the importance of going back and forth between the screens on a continual basis to fix any bugs that might be present in the game (Calder, 2010). However, this increased confidence with problem solving also created more complex problems for some of the students, because it was more difficult to debug some of these sophisticated add-ons. Although iterative design allowed some of the students to solve these problems, some were unsolvable for the entire class community, meaning portions of some games were deleted. The smart tools (Gee, 2007a) situated in the game and the students' own ability to problematize (Kafai et al., 1998) through the game still did not satisfy all the issues that surfaced through using Kodu.

In considering iterative problem solving, Gee's (2007b) four-part gaming cycle provides a further indication as to what happened between the play and edit screens. The cycle starts when a gamer first identifies the problem. Then they hypothesize the solution, reprobe and apply the hypothesis, and finally rethink the original hypothesis. For many of the students, in going back and forth between the two screens they would apply a similar process where they would first identify the problem while they played the game, or a partner played the game, then they would return back to the edit screen and scan to see what the problem was. Once deciding what the problem was, they would make the change and return back to the play screen to test whether the problem was resolved. If the problem was resolved, the students developed a new understanding of the game construction program.

Compromise.

Many of the students had to compromise on some of the elements situated in their game, which was an area of frustration. This finding aligns with the work of Brennan (2013), who also found compromise to be an area of frustration for students building games. Very few students were satisfied with having to change their games, particularly because their initial game story did not align with the kind of tools situated in Kodu. In fact, compromise was the last problem-solving tactic the students utilized, and it also led some students to consider fleeing the project. This finding affirms the work of Peppler and Kafai (2007), who suggest that the old sender-receiver model of learning no longer meets the participatory needs (Jenkins, 2006) of digital learners. Many of the students were dissatisfied that they did not have complete control over the program and the characters, particularly because they could not match the characters in their game story with those available in Kodu.

This tension with compromise was particularly true for expert users, or students who frequently “geek out” (Horst et al., 2010; Ito, 2009) with game construction technology. These gamers often compared Kodu to games such as Minecraft, and oftentimes the customization available to them in Kodu was not the same as in other programs, which inevitably made these students frustrated because they wanted to have more control over the program. Certainly for some of the students, particularly the expert users, Kodu was too simplistic a program; Caci et al. (2013) and Stoll and Fristoe (2011) indicate that Kodu is intended for novice users. However, some students felt overwhelmed by the number of tools situated in the program, and students and teachers indicated that it was easy to get lost in the details of the program.

This finding indicates that although most of the students could use the program in a relatively independent manner, some students needed more structure in the experience (Brennan, 2013). Papert (1993) emphasizes that constructionist experiences continue to be dependent on some form of instruction, while Zaharija et al. (2013) and Koloner (2006) both suggest that more formalized instruction is beneficial to support students in problem solving through game construction. Mueller et al. (2008) also suggest it is important to have an expert teacher involved in the process. In fact, most game construction research studies (Baytak & Land, 2011; Brennan, 2013; Kafai, 1995; Kafai et al., 1998; Harel & Papert, 1990; Robertson & Howells, 2008; Salen, 2007) indicate that some level of support and guidance is important to support students through game construction.

However, locating this expert support and guidance might be difficult, because not all classrooms or schools have access to an expert. Even for teachers who are confident with using technology, such as Patrick and Heather, solving complex problems with Kodu was difficult. This finding not only highlights the importance of expert support in game construction, but it also highlights the relative challenge this importance might serve to an upper elementary school, where not all teachers are expert users, or, for that matter, gamers. However, this finding also brings to light the teacher standards defined by the International Society for Technology in Education (2008), which suggest that it is a teacher's responsibility to locate professional development and support to ensure not only that game construction enters the classroom, but that other opportunities for creative production (Kafai & Ching, 2001; Peppler & Kafai, 2007; Salen, 2007; Squire, 2007) are offered to meet the participatory needs of digital learners.

Reflections for teaching and research.

Teachers are caught in the middle of balancing the amount of knowledge and structure they instill upon their students. Although the teachers were able to provide a sense of freedom to their students during the game construction process, they struggled to provide the necessary knowledge that some students craved. It seemed as though it was easier for the teachers to provide this sense of freedom than to support the students through solving problems due to the teachers' relatively limited knowledge of the game construction program. However, by providing this freedom, the teachers were also removed from the intricate process that transpired among the students, which means that they may have missed out on some teachable moments, authentic conversations between students, and meaningful representations for student assessment. Thus, it is important for a teacher to have some knowledge of video game construction to support students through the game construction process and become more involved in the process, while not allowing this knowledge to inhibit the freedom and student-based problem-solving strategies that can naturally take place.

In exploring the balance between knowledge and structure, it would be interesting to further investigate how more experienced game construction teachers tackle the balance of support and knowledge and the ways in which they come to support their students in problem solving. For example, do experienced teachers provide more open-ended responses to their students to facilitate personalized connections with the program? In essence, what is the "just right" form of support that can be provided to students in solving problems while constructing video game? In addition, what are some good leading questions that might support students to solve these game construction problems? Is there a certain "capital-d Discourse" that can be established to support students through problems?

The ways in which the students in this study problem solved through Kodu is fascinating. The relative ease they experienced in developing their own problem-solving strategies speaks well of the smart tools situated in the program. Does this kind of iterative experience extend beyond game construction, particularly into non-technical applications? Also, with continued use of game construction programs, what kind of problem-solving strategies will the students use? Will the students continue to increase their complexity of game making, or will their game making hit a plateau with regard to applying complex strategies? What kinds of problem-solving strategies do students utilize when they become more sophisticated and comfortable with the program?

Exploring how students can experience authentic and meaningful moments of problem solving is important, because students often demand more accessibility to knowledge and knowledge construction. By using programs such as Kodu*,* teachers are providing meaningful epistemic frames that signal to students that problem solving is a natural or even necessary component of learning.

This section discussed problem solving and the role it served to students while they were constructing their video games. Four main themes were discussed: messing around, remixing, iterative problem solving, and compromise. Each of these themes highlighted an approach the students used to successfully construct their video game relatively independently of any teacher support or guidance. This section also highlighted the important role the teacher plays in classroom-based game construction. It is important for teachers to be aware and develop a basic level of understanding of the game construction program to support students and to fully understand how they are solving problems. This understanding may potentially support a teacher's ability to assess the video game more effectively.

Planning and Writing

This section discusses the planning and writing experiences that took place in the classroom. This section is divided into five themes: motivation, gender, the importance of planning, extrinsic and intrinsic games, and math questions. The section provides important insights into the juxtapositions of traditional and preexisting pedagogies during video game construction.

Motivation.

Motivation played an important role in the students' experiences regarding the planning and writing portion of the unit. Many of the students in the study were motivated to write a story or plan their game because they knew that by completing their plan they would have the opportunity to build and play a video game. In fact, all the students and teachers expressed a desire to participate in a video game construction project in the future, which means that even though both the teachers and the students expressed moments of frustration during the project, the intrinsic motivation situated in building a video game was a powerful motivating factor. This finding affirms not only the work of Linnebrink and Pintrich (2002), who suggested that motivation is the enabler of learning and academic success, but also the work of Foster (2008), who found video games to be motivating because they meet the creative interests of learners. Also, what is the possible role of novelty value here?

Gender.

Gender did not seem to play a significant role in how girls and boys constructed games. One of the participants, Stella, indicated that she preferred to have her game polished and aesthetically pleasing; however, she noted that when she was helping some other students, she found that some of the boys were more concerned about the aesthetics of their game. There was no consistency in the girls' and boys' games in terms of the look or feel of the games, the amount of time the students played games, or how the students planned their games. This finding contrasts the work of Schott and Horrell (2000), who found that girl gamers prefer third-person games, and Turkle (1984), who found girl gamers to be "soft masters" as compared to boys, who were "hard masters." However, it affirms the work of Carbonaro et al. (2010), who also found no difference between girls' and boys' ability to build a video game.

The importance of planning.

Many of the students identified their preference for making a game as compared to writing a story, which affirms the importance that creative production (Kafai & Ching, 2001; Peppler & Kafai, 2007; Salen, 2007; Squire, 2006) serves to the digital learner. It also indicates that the sender-receiver model (Peppler & Kafai, 2007) no longer meets the production and design demands of students. This finding is particularly evident in the fact that many of the students did not discuss the games that were played at the beginning of the game construction unit. Although they enjoyed playing them, it was the teachers who believed it was important to provide a context of what makes a good video game (Gee, 2007a.) The only student who referenced the video games was a non-gamer who had had few opportunities to play video games. This finding brings into focus that most students have a strong understanding of video games and the ability to construct their own game. It also affirms the work of Kafai et al. (1998), who found that "students possessed culturally rich knowledge about games and the playing of games" (p. 176).

The students did find it was important to participate in some form of planning during the game construction unit. This planning helped them to generate and organize their ideas, create a better end product, and support non-gamers who were not able to visualize the look and feel of a video game. However, there was a divided perspective regarding when the planning should take place. Some students felt it was important to plan before the game construction unit, while others felt it would be helpful to plan throughout the unit. This finding is consistent with the work of Robertson and Good (2005), who found that students were divided regarding the best time to plan and design their game. This divided perspective is also consistent with research studies centred on game construction; some studies facilitated opportunities to plan primarily at the onset of the project (Baytak & Land, 2011; Robertson & Good, 2005), while others provided opportunities to plan throughout the unit (Harel & Papert, 1990; Kafai, 1995; Kafai et al., 1998). This mixed perspective suggests that there is potentially more than one way that students can plan for a video game, thus students should be provided with a greater degree of autonomy in how they plan and design their games.

Each of the teachers also came to understand that there is more than one way to plan and integrate game construction into the classroom. Certainly each of the teachers relied on a greater degree of structure (Brennan, 2013) at the beginning of the unit; however, in their final reflections, each noted that they would facilitate a greater sense of agency for their students in future game construction units. Angela felt that she would still teach the content in the traditional way, but she would scaffold the game construction experience by doing the activity with the students, while Patrick noted that he would take the story-writing process out of the experience and allow the students to plan using a storyboard or a method that suited their needs. He also felt that he would likely scaffold the experience in smaller sections, where the students would plan and then construct their game, or vice versa. Heather questioned whether there was a need to spend time writing a story, or if perhaps yes/no questions might be the best option for the students.

Confidence with the technology seemed to naturally facilitate opportunities for scaffolding, which suggests that teachers need to have time and experience with the technology before they can scaffold the experience with their students. This finding also suggests that it is difficult for teachers to establish a constructionist experience for students the first time around.

Extrinsic and intrinsic games.

In discussing the planning process, each of the teachers identified that the games were more extrinsic than intrinsic in nature, which aligns with the work of Kafai (1995) and Kafai et al. (1998). Both studies found that students and teachers were more naturally prone to construct games centred on drill and practice experiences, where questions are answered and points are accumulated. This finding is important because, as Squire (2006) suggests, most of the games situated in the classroom are exogenous in nature, where knowledge is based on truths and learning is defined through transmission. By integrating math questions into the game unit, the grade 6 students created extrinsic, exogenous games, which unequivocally highlights the students' math questions and generally disregards their narrative story or design. The grade 4 students' use of yes/no questions also exemplifies extrinsic games.

Kafai et al. (1998) suggest that writing an intrinsic game is more difficult than writing an extrinsic game, which seems to parallel the experiences of the teachers and students in this study. This finding also parallels the work of Robertson and Good (2006), who found that writing an interactive story was more difficult for students than writing a linear story. This finding highlights that teachers need to explore how an interactive story can be written. This was particularly true in this study, because none of the teachers had integrated video game construction into the classroom before. In fact, Patrick began a lesson by discussing the differences between a traditional story and a game story, but he found the ideas difficult to communicate. Again, experience with video game construction is imperative to support teachers in helping move students beyond extrinsic, question-based games.

Each of the teachers reflected at the end of the game unit on the importance of scaffolding the experience for the students. This finding indicates that each of the teachers wants to move the students beyond extrinsic games. This finding aligns with Kafai et al. (1998), who suggest that students must be provided with conceptual design tools to create more sophisticated games, or games that are not based around asking and answering questions. Each of the teachers identified the importance of non-question based games as one of their areas of growth for future game construction experiences where they would move away from questions and locate other ways to support the students in building an intrinsic game. Certainly constructing these conceptual design tools is complex and challenging, and needs to be developed based on the needs of the students.

Math questions.

For most of the students the math questions were a powerful force that altered the very essence of their games. One student in particular highlighted her disinterest in playing extrinsic, educational math games, and expressed that she felt dissatisfied that she inadvertently created one. Although some of the students felt dissatisfied with the math questions, others liked the structure the questions provided for them. These students had a clear expectation of how they would construct their game. Students who take fewer risks in their writing or are less accomplished in their writing preferred this method. However, other students who took bigger risks in their story and had a more detailed storyline, experienced greater setbacks with regard to integrating the math questions. These more accomplished writers were dissatisfied because they had to modify their story and their map to suit the tools situated in both the game program and the extrinsic narrative. This finding is consistent with the work of Robertson and Good (2006), who also found that more accomplished authors experienced more setbacks and more complex problems when constructing their game.

Certainly it is important to provide these more accomplished authors the freedom to construct a game; however, this freedom must be approached with caution. Kafai (1995) found that when students were provided with an open structure, they experienced a relatively strong process but a weak product. The students were able to create a detailed fantasy, but they became so off-task that they forgot about the content they were supposed to highlight in their game. Brennan (2013) suggests that a balance between agency and structure is important, and it seems necessary in game construction, where the students require some support and direction, even those who are more experience and willing to take risks.

Some of the students also shared a similar sentiment regarding the maps they constructed. Although some students liked how the map allowed them to create a vision of their game and kept them focused, others found that it created an unrealistic vision of what they could construct with Kodu. However, this difficulty was more dependent on the tools situated in Kodu*,* as opposed to the overarching planning process. It is possible that the mapping process could be a more on-demand experience; Brennan (2013) found that students drew maps as a way to problem solve through issues they experienced while building their games. It is possible that some students might prefer to draw maps or diagrams while they are building their games, or when it is merited. Future research should focus on mapping and video game construction.

Reflections for teaching and research.

The tension that exists between the demands of constructionist technologies such as video game construction and the general knowledge of 21^{st}-century teachers is an important topic to emphasize, particularly because teachers will only have the time and space to learn how to integrate these technologies by experiencing them in the classroom. How can teachers provide these experiences without a considerable amount of fumbling and flailing? And, in considering this need to explore, is there the time or the space for teachers to experience this learning by doing, and more so, does the culture of school allow for this? Teachers generally have little time to participate in free exploration with their students, particularly because of the demands of the Program of Studies. Can teachers in fact participate in a learning-by-doing experience in their own classroom? However, these kinds of experiences are of utmost importance for digital learners, thus it is essential that teachers try them out in their classrooms.

It is important for the school culture to honour and applaud the risks that teachers are willing to make with their students, and also the strides they make in integrating experiences such as video game construction into the classroom. If teachers feel supported and validated in their exploration of emerging technologies, it is possible that they will want to continue to extend their learning with other constructionist technologies.

In addition, repetition seems to be a key component in successfully integrating video game construction into the classroom. Each of the teachers began to understand how to scaffold certain components of the project at the end of the unit, while also pondering how they might support students in constructing games that centred less on asking and answering questions. Further research needs to investigate the role that repetition plays in game construction and whether teachers are able to support students in constructing more intrinsic video games. Also, research should explore the relationship between repetition and motivation.

Moreover, further research should explore the kinds of resources that can be created to support teachers to integrate game construction into the classroom. Students are at ease with the collaboration that takes place when they are immersed in game construction; however, the same cannot be said for their teachers in designing game construction. Thus, it is possible that teachers require more traditional forms of support and resources, as compared to the dynamic, collaborative exchanges that can take place between students both physically and virtually. Considering the kinds of resources teachers use, a print book highlighting some potential ways to integrate game construction into the class or a series of videos might be helpful to support teachers to create a more conceptual understanding of this emerging technology. Also, engaging teachers in creating a video game, through courses like the one offered at the University of Alberta, would be helpful for teachers.

It would also be interesting to further identify the role of a technology coach or technology mentor and explore if and how they support teachers to integrate game construction in the class. Both Patrick and Heather had played the role of technology coach, and it would be interesting to follow up and see if their identified role helped other teachers.

Although resources like the ones mentioned above might be helpful, it might also be possible that game construction is learned best through a learning-by-doing framework that allows teachers to tinker around with the program to understand how it is used and to generate ways it might connect with the curriculum.

This section discussed the planning and writing that was designed and integrated by the teachers and experienced by the students during the game construction unit. Five themes were discussed: motivation, gender, the importance of planning, extrinsic and intrinsic games, and math questions. Some of the major ideas generated through these themes included the importance of planning, concurrent with providing students with a greater sense of freedom in how they planned for their video game. In addition, the math questions were highlighted as a distracting factor that led the students to construct extrinsic games. By removing these questions, both teachers and students should be able to construct games that are centred less on questions and more on the story of the game.

Conclusion

This discussion was organized into seven sections: pedagogy and technology integration, time, assessment, teacher collaboration, student collaboration, problem solving, and planning and writing. The implications for game construction in the upper elementary classroom are numerous, suggesting, but with a sense of caution, that it is possible for upper elementary students to construct a video game in class. Each of the seven themes provided suggestions in identifying areas of growth and improvement regarding how game construction can be experienced in the classroom.

The next and last chapter highlights the implications and conclusions of this study and the value it potentially will serve for future teachers, students, and researchers.

Chapter 8: Implications and Conclusions

The neighbours across the street are having a garage sale today. There are remnants of the past on their shelves: dusty children's toys, old books, and a myraid of other artifacts that once held significance in their lives. In the back of the garage sale lies an old Super Nintendo game console. This artifact likely brought countless hours of play to my neighbours and it also brings me back to my childhood. I think of my brother being Mario and I Luigi as we collaborate to defeat the evil boss known as Bowser. In sweeping the dust off this distant artifact, I feel tempted, deeply tempted to bring it home and once again play Super Mario World. But I would be remiss to not fully realize that technology has changed. In fact, I have changed, and the world around me has also changed. And although it is pleasant to spend time reconnecting with the past, it is also important to understand that the very threads that comprise our existence are defined by a much different reality.

I am no longer the young child awed by the confounding nature of Super Mario World. Instead I am the aunt who is confounded by the ways in which my nieces experience today's new technology. The video games my nieces and my students play are different from the games that I once played. My brother and I embodied the very characterization of Mario and Luigi, while my nieces are redefining video game characters on their own terms. My limited experience as a child painting original music in Mario Paint pales in comparison to the infinite possibilities my nieces have in their own gaming experiences. Games such as Infinity, Sky Walkers, Animal Jam, and Roblox all offer the potential to build and construct a video game, with relative ease.

Using the tool as a tutee (Taylor, 1980) exemplifies the role that technology plays for young learners, where creative production is the epicentre of the digital experience. In this constructionist experience, students remix technology (Kafai & Burke, 2014), hang out in online spaces, mess around with varying tools, and geek out (Horst et al., 2010) with a particular favourite. In fact, in messing around and working through a relatively collaborative affinity (Gee, 2004), these experiences with technology begin to exemplify the differences that exist between in-school and out-of-school contexts. The reality is that many schools are simply not equipped to meet the participatory demands of young learners and readily facilitate opportunities to integrate technologies such as video game construction into the classroom (Brennan, 2013; Buckingham, 2007; Dougherty, 2013).

This reality inevitably creates a jarring disconnect for young learners, who are not necessarily asked to power down when they enter the classroom, but instead are asked to power up in a much different manner: Power up to read information online. Power up to work on a Word document. Power up to watch an educational video. Power up to check a class mark. Although each of these applications is an adequate representation of technology use, they do not represent the central role that creative production plays for the digital learner. It is crucial that digital learners have the opportunity to actively participate and contribute to learning experiences that centre on creative production.

It is very act of creative production that demonstrates the differences between in-school and out-of-school contexts. Young learner are continually mussing over and messing around with technologies outside of school, while they are often simply consuming technology in school. The act of creative production also represents the relative challenges a teacher faces in facilitating this kind of change within the classroom. Constructive barriers such as time, assessment, collaboration, and pedagogy all are representative forms that often work against the ebb and flow of a classroom, meaning that it is easier for a teacher to craft an experience around writing a linear story than constructing a video game. This is an important idea, because it is easier for a teacher to continue to embrace the status quo that is defined by the school culture than to work against the flow to locate innovative and creative ways to meet the participatory needs of learners (Jenkins, 2006).

Although it is difficult for teachers to fully embrace change in the classroom, organizations such as the International Society for Technology in Education (2008) and the National Media Consortium (2014) identify the importance of teachers staying on trend with the complexities associated with educational technologies. In understanding this responsibility, we know that change is important to align schools with the creative production needs of young learners. The pivotal role of the teacher in supporting the needs of constructionist experiences such as video game construction represents the first of six lessons that were learned from this research study. The other lessons are as follows:

- Students and teachers must work together in video game construction.
- Integrating video game construction requires multiple attempts.
- Video game construction is aligned with constructionism.
- Assessment is a challenging component of video game construction.
- Video game construction is not only good for learning, but for education.

Each of these six lessons is elaborated below. This chapter then concludes with some final thoughts on what video game construction means to me as an educator and as a teacher researcher.

Lesson 1: Teachers Play a Pivotal Role in Video Game Construction

Lesson 1 may seem like a counterintuitive statement, particularly considering the limited amount of structure students experience in out-of-school contexts and their subsequent success in learning with and about technology outside of school. However, there were multiple indicators throughout the study which suggest that the teacher is important in supporting video game construction in the classroom. The first indicator was seen when the students were trying to problem solve through complex issues with their video game. It was important that the teacher was present, not only to support the students but to work through the problems with them. This finding indicates that teachers need to have at least enough knowledge of the video game construction program to problem solve with the students.

The second indicator was seen during the planning and writing phase of the game construction unit. Although there was a mixed perception of when and how the students should plan, the students emphasized that they required some support in planning their games, particularly if they were connecting to a particular content area, such as social studies. Herein lies the difference between out-of-school contexts and in-school contexts: students still require some form of structure from the teacher when constructing video games. Without some structure, students will likely struggle to make connections to the content area.

This finding identifies the important role the teacher plays in not only supporting students to move beyond the 'good process, weak product' paradigm that has plagued game construction experiences for the past few decades, but also to begin to explore ways to support students to construct games that are both intrinsic and endogenous in their design. This paradigm shift is significant, because upper elementary students will generally construct question-based drill-and-practice games. Creating intrinsic games is difficult, but not impossible, particularly with the support and guidance of a teacher.

Questions for future research.

- How can teachers and students work together to construct intrinsic, endogenous video games?

- What level of support is best suited to the needs of students when problem solving through game construction?

Lesson 2: Students and Teachers Must Work Together in Video Game Construction

In considering the pivotal role the teacher plays in game construction, it is equally important to highlight the role of the student. There is no question that each of the teachers in this study would not have been successful in the game construction unit without the support and guidance of the students. Considering the size and complexities situated in the 21st-century classroom, teachers and students need to work together to use technology effectively. Each of the teachers in the research study did a fantastic job of facilitating a greater sense of agency among the students. Whether this agency was provided due to the teacher's lack of knowledge regarding the game program, or whether the teacher inherently understands the value collaboration serves to their digital learners, this freedom was imperative. Again, this finding reiterates the teacher's significant role in understanding when to be involved in the students' learning and when to take a step back and allow the students to support each other.

It seems as though students are naturally prone to work together in building video games, where the collaborative agency between newcomers and old-timers continually evolves. This tendency was highlighted in the study because the grade 6 teachers initially created the tech ninja program to recognize student experts in the class. However, this study's findings indicate that students may not require any structured peer support when collaborating in game construction. They have their own affinity to support each other, which is directly dependent on the needs of the group.

Question for future research.

- How do upper elementary students create affinity while building video games in the classroom?

Lesson 3: Integrating Video Game Construction Requires Multiple Attempts

The teachers in this study had to walk a thin line regarding the support and guidance they provided to the students throughout the unit. However, their collective enthusiasm for game construction at the end of the unit showcases their interest in trying it again. Their enthusiasm also shows that it is possible to integrate game construction into the classroom, and although it is difficult, it is not impossible. This finding also suggests that teachers with little or no experience with video games and video game construction can integrate game construction into the classroom. It is helpful, but not essential, that the teacher have some knowledge of the technology.

Although the teachers found it possible to integrate game construction into the classroom, upon reflection they would do certain parts of the unit differently. Their reflections primarily focused on how they had implemented the planning and writing component of the unit, where they would allow for more autonomy in the planning process in the future. This result indicates that teachers are aware of students' digital needs, and that the more traditional application of writing did not facilitate the best possible learning experience for their students.

It also indicates that the planning and writing portion of the unit was the most challenging because it created the most tension. The students and teachers found that it was difficult to make the leap between their game story and their video games, and thus the more traditional and linear planning and writing experiences did not necessarily fit into the more constructionist, non-linear, video game construction experience. This finding further suggests that it can be difficult to integrate a traditional method of teaching and learning into a constructionist experience. To attempt to do so is akin to placing a square peg into a round hole.

The teachers' final reflections also identified the important role that scaffolding played for the students, and how teachers could improve the support they provided to the students. In fact, teachers struggled to know when to pause and reflect or when to provide support to their students. This finding suggests that in making more than one attempt at game construction, teachers will feel better equipped to scaffold the experience for their students.

The grade 6 teachers also came to realize that combining multiple content areas added tension to the unit. The grade 6 teachers found that combining math and language arts detracted from the experience of the project, and the students were only able to focus on either math or language arts, but not both. In combining the subjects, the students relied on asking relatively formulaic questions, because it was too complex to combine their story narratives and their math problems. However, in considering the relatively tight time constraints placed on teachers and the large amount of time game construction takes, it is possible to combine a content area and technology curricular outcomes. The teachers identified that game construction was a good way to learn more about technology.

It has been suggested that education is a slow revolution (Cuban et al, 2001), which is consistent with the teachers' experiences in this study: they required more than one attempt to feel confident with video game construction. This finding brings into focus the importance of teacher collaboration or teachers having access to an expert teacher. As opposed to starting from scratch regarding game construction, it is important that a teacher either has access to an expert or works collaboratively to share the load of the project. This finding brings into focus that teachers need to be provided not only time to collaborate, but also the understanding of how to collaborate effectively. Increased collaboration will likely facilitate a gentler learning curve regarding video game construction.

Questions for future research.

- What experiences with game construction do teachers need to feel more confident with the unit?
- How do experienced game construction teachers scaffold game construction for their students?
- How does increased collaboration among teachers support technology integration?
- What subject areas are best suited for game construction?
- What forms of planning and writing (or storyboarding) are the most conducive to game construction?

Lesson 4: Video Game Construction is Aligned with Constructionism

Understanding that game construction is well aligned with the creative production demands of digital learners illuminates the pivotal role that game construction plays in reimagining the 21st-century classroom as a constructionist learning-by-doing space. This finding further indicates that constructionism, not only as a philosophy of learning, but also as a pedagogy of teaching, is best suited for video game construction. Constructionist teachers will likely have an easier time integrating video game construction into the classroom than instructionist teachers will. Although instructionist teachers can integrate game construction into the classroom, there will likely be more roadblocks, such as allowing the students the time and space to construct and interpret their own game. Certainly, in applying a constructionist pedagogy, there is no certainty that the students will learn the content (Robertson & Howells, 2008); however, the teacher can guide the students to construct with the technology while connecting with the content. It is Papert's (1980) interpretation that programs such as Kodu are objects to think with and to share with.

This perspective further illuminates that, in constructionism, students have the ability to learn with and through the technology and will likely experience their interconnected relationship with the tool. This finding brings forth the innate problem-solving strategies that many of the students incorporated while constructing their games. Constructionism also allows for the practice of new problem-solving skills and strategies. It allows students to tinker and mess around with technology, more so than is possible through an instructionist pedagogy. And, while one of the teachers in the study was identified as an instructionist, in her delivery of the game construction unit, she was able to transition, step aside, and allow her students the opportunity to problem solve with the technology by tinkering, by iterative design, by collaborating, by remixing, and by playing other students' games.

How can teachers who are more traditional in their pedagogy identify the needs of their digital learners and provide them with a greater sense of agency? It seemed as though the instructionist teacher in this study provided moments of this shift by understanding the value game construction served to her students. It is possible that by using constructionist technologies such as game construction programs, traditional teachers might transition some of their practice to a more constructionist pedagogy. There is tension between a more instructionist pedagogy and video game construction. Students would likely struggle to construct a game if they were not given the freedom to tinker and mess around with the technology.

Question for future research.

- How does game construction influence a teacher's pedagogical practice?

Lesson 5: Assessment is a Challenging Component of Video Game Construction

Assessment plays an important role in the classroom, and each of the teachers in this study certainly found ways to assess their students throughout the unit, including the process and products of the planning of the game construction. However, the teachers did not assess the video games constructed by the students. They found that assessing a video game is very difficult. This was likely the case not only because this was their first experience with game construction, but also because video games are different from anything they have assessed before. Teachers had no experience with assessing a game's "playability."

This finding brings into question whether video games need to be assessed, given that assessing them causes such tension for both the students and the teachers. Certainly the teachers were hesitant to stifle student creativity. Yet we know that art teachers assess both process and product, so there is much to learn from those who assess creative works. And certainly the teachers were interested in creating a rubric to assess the students' video games, but it seemed like a very difficult task, particularly because this was their first time integrating such an experience in the classroom. It is hard to assess what we do not understand. For example, the teachers assessed story writing based on a clear understanding of the product; however, they lacked a clear understanding of what a game story is and consequently what a video game product might look like.

Certainly it is possible that the teachers might have more success in subsequent game construction experiences, because they have a foundation now of what students can create, but help is needed here from those who play games and understand the process and final product.

However, each of the teachers did indicate the importance of having the students assess each other's games as they developed a breadth of knowledge regarding Kodu. Having students help to build a game rubric might support teachers in understanding how to assess a video game, while peer assessment might also be an excellent response to the complexities associated with game assessment. Peer assessment might be particularly helpful because students are naturally keen to support each other and provide feedback throughout the game construction experience. It is likely that students would be open to and accepting of peer assessment at the end of the unit.

Questions for future research.

- How can student-constructed video games be assessed?
- What assessment measures are best suited for a game construction unit?

Lesson 6: Video Game Construction is Not Only Good for Learning, But for Education

In considering Gee's (2007a) tenet that video games are good for learning, we can suggest that video game construction is good for education. The experience of video game construction begins to respond to the complex needs of digital learners. Not only is video game construction good for digital learners, it is also good for teachers because it provides an opportunity for teachers to explore creative production with the support of their students. Certainly an array of complexities are associated with video game construction and how it can work within the time schedule and curricular demands situated in Alberta. However, the teachers in this study demonstrate that game construction is possible. Even with the demands of inclusive learning, the curriculum, assessment, pedagogy, and time, the teachers in this study were able to change and flex their own pedagogy to facilitate video game construction in the classroom.

Game construction facilitates a constructionist experience for students. But beyond this learning-by-doing context, it also creates an epistemic frame (Shaffer, 2006) of being a game designer and also understanding how constructionist technology can be used for learning. Perhaps we can refer to this as a revised epistemic frame of being a student where, by experiencing video game construction in the classroom, a student may perceive learning in a different light, not simply through drill-and-practice experiences, but through constructing experiences. It is possible that the dualistic tension between in-school and out-of-school contexts can be shifted, and students can begin to think of using programs such as Kodu to learn social studies or science. The study findings also validate the epistemological pluralism that is situated in the constructionist classroom, where students learn through concrete, hands-on applications as well as more traditional paper-and-pencil tasks.

Final Thoughts

I experienced something very poignant in my classroom this year, which was both humbling and inspirational. At the beginning of a photography class, I was chatting with the students about a particular technology that was new to me, and that I was not confident in using. As I entered the classroom I had visions of students scoffing at the idea that their teacher did not know how to use the technology, and that my own authority as a teacher was going to be compromised. But this did not happen. Instead, my students responded by stating, "That is okay," "I know how to do that," and "How can I help?" I was humbled by their generous support and I realized that there were experts in using these technologies in the classroom. As a teacher, it is impossible to know everything about a particular tool, and it is important that we collaborate with our students to share the load of technology integration.

This experience also suggests that we are often too hard on ourselves as educators, and that it is okay to make mistakes and learn by doing, just as our students are experiencing in the classroom. Oftentimes in education if something doesn't work, we "abandon ship" as the 30 pairs of eyes that are watching our every move suggest that it is not okay to fail. But in reality, the students are simply willing and eager to learn, and by experimenting and trying to integrate experiences that are aligned with their digital needs, they know all too well how it feels like to struggle with a particular technology. And they see learning as risk taking. Thus, when our students enter the classroom, let us provide them with opportunities to stay powered up, but in ways that meet their constructionist, participatory demands. Let them power up to build a video game, to mess around with Photoshop, or to "geek out" with the 3-D printer and AutoCAD.

The only way we are going to be able to continue to evolve to ensure that our classrooms are spaces that support constructionist experiences is to collaborate and share our knowledge with our colleagues. We cannot remain confined within the four walls of our classrooms. This is not how our students collaborate, and if we want to keep pace, we have to share our ideas, open up our doors, and begin to talk and trust the teachers we work with, regardless of age or technology expertise.

And, perhaps finally, we need to continue to be cognizant of the kinds of technologies that live and breathe within our classrooms. We need to think deeply about the kinds of technology we need in the classroom, the kinds of tools that truly have the ability to transcend education. Certainly tools such as video game construction programs and makerspace technologies are strong contenders in meeting the participatory needs of learners. But I believe that Kafai and Burke's (2014) reference to low floors, high ceilings, and wide walls is an exemplary framework for choosing technologies that best serve our students. Consider Kodu. It offers a low floor, because students can learn gradually and with a degree of confidence, high ceilings, because student games can become more complex with increased skill level, and wide walls, because Kodu provides a wide range of possibilities regarding the smart tools situated in the game.

Video game construction is indeed good for the 21st-century learner, and it is also good for education. Thus, for the hesitant teacher I would simply say, give video game construction a try. Try it out in the classroom and see how your students collaborate with each other. See how they exchange dynamic and sophisticated problem-solving strategies. And see how they engage in their game and lose complete track of time. Challenge yourself to extend the barriers that restrict our practice, such as time, curriculum, and assessment, and redefine how you experience your own practice. Our classroom is, in essence, our sandbox. Use this space to explore, to play, to tinker, to build, and above all else, to share.

To conclude, I want to share a recent text message I received from Patrick. It is uplifting and significant in that it solidifies the importance of game construction in the classroom. Patrick wrote, “By the way, our provincial achievement test scores were great. Significantly better than the province in everything except science. We were on par there. I’m sure the Kodu writing and coding helped. In fact I know it did.”

Game construction is good for learning and good for education.

References

Abrams, S. S. (2009). A gaming frame of mind: Digital contexts and academic implications. *Educational Media International, 46*(4), 335–347. doi:10.1080/09523980903387480

Ackerman, E. (1996). Perspective taking and object construction: Two keys to learning. In Y. Kafai & M. Resnick (Eds.), *Constructionism in practice: Designing, thinking, and learning in a digital world* (pp. 25–35). Mahwah, NJ: Lawrence Earbaum Associates.

Allan, W. C., Erickson, J. L., Brookhouse, P., & Johnson, J. L. (2010). Teacher professional development through a collaborative curriculum project- an example of TPACK in Maine. *Techtrends, 54*(6), 36-43. doi: 10.1007/s11528-010-0452-x

Anderson, C. A., & Bushman, B. J. (2001). Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: A meta-analytic review of the scientific literature. *Psychological Science*, *12*(5), 353–359. doi: 10.1111/1467-9280.00366

Andrew, L. (2007). Comparison of teacher educators' instructional methods with the constructivist ideal. *The Teacher Educator, 42*(3), 157–184. doi:10.1080/08878730709555401

Apperley, T., & Beavis, C. (2011). Literacy into action: digital games as action and text in the English and literacy classroom. *Pedagogies: An International Journal, 6*(2), 130–143. doi: 10.1080/1554480X.2011.554620

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology, 52*(1), 1–26. doi:10.1146/annurev.psych.52.1.1

Barth, R. (2002). The culture builder. *Educational Leadership, 59*(8), 6–11.

Baylor, A. L., & Ritchie, D. (2002). What factors facilitate teacher skill, teacher morale, and perceived student learning in technology-using classrooms? *Computers & Education, 39*(4), 395–414. doi:10.1016/s0360-1315(02)00075-1

Baytak, A., & Land, S. M. (2011). An investigation of the artifacts and process of constructing computers games about environmental science in a fifth grade classroom. *Educational Technology, Research and Development, 59*(6), 765–782. doi:10.1007/s11423-010-9184z

Beavis, C., & O'Mara, J. (2010). Computer games: Pushing at the boundaries of literacy. *Australian Journal of Language & Literacy*, *33*(1), 65–76. Retrieved from: http://hdl.handle.net/10536/DRO/DU:30043948

Black, P., McCormick, R., James, M., & Pedder, D. (2006). Learning how to learn and assessment for learning: A theoretical inquiry. *Research Papers in Education, 21*(2), 119–132. doi:10.1080/02671520600615612

Borko, H., & Putman, R. T. (1995). Expanding a teacher's knowledge base: A cognitive psychological perspective on professional development. In *Professional development in education: New paradigms & practices* (pp. 35–66). New York: Teachers College Press.

Borko, H., Whitcomb, J., & Liston, D. (2009). Wicked problems and other thoughts on issues of technology and teacher learning. *Journal of Teacher Education*, *60*(1), 3–7. doi: 10.1177/0022487108328488

Brennan, K. A. (2013). *Best of both worlds: Issues of structure and agency in computational creation, in and out of school* (Doctoral dissertation). Retrieved from: ProQuest Dissertations. Massachusetts Institute of Technology, School of Architecture and Planning, Program in Media Arts and Sciences. (edsoai.854514584)

Brennan, K., Monroy-Hernandez, A., & Resnick, M. (2010). Making projects, making friends: Online community as catalyst for interactive media creation. In M. Bers (Ed), *New media and technology: Youth as content creators* (pp. 75–83). San Francisco: Jossey-Bass.

Buckingham, D. (2007). Schooling the digital generation: Popular culture, new media and the future of education. *Medien Impulse, 59*, 5–20. Retrieved from: http://www.ioe.ac.uk/about/23486.html

Burn, A. & Carr, D. (2006). Motivation and online gaming. In D. Carr, D. Buckingham, A. Burn, & G. Schott. (Eds.) *Computer games: text, narrative and play* (pp. 103–118). Cambridge, UK: Polity Press.

Carbonaro, M., Szafron, D., Cutumisu, M., & Schaeffer, J. (2010). Computer-game construction: A gender-neutral attractor to computing science. *Computers & Education, 55*(3), 1098–1111. doi: 10.1016/j.compedu.2010.05.007

Carver, S. (2006). Assessing for deep understanding. In K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 205–221). Cambridge, MA: Cambridge University Press.

Caci, B., Chiazzese, G., & D'Amico, A. (2013). Robotic and virtual world programming labs to stimulate reasoning and visual-spatial abilities. *Procedia: Social and Behavioral Sciences, 93*, 1493–1497. doi:10.1016/j.sbspro.2013.10.070

Calder, N. (2010). Using Scratch: An integrated problem-solving approach to mathematical thinking. *Australian Primary Mathematics Classroom*. *15*(4), 9–14. Retrieved from: http://www.aamt.edu.au/Webshop/Entire-catalogue/Australian-Primary-Mathematics-Classroom

Chee, Y. S., & Tan, K. C. D. (2012). Becoming chemists through game-based inquiry learning: The case of "legends of alkhimia". *Electronic Journal of e-Learning, 10*(2), 185–198. Retrieved from: www.ejel.otg

Ching, C. C. (2000). *Apprenticeship, education, and technology: Children as oldtimers and newcomers to the culture of learning through design* (Doctoral dissertation). Retrieved from: ProQuest Dissertations. University of California, Los Angles. (9993013)

Clark, K., & Sheridan, K. (2010). Game design through mentoring and collaboration. *Journal of Educational Multimedia and Hypermedia, 19*(2), 125–145. Retrieved from: http://www.editlib.org/p/33097

Collins, A., & Halverson, R. (2009). *Rethinking education in the age of technology: The digital revolution and schooling in America*. New York: Teachers College Press.

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. Thousand Oaks, CA: Sage.

Crowley, K. & Jacobs, M. (2002). Building islands of expertise in everyday family activity. In G. Leinhardt, K. Crowley, & K. Knutson (Eds.), *Learning conversations in museums (*pp. 333–356). Mahwah, NJ: Lawrence Erlbaum.

Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technologies in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal. 38*(4), 813–834. doi: 10.3102/00028312038004813

Denner, J., Werner, L., Bean, S., & Campe, S. (2005). The girls creating games program. *Frontiers: A Journal of Women Studies, 26*(1), 90–98. doi: 10.1353/fro.2005.0008

Devane, B. (2012). Whither membership? Identity and social learning in affinity spaces. In E. R. Hayes, & S. C. Duncan. (Eds.) *Learning in video game affinity spaces (*pp. 162–185*).* New York: Peter Lang.

Dickey, M. D. (2006). Game design narrative for learning: Appropriating adventure game design narrative devices and techniques for the design of interactive learning environments. *Educational Technology Research and Development, 54*(3), 245–263. doi: 10.1007/s11423-006-8806-y

Dickey, M. D. (2011). Murder on grimm isle: The impact of game narrative design in an educational game-based learning environment. *British Journal of Educational Technology, 42*(3), 456–469. doi: 10.1111/j.1467-8535.2009.01032.x

Doering, A., Scharber, C., Miller, C., & Veletsianos, G. (2009). GeoThentic: Designing and assessing with technology, pedagogy, and content knowledge. *Contemporary Issues in Technology and Teacher Education*, *9*(3), 316–336. Retrieved from: http://www.editlib.org/p/29379.

Dougherty, D. (2013). The maker mindset. In *Design, make, play: Growing the next generation of STEM innovators* (pp. 7–11). New York: Routledge.

Drent, M., & Meelissen, M. (2008). Which factors obstruct or stimulate teacher educators to use ICT innovatively? *Computers & Education, 51*(1), 187–199. doi:10.1016/j.compedu.2007.05.001

Dyson, A. H., Genishi, C. (2005). *On the case: Approaches to language and literacy research.* New York: Teachers College Press.

Eder, D. & Fingerson, L. (2003) Interviewing children and adolescents. In J. A. Holstein & J. F. Gubrium (Eds.), *Inside interviewing: New lenses, new concerns* (pp. 33–54). Thousand Oaks, CA: Sage.

Egenfeldt-Nielsen, S. (2007). *Educational potential of computer games.* London, England: Bloomsbury Academic.

Egenfeldt-Nielsen, S., Smith, J. H., & Tosca, S. P. (2012). *Understanding video games: The essential introduction.* New York: Routledge.

Ellis, J. L. (2006). Researching children's experience hermeneutically and holistically. *The Alberta Journal of Educational Research*, *52*(3), 111–126. Retrieved from: http://ajer.synergiesprairies.ca/ajer/index.php/ajer/index

Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development, 53*(4), 25–39. doi:10.1007/bf02504683

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology. 42*(3), 255–284. doi: 10.1080/15391523.2010.1078255

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practice: A critical relationship. *Computers & Education, 59*, 423–435. doi:10.1016/j.compedu.2012.02.001

Evans-Andris, M. (1995). An examination of computing styles among teachers in elementary schools. *Educational Technology Research and Development, 43*(2), 15–31. doi:10.1007/bf02300470

Ferguson, C. J., Rueda, S. M., Cruz, A. M., Ferguson, D. E., Fritz, S., & Smith, S. M. (2008). Violent video games and aggression: Causal relationship or byproduct of family violence and intrinsic violence motivation? *Criminal Justice and Behavior*, *35*(3), 311–332. doi: 10.1177/0093854807311719

Fontana, A., & Frey, J. H. (2005). The interview: From neutral stance to political involvement. In N. K. Denzin & Y. S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (3rd ed.; pp. 695–727). Thousand Oaks, CA: Sage.

Foster, A. (2008). Games and motivation to learn science: Personal identity, applicability, relevance and meaningfulness. *Journal of Interactive Learning Research, 19*(4), 597–614. Retrieved from: http://www.aace.org/pubs/jilr/

Freeman, M., & Mathison, S. (2008). *Researching children's experiences.* New York: Guilford Press.

Fullan, M. (2001). *The meaning of educational change* (3rd ed.). New York: Teachers College Press.

Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation & Gaming, 33*(4), 441–467. doi: 10.1177/1046878102238607

Gaydos, M. J., & Squire, K. D. (2012). Role playing games for scientific citizenship. *Cultural Studies of Science Education, 7*(4), 821–844. doi: 10.1007/s11422-012-9414-2

Gee, J. P. (1999). *An introduction to discourse analysis: Theory and method*. London, England: Routledge.

Gee, J. P. (2005). Learning by design: Good video games as learning machines. *E-Learning, 2*(1), 5–16. doi: 10.2304/elea.2005.2.1.5

Gee, J. P. (2004). *Situated language and learning*. New York: Routledge

Gee, J. P. (2007a). *Good video games +good learning*. New York: Peter Lang.

Gee, J. P. (2007b). *What video games have to teach us about learning and literacy*. New York, NY: Palgrave Macmillan.

Gee, J. P. (2012). Afterword. In E. R. Hayes, & S. C. Duncan (Eds.) *Learning in video game affinity spaces (*pp. 235–242*)*. New York: Peter Lang.

Gentile, D. A., Lynch, P. J., Linder, J. R., & Walsh, D. A. (2004). The effects of violent video game habits on adolescent hostility, aggressive behaviors, and school performance. *Journal of Adolescence*, *27*(1), 5–22. doi: 10.1016/j.adolescence.2003.10.002

German, T. P., & Barrett, H. C. (2005). Functional fixedness in a technologically sparse culture. *Psychological Science, 16*(1), 1–5. doi:10.2307/40064063

Gros, B. (2007). Digital games in education: The design of games-based learning environments. *Journal of Research on Technology in Education, 40*(1), 23–38. Retrieved from: http://www.iste.org

Habgood, M. P. J., & Ainsworth, S. E. (2011). Motivating children to learn effectively: Exploring the value of intrinsic integration in educational games. *Journal of the Learning Sciences, 20*(2), 169–206. doi:10.1080/10508406.2010.508029

Harel, I., & Papert, S. (1990). Software design as a learning environment. *Interactive Learning Environments, 1*(1), 1–32. doi:10.1080/1049482900010102

Hassett, J. (1984, September). Computers in the classroom. *Psychology Today*, *18*(9), 22-28.

Hayes, D. N. (2007). ICT and learning: Lessons from Australian classrooms. *Computers & Education, 49*(2), 385–395. doi:10.1016/j.compedu.2005.09.003

Holdich, C., & Chung, P. (2003). A ‘computer tutor’ to assist children develop their narrative writing skills: Conferencing with HARRY. *International Journal of Human-Computer Studies, 59*(5), 631–669. doi:10.1016/s1071-5819(03)00086-7

Horst, H., Herr-Stephenson, B., & Robinson, L. (2010). Media ecologies. In M. Ito (Ed.), *Hanging out, messing around, and geeking out: Kids living and learning with new media* (pp. 29–78). Cambridge, MA: MIT Press.

Hughes, J. (2005). The role of teacher knowledge and learning experiences in forming technology-integrated pedagogy. *Journal of Technology and Teacher Education*, *13*(2), 277–302. Retrieved from: http://www.aace.org/pubs/jtate/

International Society for Technology in Education. (2005). *National educational teaching standards- teachers*. Retrieved from: http://www.iste.org/standards/iste-standards/standards-for-teachers

Ito, M. (2009). *Engineering play: A cultural history of children's software*. Cambridge, MA: MIT Press.

Jenkins, H. (2006). *Convergence culture: Where old and new media collide*. New York: New York University Press.

Jenson, J. & de Castell, S. (2008). Theorizing gender and digital gameplay: Oversights, accidents and surprises. *Journal for Computer Game Culture, 2*(1), 15-25. Retrieved from http://www.eludamos.org/

Jenson, J. & de Castell, S. (2010). Gender, simulation, and gaming: Research review and redirections. *Simulations and Gaming. 41*(1), 51-71. doi: 10.1177/1046878109353473

John-Steiner, V., Weber, R. J., & Minnis, M. (1998) The challenge of studying collaboration. *American Educational Research Journal, 35(4),* 773–783. doi: doi:10.3102/00028312035004773

Kafai, Y. B. (1995). *Minds in play: Computer game design as a context for children's learning*. Hillsdale, NJ: Lawrence Erlbaum.

Kafai. Y.B. (2006). Constructionism. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 35–46). New York: Cambridge University Press.

Kafai, Y. B., & Burke, Q. (2014). *Connected code: Why children need to learn programming*. Cambridge, MA: MIT Press.

Kafai, Y. B., & Ching, C. C. (2001). Affordances of collaborative software design planning for elementary students' science talk. *The Journal of the Learning Sciences*, *10*(3), 323–363. doi: 10.2307/1466754

Kafai, Y. B., Ching, C. C., & Marshall, S. (1997). Children as designers of educational multimedia software. *Computers & Education, 29*(2/3), 117–126. doi: 10.1016/S0360-1315(97)00036-5

Kafai, Y. B., Fields, D. A., Roque, R., Burke, Q., & Monroy-Hernandez, A. (2012). Collaborative agency in youth online and offline creative production in Scratch. *Research and Practice in Technology Enhanced Learning, 7*(2), 63–87. Retrieved from http://www.telrp.com/

Kafai, Y. B., Franke, M. L., Shih, J. C., & Ching, C. C. (1998). Game design as an interactive learning environment for fostering students' and teachers' mathematical inquiry. *International Journal of Computers For Mathematical Learning*, 3(2), 149–84. doi: 10.1023/A:1009777905226

Kafai, Y. B., Peppler, K. A., & Chapman, R. N. (2009). *The computer clubhouse: Constructionism and creativity in youth communities.* New York: Teachers College Press.

Kafai, Y. B., & Resnick, M. (1996). *Constructionism in practice: Designing, thinking, and learning in a digital world.* Mahwah, NJ: Lawrence Erlbaum Associates.

Kahn, R. L., & Cannell, C. F. (1957). *The dynamics of interviewing: Theory, technique, and cases.* New York: Wiley.

Kalelioğlu, F. & Gülbahar, Y. (2014). The effect of instructional techniques on critical thinking and critical thinking dispositions in online discussion. *Educational Technology & Society*,17(1), 248–258. Retrieved from: http://www.ifets.info/

Kenny, R., & Gunter, G. (2011). Factors affecting adoption of video games in the classroom. *Journal of Interactive Learning Research, 22*(2), 259–276. Retrieved from: http://www.aace.org/pubs/jilr/

Kenny, R., & McDaniel, R. (2011). The role teachers' expectations and value assessments of video games play in their adopting and integrating them into their classrooms. *British Journal of Educational Technology, 42*(2), 197–213. doi: 10.1111/j.1467-8535.2009.01007.x

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist, 41*(2), 75–86. doi:10.1207/s15326985ep4102_1

Koehler, M. J., & Mishra, P. (2008). Introducing TPCK. In The AACTE Committee on Innovation and Technology, M. Herring, P. Mishra & M, Koehler (Eds.) *Handbook of* *technological pedagogical content knowledge for educators* (pp. 3–30). New York: Routledge.

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education*, *9*(1), 60–70. Retrieved from: http://www.aace.org/pubs/cite/

Kolodner, J. L. (2006). Case-based reasoning. In K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 225–242). Cambridge, MA: Cambridge University Press.

Kolodner, J. L., Camp, P. J., Crismond, D., Fasse, B., Gray, J., Gray, J., Holbrook, J., ... Ryan, M. (2003). Problem-based learning meets case-based reasoning in the middle-school science classroom: Putting learning by design into practice. *Journal of the Learning Sciences*, *12*(4), 495–547. doi:10.1207/s15327809jls1204_2

Kvale, S. (1996). *Interviews: An introduction to qualitative research interviewing,* Thousand Oaks, CA: Sage.

Kynigos, C. (2004). A "black-and-white box" approach to user empowerment with component computing. *Interactive Learning Environments*, *12*(1), 27–71. doi: 10.1080/1049482042000300896

Lai, A., & Yang, S. (2011). The learning effect of visualized programming learning on 6th graders' problem solving and logical reasoning abilities. *Proceedings of the International Conference on Electrical and Control Engineering,* Yichang, 6940–6944. doi:10.1109/iceceng.2011.6056908

Leonard, P. E., & Leonard, L. J. (2001). Assessing aspects of professional collaboration in schools: Beliefs versus practices? *The Alberta Journal of Educational Research, 47*(1), 4-23. Retrieved from www.ajer.ca

Levi-Strauss, C. (1966). *The savage mind.* Chicago: University of Chicago Press.

Lim, C. P. (2008). Spirit of the game: Empowering students as designers in schools? *British Journal of Educational Technology, 39*(6), 996–1003. doi: 10.1111/j.1467-8535.2008.00823_1.x

Linnenbrink, E. A., & Pintrich, P. R. (2002). Motivation as an enabler for academic success. *School Psychology Review, 31*(3), 313–327. Retrieved from: http://www.nasponline.org/publications/spr

Lovell, M. (2014). *Interactive whiteboard use: Changes in teacher pedagogy in reading instruction in the primary grades* (Doctoral dissertation). Retrieved from: University of Alberta Library. (alb.6646110)

MacLaurin, M. (2011). The design of Kodu: A tiny visual programming language for children on the Xbox 360. *Proceedings of the 38th annual ACM SIGPLAN-SIGACT symposium on principles of programming languages,* Austin, USA, 241–246. doi: 10.1145/1926385.1926413

McGonigal, J. (2011). *Reality is broken: Why games make us better and how they can change the world*. New York: The Penguin Press.

McGrail, E. (2005). Teachers, technology, and change: English teachers' perspectives. *Journal of Technology and Teacher Education, 13*(1), 5–24. Retrieved from: http://www.editlib.org.login.ezproxy.library.ualberta.ca/p/18893/

Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science, 5*(4), 333–369. doi:10.1016/S0364-0213(81)80017-1

Maloney, J., Burd, L., Kafai, Y., Rusk, N., Silverman, B., & Resnick, M. (2004). Scratch: A sneak preview. *Proceedings. Second international conference on creating, connecting and collaborating through computing,*104–109. doi: 10.1109/C5.2004.1314376 *2004.*

Martinez, S. L., & Stager, G. (2013). *Invent to learn: Making, tinkering, and engineering in the classroom*. Torrance, CA: Constructing Modern Knowledge Press.

Merriam, S. (1998). *Qualitative research and case study applications in education: Revised and expanded from case study research in education*. San Francisco: Jossey-Bass.

Mevarech, Z. R., & Kramarski, B. (1993). Vygotsky and Papert: Social-cognitive interactions within Logo environments. *British Journal of Educational Psychology, 63*(1), 96–109. doi:10.1111/j.2044-8279.1993.tb01044.x

Mikropoulos, T. A., & Natsis, A. (2011). Educational virtual environments: A ten-year review of empirical research (1999–2009). *Computers & Education, 56*(3), 769–780. doi:10.1016/j.compedu.2010.10.020

Miles, M. B., & Huberman, A. M. (1998). *Qualitative data analysis: A methods sourcebook* (2nd ed.). Thousand Oaks, CA: SAGE.

Miles, M. B., & Huberman, A. M. (2013). *Qualitative data analysis: A methods sourcebook* (3rd ed.). Thousand Oaks, CA: SAGE.

Montiel-Overall, E. (2005). A theoretical understanding of teacher and librarian collaboration. *School Libraries Worldwide*, 11(2), 24–48. Retrieved from: http://www.iasl-online.org/

Montiel-Overall, E. (2010). Further understanding of collaboration: A case study of how it works with teachers and librarians. *School Libraries Worldwide, 16(2),* 31–54. Retrieved from: http://www.iasl-online.org/

Montiel-Overall, P., & Jones, P. (2011). Teacher and school librarian collaboration: A preliminary report of teachers' perceptions about frequency and importance to student learning. *Canadian Journal of Information and Library Science, 35*(1), 49–76. doi:10.1353/ils.2011.0001

Mueller, J., Wood, E., Willoughby, T., Ross, C., & Specht, J. (2008). Identifying discriminating variables between teachers who fully integrate computers and teachers with limited integration. *Computers & Education, 51*(4), 1523–1537. doi:10.1016/j.compedu.2008.02.003

Olson, C. K. (2010). Children's motivations for video game play in the context of normal development. *Review of General Psychology*, *14*(2), 180–187. doi: 10.1037/a0018984

Overbay, A., Patterson, A. S., Vasu, E. S., & Grable, L. L. (2010). Constructivism and technology use: Findings from the IMPACTing Leadership project. *Educational Media International, 47*(2),103–120. doi:10.1080/09523987.2010.492675

Packer, M. J., & Goicoechea, J. (2000). Sociocultural and constructivist theories of learning: Ontology, not just epistemology. *Educational Psychologist, 35*(4), 227–241. doi: 10.1207/S15326985EP3504_02

Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas*. New York: Basic Books.

Papert, S. (1987). Computer criticism vs. technocentric thinking. *Educational Researcher, 16*(1), 22–30. doi:10.2307/1174251

Papert, S. (1988). A critique of technocentrism in thinking about the school of the future. In B. Sendov & I. Stanchev (Eds.). *Children in the Information Age* (pp. 3–18). doi:10.1016/b978-0-08-036464-3.50006-5

Papert, S. (1991). Situating constructionism. In I. Harel & S. Papert (Eds.) *Constructionism* (pp. 1–11). New York, NY: Ablex Publishing.

Papert, S. (1993). *The children's machine: Rethinking school in the age of the computer.* New York: Basic Books.

Papert, S. (1996). A word for learning. In Y. Kafai & M. Resnick (Eds.) *Constructionism in practice: Designing, thinking, and learning in a digital world* (pp. 25–35). Mahwah, NJ: Lawrence Earbaum.

Pelgrum, W. (2001). Obstacles to the integration of ICT in education: Results from a worldwide educational assessment. *Computers & Education, 37*(2), 163–178. doi:10.1016/s0360-1315(01)00045-8

Peppler, K. A., & Kafai, Y. B. (2007). From SuperGoo to scratch: Exploring creative digital media production in informal learning. *Learning, Media and Technology, 32*(2), 149–166. doi: 10.1080/17439880701343337

Piaget, J. (1973). *The child and reality; problems of genetic psychology*. New York: Penguin.

Prensky, M. (2007). *Digital game-based learning*. New York: Paragon House.

Prensky, M. (2008). Students as designers and creators of educational computer games: Who else? *British Journal of Educational Technology, 39*(6), 1004–1019. doi:10.1111/j.1467-8535.2008.00823_2.x

Przybylski, A. K., Rigby, C. S., & Ryan, R. M. (2010). A motivational model of video game engagement. *Review of General Psychology*, *14*(2), 154–166. doi:10.1037/a0019440

Pugach, M. C. & Johnson, L. J. (1995). *Collaborative practitioners: Collaborative schools.* Denver, CO: Love Publishing Company.

Rice, J. (2007). Assessing higher order thinking in video games. *Journal of Technology and Teacher Education, 15*(1), 87–100. Retrieved from: http://www.aace.org/pubs/jtate/

Rieber, L. (1996). Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games. *Educational Technology Research and Development*, *44*(2), 43–58. doi: 10.1007/BF02300540

Robertson, J., & Good, J. (2005). Children's narrative development through computer game authoring. *TechTrends: Linking Research & Practice to Improve Learning, 49*(5), 43–59. Retrieved from: http://www.springer.com/education+%26+language/learning+%26+instruction/journal/11528

Robertson, J., & Howells, C. (2008). Computer game design: Opportunities for successful learning. *Computers & Education, 50*(2), 559–578. doi:10.1016/j.compedu.2007.09.020

Russell, M., Bebell, D., O'Dwyer, L., & O'Connor, K. (2003). Examining teacher technology use: Implications for preservice and inservice teacher preparation. *Journal of Teacher Education, 54*(4), 279–310. doi:10.1177/0022487103255985

Salen, K. (2007). Gaming literacies: A game design study in action. *Journal of Educational Multimedia & Hypermedia, 16*(3), 301–322. Retrieved from: http://www.aace.org/pubs/jemh/

Salen, K. (2008). *The ecology of games: Connecting youth, games, and learning.* Cambridge, MA: MIT Press.

Salen, K., Torres, R., Wolozin, L., Rufo-Tepper, R., & Shapiro, A. (2011). *Quest to learn: Developing the school for digital kids.* Cambridge, MA: MIT Press.

Salen, K., & Zimmerman, E., (2004). *Rules of play: Game design fundamentals*. Cambridge, MA: MIT Press.

Sandford, R. (2014). Teachers as game designers: Using a game in formal learning in a Singapore primary school. *Educational Media International, 51*(1), 66–78. doi:10.1080/09523987.2014.889410

Scharber, C. M. (2008). Leveraging the development of English TPCK within the deictic nature of literacy. In J. E. Hughes (Ed.), *Handbook of technological pedagogical content knowledge (TPCK) for educators*. New York: Routledge for the American Association of Colleges for Teacher Education.

Schott, G. R., & Horrell, K. R. (2000). Girl gamers and their relationship with the gaming culture. *Convergence, 6(4),* 36–53. doi: 10.1177/135485650000600404

Shaffer, D. W. (2006). Epistemic frames for epistemic games. *Computers and Education, 46*(3), 223–234. doi: 10.1016/j.compedu.2005.11.003

Shaffer, D.W., Squire, K., & Gee, J.P. (2005). Video games and the future of learning. *Phi Delta Kappa,* 87(2), 104–111. Retrieved from: http://www.jstor.org/stable/20441942

Shaw, A. (1996). Social constructionism and the inner city: Designing environments for social development and urban renewal. In Y. Kafai & M. Resnick (Eds.), *Constructionism in practice: Designing, thinking, and learning in a digital world* (pp. 175–206). Mahwah. NJ: Lawrence Earbaum.

Shelton, B. E., & Scoresby, J. (2010). Aligning game activity with educational goals: Following a constrained design approach to instructional computer games. *Education Technology Research and Development*, 59(1), 113–138. doi:10.1007/s11423-010-9175-0

Skinner, B.F. (1986). Programmed instruction revisited. *The Phi Delta Kappan*, *68*(2), 103–110. Retrived from http://pdkintl.org/

Smeets, E. (2005). Does ICT contribute to powerful learning environments in primary education? *Computers & Education, 44*(3), 343–355. doi:10.1016/j.compedu.2004.04.003

Squire, K. (2006). From content to context: Videogames as designed experience. *Educational Researcher, 35*(8), 19–29. doi: 10.3102/0013189X035008019

Squire, K. (2008). Video game-based learning: An emerging paradigm for instruction. *Performance Improvement Quarterly*, *26*(1), 101–130. doi: 10.1002/piq.21139

Squire, K. (2011). *Video games and learning: Teaching and participatory culture in the digital age.* New York: Teachers College Press.

Squire, K., Giovanetto, L., Devane, B., & Durga, S. (2005). From users to designers: Building a self-organizing game-based learning environment. *TechTrends, 49*(5), 34–42. doi:10.1007/bf02763688

Stake, R. (1995). *The art of case study research*. Thousand Oaks, CA: SAGE.

Stolee, K. T., & Fristoe, T. (2011). Expressing computer science concepts through Kodu game lab. *Proceedings of the 42nd ACM Technical Symposium on Computer Science Education*, 99–104. doi:10.1145/1953163.1953197

Tangdhanakanond, K., Pitiyanuwat, S., & Archwamety, T. (2006). A development of portfolio for learning assessment of students taught by full-scale constructionism approach at Darusikkhali School. *Mid-South Educational Research Association, 12*(2), 24–36. Retrieved from: http://www.msstate.edu/org/msera/rits.htm

Taylor, R. (1980). *The computer in the school: Tutor, tool, tutee*. New York: Teachers College Press.

Tondeur, J., Keer, H. V., Braak, J. V., & Valcke, M. (2008). ICT integration in the classroom: Challenging the potential of a school policy. *Computers & Education, 51*(1), 212–223. doi:10.1016/j.compedu.2007.05.003

Turkle, S. (1984). *The second self: Computers and the human spirit.* New York: Simon and Schuster.

Turkle, S. & Papert, S. (1990). Epistemological pluralism: Styles and voices within the computer culture. *Signs, 16*(1), 128–157. Retrieved from http://www.jstor.org/stable/3174610

Upitis, R. (1998). From hackers to luddites, game players to game creators: Profiles of adolescent students using technology. *Journal of Curriculum Studies, 30*(3), 293–318. doi: 10.1080/002202798183620

Van den Dool, P., & Kirschner, P. (2003). Integrating the educative functions of information and communications technology (ICT) in teachers' and learners' toolboxes: A reflection on pedagogical benchmarks for ICT in teacher education. *Technology, Pedagogy and Education, 12*(1), 161–179. doi:10.1080/14759390300200151

Vannatta, R. A., & Fordham, N. (2004). Teacher Dispositions as Predictors of Classroom Technology Use. *Journal of Research on Technology in Education, 36*(3), 253–271. doi:10.1080/15391523.2004.10782415

Vygotsky L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge. MA: Harvard University Press.

Welch, M. (1998). Collaboration: Staying on the bandwagon. *Journal of Teacher Education,* *49(1),* 26–38. doi:10.1177/0022487198049001004

Yin, R. K. (2009). *Case study research: Design and methods (fourth edition).* Los Angeles: Sage.

Zaharija, G., Mladenović, S., & Boljat, I. (2013). Introducing basic programming concepts to elementary school children. *Procedia – Social and Behavioral Sciences, 106*, 1576–1584. doi:10.1016/j.sbspro.2013.12.178

Zevenbergen, R., & Lerman, S. (2008). Learning environments using interactive whiteboards: New learning spaces or reproduction of old technologies? *Mathematics Education Research Journal, 20*(1), 107–125. doi: 10.1007/BF03217471

Appendix A: Coding Themes

Teachers

Theme	Color Code
Pedagogy - Teacher Centered	
Pedagogy - Student Centered	
Collaboration – Teacher - Teacher	
Collaboration – Teacher – Student	
Collaboration – Teacher – Technology	
Collaboration – Teacher – Principal	
Planning and Writing	
Assessment	
Time	

Students

Theme	Color Code
Motivation (Intrinsic)	
Planning, Writing	
Collaboration – Student- Teacher	
Collaboration – Student - Student	
Collaboration – Student – Technology	
Kodu Game/Game Play	
Problem Solving	
Understanding Content	
Game Construction	

Appendix B: Quick Student Reference

This section is to be used as a tear out page to support readers in connecting with the students and teachers. It will help in understanding the choices particular students and teachers made in the game construction project.

Teachers

Patrick: An experienced grade six teacher who integrates technology into his classroom on a regular basis. Is also the technology coach for the school.

Heather: An experienced grade four teacher who has a considerable amount of experience integrating Lego robotics into the elementary classroom. Is also a technology coach for the school.

Angela: An experienced teacher who is new to grade six. Her own expertise is centered on literacy, particularly in writing development.

Students

Stella: A grade six student in Patrick's class. She is an enthusiastic learner who prefers to collaborate than working individually.

Aiden: A grade six student in Patrick's class. He is an enthusiastic gamer but struggles at times in both Mathematics and Language Arts.

John: A grade six student in Patrick's class. He is a strong leader who is quick to learn new technologies.

Clara: A grade six student in Angela's class. She is a strong student who is an avid reader. Very creative and likes to explore new technologies.

Beth: A grade six student in Angela's class. She is a quiet but strong student who enjoys using technology at school.

Robert: A grade six student in Angela's class. He is an athletic and social students who plays video games at home. At times struggles in school, but enjoys using hands-on tools to help him learn.

Samantha: A grade six student in Angela's class. She is an athletic student who enjoys working through projects.

Meghan: A grade four student in Heather's class. She is an academically strong student who is eager to help others.

Ellen: A grade four student in Heather’s class. She is a hard working student but doesn’t really enjoy playing video games.

Caleb: A grade four student in Heather’s class. He is an active, natural leader who likes to play sport video games. Caleb also likes to go against the general status quo, and create his own rules.

Colin: A grade four student in Heather’s class. He is a strong student who likes to use technology, in particular Minecraft.

Appendix C: Kodu Tutorial Lesson

1. First we showed the students how to build land. How to paint the land, change the look of the land, change the elevations – heighten or lowered, and add water (we remind the students that your land can become flooded if you don't develop some hills or elevation to ensure the rest of the land doesn't become flooded). Many of the students were interested in building caves in Kodu, and creating a world that looked very similar to their worlds that they build using Minecraft. We reflected that some of the things they build in Minecraft are not as easy to build in Kodu because they are different gaming platforms.
2. Next we showed the students how to change some of the game settings, such as how to change to day and night, how to add a countdown, add a game description how to add or take away glass walls, etc.
3. Next, we showed the students how to add characters and land elements, such as huts, castles, starts, apples, etc. We also talked about Kodu, who is often the main character of the game.
4. Next, we demonstrated how to add Kodu, change his color, change his size and height, colour (we emphasized how important colour is in identifying the program of the character) and also change some of his settings including speed, mobility, etc.
5. Next we began with some simple programming – which began with how to eat an apple and get one point. We demonstrated first that we needed to ensure that Kodu could move. As a class we are using the keyboard and mouse with Kodu, which means we are programming with the keyboard and mouse in mind. Thus, we asked the students to use

the arrow or WASD keys to move Kodu. Then we created a new script line with Kodu, and noted, WHEN-I bump into an apple, DO-I will eat it. Once we entered the command, we also noted that we needed to add a point value to eating the apple. Thus we tabbed the next script line over, suggesting that we didn't need a WANT for this script – as it was noted in the above line, however we needed a do line, which was one point (whatever colour they chose for Kodu).

6. The next programming topic we showed the student to do was how to win the game. We decided that when we picked up five apples we would win the game. Thus we programmed this into the game, under our Kodu.
7. Next, we showed the students how to program an additional character, whether a different colour Kodu, or a different character entirely – such as the Rover, a Blimp, a Saucer, etc. We can program characters or objects without having to move them – thus we program the other character to also pick up apples and if this character picks up the five apples first the game is over. Programming looked something like
    a. When Kodu sees an apple, move toward it.
    b. When Kodu sees NOT an apple, set to wander.
    c. When Kodu bumps into apple, eat it.
        i. Score one point.
    d. When achieves five points, game over.
8. Then we showed the students some other features such as holding objects, programming objects to play sounds, then have something happen when the sounds is played. Such as we program a rock to play music after 10 seconds into the game, when the rock played

music, a saucer would start shooting out apples every five seconds, until the game was either won or over.

9. We also showed objects or characters can say something, such as when Kodu bumps into an objects, it will say something. Or when Kodu hears something, it was say something, or when 30 seconds go by, Kodu will say something, etc.
10. We also showed the students how to follow a path, which can look like a road, a castle wall, etc. We talked that this is often effective with a boat or a vehicle.
11. The last thing we showed the students was how to use the creatable button. We demonstrated that when you add an object, you can change the settings to creatable. Then you can program a character or a object to do something such as bump into a star, and when this happens, something will be created.
12. After we showed the students how to do the basic elements of a game, we then took a step back and allowed them about an hour and a half of play. However, when we were showing the programming to the students, we took a I show, and you try philosophy, whereas we didn't show everything at once, showed a little, then the students tried it out.
13. The last hour, we identified some tech ninjas – students who were exceptionally good at programming and had a strong knowledge of how to debug the program. They took over the job of supporting the students. These three tech ninjas – all boys – were highly effective and excited to help other students in solving and debugging their games.
14. The last thirty minutes, we asked the students to try to problem solve on their own – meaning the tech ninjas and ourselves were now simply going to us solve problems on our own – try to look deeply into the program in solving the problem. These was certainly a bit of initial despair with the students, noting – I don't know what to do, but

when they looked deeper into the problem, most of the students were able to be successful. Kodu, the game – provides enough scaffolds – just a good video game, to support the students to solve the debugging issues. It often provides a popup message suggesting when there is a programming error – and it also provide both text and pictorial messages of how to solve certain problems.

15. As the students begin to drill down and further explore the program they located the Combat mode and some of the shooting elements located in the game. Paul identifies that although these are elements located in the game, at this point the students would not be using them, particularly as they are at school, and shooting does not fit within the student's conduct policy. The students seem to react well to the conversation, and continued to explore the other elements located in the game.

Appendix D: Sample Video Game Story

Patrick, one of the grade six teachers, wrote this story as an exemplar for the grade six students.

Marvin the Martian lived on Mars in the capital city of Marzania. He lived in a small room attached to his science lab in the middle of city. Marvin was a scientist, and his scientific mission in life was to find a way to eliminate pollution on his planet. He had seen what was happening on the planet Earth and was determined to make sure the same thing did not happen to his planet. Unfortunately, Marvin was not a very good scientist. He had brilliant ideas and was a dedicated worker. Once he started on an idea he wouldn't stop until he solved it. Or something blew up and forced him to stop. While Marvin had great vision and worked hard, he was terrible at Math. When you are an experimental scientist with poor Math skills, things tend to go kaboom fairly often.

This is what happened to Marvin on the morning of October 22nd. Marvin had spent all night working on a new fuel to help Martians get around their planet. Martians did not need vehicles because their body was like a vehicle. All Martians could hover and float. They used their large bulging eyes to see where they were going, and the antenna on top of their heads helped them keep track of where they were. Unfortunately, the fuel they used to power their bodies gave off exhaust that could eventually cause severe pollution issues to the planet.

Marvin shuddered awake and looked at the bulletin board in his lab. It was covered with calculations that he had spent all night working on. He was sure this was the answer. He had worked out a new formula for fuel that would result in clean emissions that would not harm his planet. However, while Marvin had great ideas, he also was lousy at Math. What Marvin didn't realize was that instead of adding 100 grams of highly explosive martiananium to his fuel, he accidentally wrote down 10000 grams. Without realizing his mistake, Marvin mixed up the first batch of fuel and added it to the testing engine.

The resulting explosion almost shattered the planet.

After the dust settled and the planet stopped shaking, Marvin was arrested and brought before Commander Dodgers, the president of Mars. Commander Dodgers did not like Marvin. Commander Dodgers was a Martian who believed in order, and having everything neat, tidy and correct. He viewed Marvin as a menace who kept messing up his opinion of how Martian society should be. But this was the last straw. Marvin had almost blown up the entire planet! Something had to be done, and Commander Dodgers knew exactly what to do. Marvin was to be exiled to Forbidden Exile Math Zone of Doom. Anyone sent there had to solve the most diabolical Math problems the greatest minds on Mars had every devised in order to escape. Only those who had proven themselves to have superior Math skills would able to escape the Zone and be considered worthy to rejoin Martian society. Commander Dodgers was very confident that Marvin would spend the rest of his natural life in the Forbidden Exile Math Zone of Doom.

Marvin was roughly hauled to edge of the canyon surrounding the Forbidden Exile Math Zone of Doom and pushed into it. A deep canyon and high walls surrounded Marvin. As he looked around he saw a deep lake in the middle that glittered green in the sunlight. The pinkish red rocks radiated the heat of day back at him. Trees could be seen in spotty patches along the rim of the canyon. As Marvin got his bearings he noticed a path winding its way through the zone. It appeared to be on the only safe way through the zone. From his initial landing point it appeared that there was some kind of gate or door blocking the path at stages along the path.

Marvin began to work his way along the path. Shortly into his journey he noticed a sign. It read, “Beware! The only way out is to correctly solve math problems to open the Gates to

Freedom. Fail to answer one correctly and you will be sent back to the beginning of the Trail of Tears."

Marvin cautiously made his way down the trail. He approached the first gate. There appeared to be a combination lock on the gate. Above the gate were the following instructions:

To open this gate, you must choose numbers that are multiples of 2, 3, AND 6.

Below that were the following numbers: 2, 12, 45, 18, 22, 21, 30, 42, and 10. Marvin stopped at the gate and carefully studied the numbers. He knew that he could find multiples by skip counting or by division. Marvin decided to use division because he thought that would be faster. He started with the numbers that could be divided by six. After spending one hour carefully working out his division facts, Marvin knew he could use 12, 18, 30, and 42. He was amazed when he realized that 2 and 3 could also divide all those numbers. All that practice with dividing by six had really sharpened his division skills. Marvin entered the numbers in the lock and the gate slowly swung open.

Marvin was feeling more confident as he made his way down the path. The path climbed up the side of one of hills. The next gate was wedged in between two tall cliffs and there was no way around it or over it. Marvin cautiously approached the gate and read the sign beside it. It read:

Knock on the gate to open. But you must knock exactly the correct amount. The correct amount is the greatest common factor of 24, 36 and 80.

Marvin froze as he carefully considered the problem. He remembered that the rainbow method was a really good way to work out the factors of a number because you make sure you had all the factors of a given number. Marvin carefully looked at the rainbows he made realized the common factors of those numbers were 1, 2 and 4. Marvin carefully bumped into the gate 4 times. He was amazed as the gate slowly swung open.

The trail led down a bridge over the lake. In the middle of the bridge was another gate. Marvin floated down the trail and approached the bridge. Carefully he floated onto the bridge. He did not want to fall off. Martians tended to rust when they got wet. Once again there was a sign next to the gate. It read:

To open this gate you must knock on this gate with the highest prime number between 10 and 30.

Marvin kept very still as he floated in place and thought about what he knew about prime and composite numbers. He knew composite numbers had more than two factors, and prime numbers had only two factors. As Marvin thought and thought about the numbers between 10 and 30 a new sign appeared. It was a countdown timer! It started at 1 minute and worked its way down. Marvin panicked and his mind began to blank. Before he knew it the timer was at zero.

Kaboom!

Marvin opened his eyes and saw he was back at the beginning of the trail. He began to cry. Now he knew why it was called the Trail of Tears. After crying for a while, Marvin realized that he already knew the answers to the first two gates.

After moving quickly through the first two gates Marvin paused before floating on to the bridge. He thought about the prime numbers between 10 and thirty before approaching the gate. He began to knock on it 37 times. As he was knocking the countdown timer appeared again. He just finished his 37^{th} knock as the timer reached the last 5 seconds. The gate opened and Marvin floated through to the other side.

Marvin followed the trail along the lake to what appeared the last gate. The trail spiraled up the single mountain in the middle of the canyon. Marvin cautiously approached the last gate at the very top of the mountain. The sign next to the gate read:

To open this gate you must solve this skill-testing question. The answer to this questions contains the number of times you must knock on this gate to be free of the Forbidden Exile Math Zone of Doom. $3\times 2 - 12 \div 4$

Almost immediately at 20 second timer appeared. Marvin frantically tried to remember the rules for order of operations in Math.

Unfortunately, Marvin doesn’t work well under pressure.

Kaboom! Back to the start.

Marvin was determined that this was not going to his Trail of Tears. He confidently floated down the trail and worked his through the first three gates and made his way up to the final gate.

Kaboom!

Kaboom!

Kaboom!

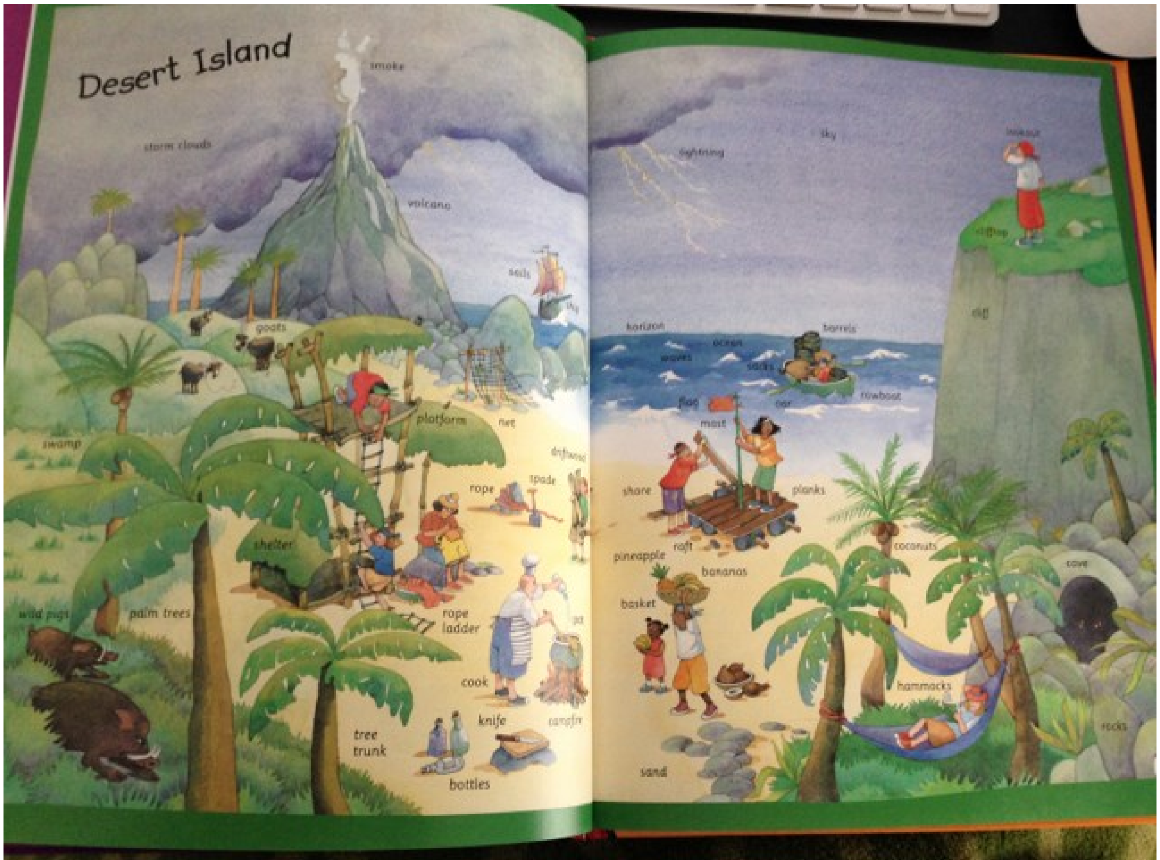
By the fifth attempt Marvin had the challenge at the last gate memorized. He confidently floated up the gate and bumped into twice.

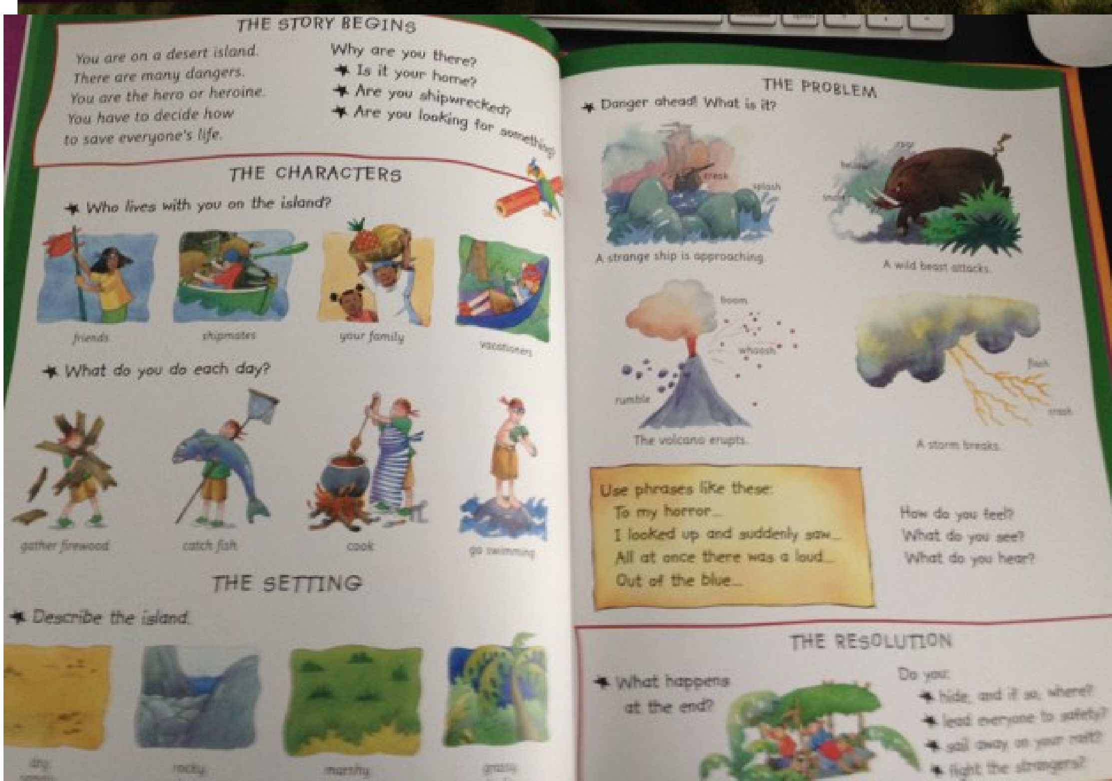
Bam!

Marvin braced himself for disappointment. But when he opened his eyes he realized that he was not back at the start of the Trail of Tears. That was when he realized he had heard a different sound. Marvin slowly looked around and saw that he was in the home of Commander Dodgers. Actually he was in the Commander’s bedroom. Needless to say, Commander Dodgers was somewhat surprised to see Marvin anywhere, let alone his bedroom. Commander Dodgers had to accept that Marvin had proven himself a responsible scientist by escaping the Forbidden Exile Math Zone of Doom.

Marvin was permitted to return to his home and lab and resume his work on stopping the pollution on Mars. However, he was clearly warned that should be almost blow up the planet again, he would find his next experience in the Forbidden Exile Math Zone of Doom even more challenging.

Appendix E: Example Pages from the Start Writing Adventure Stories Book





Appendix F: Student Example of Kodu Story Highlighted With Game Portion

Marvin the Martian lived on Mars in the capital city of Marzania. He lived in a small room attached to his science lab in the middle of city. Marvin was a scientist, and his scientific mission in life was to find a way to eliminate pollution on his planet. He had seen what was happening on the planet Earth and was determined to make sure the same thing did not happen to his planet. Unfortunately, Marvin was not a very good scientist. He had brilliant ideas and was a dedicated worker. Once he started on an idea he wouldn't stop until he solved it. Or something blew up and forced him to stop. While Marvin had great vision and worked hard, he was terrible at math. When you are an experimental scientist with poor math skills, things tend to go kaboom fairly often.

This is what happened to Marvin on the morning of October 22nd. Marvin had spent all night working on a new fuel to help Martians get around their planet. Martians did not need vehicles because their body was like a vehicle. All Martians could hover and float. They used their large bulging eyes to see where they were going, and the antenna on top of their heads helped them keep track of where they were. Unfortunately, the fuel they used to power their bodies gave off exhaust that could eventually cause severe pollution issues to the planet.

Marvin shuddered awake and looked at the bulletin board in his lab. It was covered with calculations that he had spent all night working on. He was sure this was the answer. He had worked out a new formula for fuel that would result in clean emissions that would not harm his planet. However, while Marvin had great ideas, he also was lousy at math. What Marvin didn't realize was that instead of adding 100 grams of highly explosive martiananium to his fuel, he accidentally wrote down 10000 grams. Without realizing his mistake, Marvin mixed up the first batch of fuel and added it to the testing engine.

The resulting explosion almost shattered the planet.

After the dust settled and the planet stopped shaking, Marvin was arrested and brought before Commander Dodgers, the president of Mars. Commander Dodgers did not like Marvin. Commander Dodgers was a Martian who believed in order, and having everything neat, tidy and correct. He viewed Marvin as a menace who kept messing up his opinion of how Martian society should be. But this was the last straw. Marvin had almost blown up the entire planet! Something had to be done, and Commander Dodgers knew exactly what to do. Marvin was to be exiled to Forbidden Exile Math Zone of Doom. Anyone sent there had to solve the most diabolical math problems the greatest minds on Mars had every devised in order to escape. Only those who had proven themselves to have superior math skills would able to escape the Zone and be considered worthy to rejoin Martian society. Commander Dodgers was very confident that Marvin would spend the rest of his natural life in the Forbidden Exile Math Zone of Doom.

Marvin was roughly hauled to edge of the canyon surrounding the Forbidden Exile Math Zone of Doom and pushed into it. A deep canyon and high walls surrounded Marvin. As he looked around he saw a deep lake in the middle that glittered green in the sunlight. The pinkish red rocks radiated the heat of day back at him. Trees could be seen in spotty patches along the rim of the canyon. As Marvin got his bearings he noticed a path winding its way through the zone. It appeared to be on the only safe way through the zone. From his initial landing point it appeared that there was some kind of gate or door blocking the path at stages along the path.

Marvin began to work his way along the path. Shortly into his journey he noticed a sign. It read, "Beware! The only way out is to correctly solve math problems to open the Gates to Freedom. Fail to answer one correctly and you will be sent back to the beginning of the Trail of Tears."

Marvin cautiously made his way down the trail. He approached the first gate. There appeared to be a combination lock on the gate. Above the gate were the following instructions:

To open this gate, you must choose numbers that are multiples of 2, 3, AND 6.

Below that were the following numbers: 2, 12, 45, 18, 22, 21, 30, 42, and 10. Marvin stopped at the gate and carefully studied the numbers. He knew that he could find multiples by skip counting or by division. Marvin decided to use division because he thought that would be faster. He started with the numbers that could be divided by six. After spending one hour carefully working out his division facts, Marvin knew he could use 12, 18, 30, and 42. He was amazed when he realized that 2 and 3 could also divide all those numbers. All that practice with dividing by six had really sharpened his division skills. Marvin entered the numbers in the lock and the gate slowly swung open.

Marvin was feeling more confident as he made his way down the path. The path climbed up the side of one of hills. The next gate was wedged in between two tall cliffs and there was no way around it or over it. Marvin cautiously approached the gate and read the sign beside it. It read:

Knock on the gate to open. But you must knock exactly the correct amount. The correct amount is the greatest common factor of 24, 36 and 80.

Marvin froze as he carefully considered the problem. He remembered that the rainbow method was a really good way to work out the factors of a number because you make sure you had all the factors of a given number. Marvin carefully looked at the rainbows he made realized the common factors of those numbers were 1, 2 and 4. Marvin carefully bumped into the gate 4 times. He was amazed as the gate slowly swung open.

The trail led down a bridge over the lake. In the middle of the bridge was another gate. Marvin floated down the trail and approached the bridge. Carefully he floated onto the bridge. He did not want to fall off. Martians tended to rust when they got wet. Once again there was a sign next to the gate. It read:

To open this gate you must knock on this gate with the highest prime number between 10 and 30.

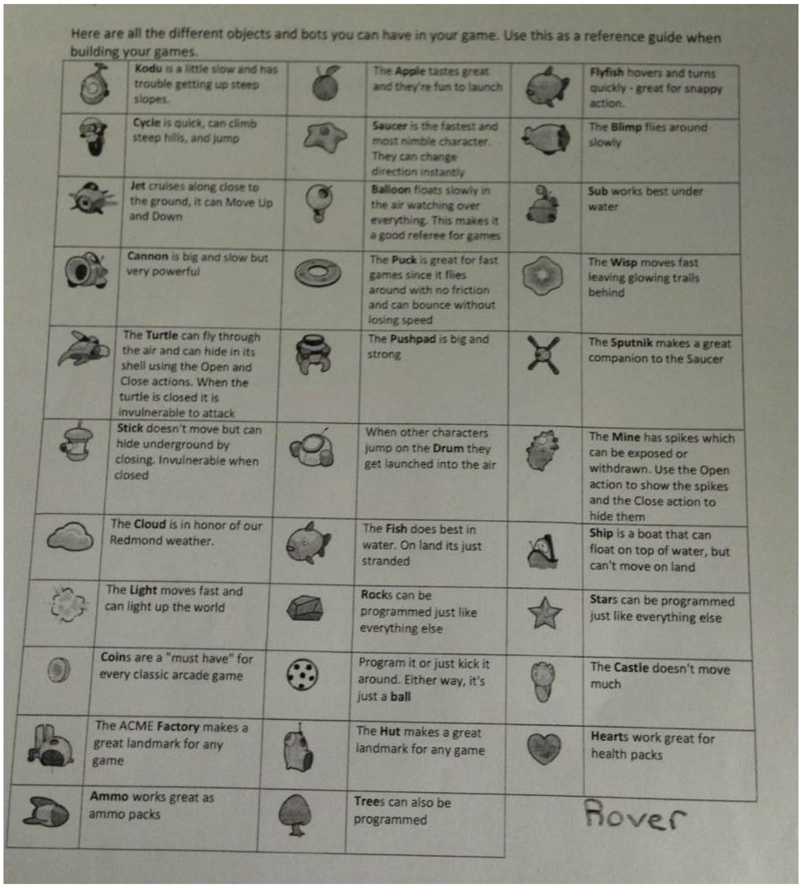
Marvin kept very still as he floated in place and thought about what he knew about prime and composite numbers. He knew composite numbers had more than two factors, and prime numbers had only two factors. As Marvin thought and thought about the numbers between 10 and 30 a new sign appeared. It was a countdown timer! It started at 1 minute and worked its way down. Marvin panicked and his mind began to blank. Before he knew it the timer was at zero.

Kaboom!

Marvin opened his eyes and saw he was back at the beginning of the trail. He began to cry. Now he knew why it was called the Trail of Tears. After crying for a while, Marvin realized that he already knew the answers to the first two gates.

After moving quickly through the first two gates Marvin paused before floating on to the bridge. He thought about the prime numbers between 10 and thirty before approaching the gate. He began to knock on it 37 times. As he was knocking the countdown timer appeared again. He just finished his 37th knock as the timer reached the last 5 seconds. The gate opened and Marvin floated through to the other side.

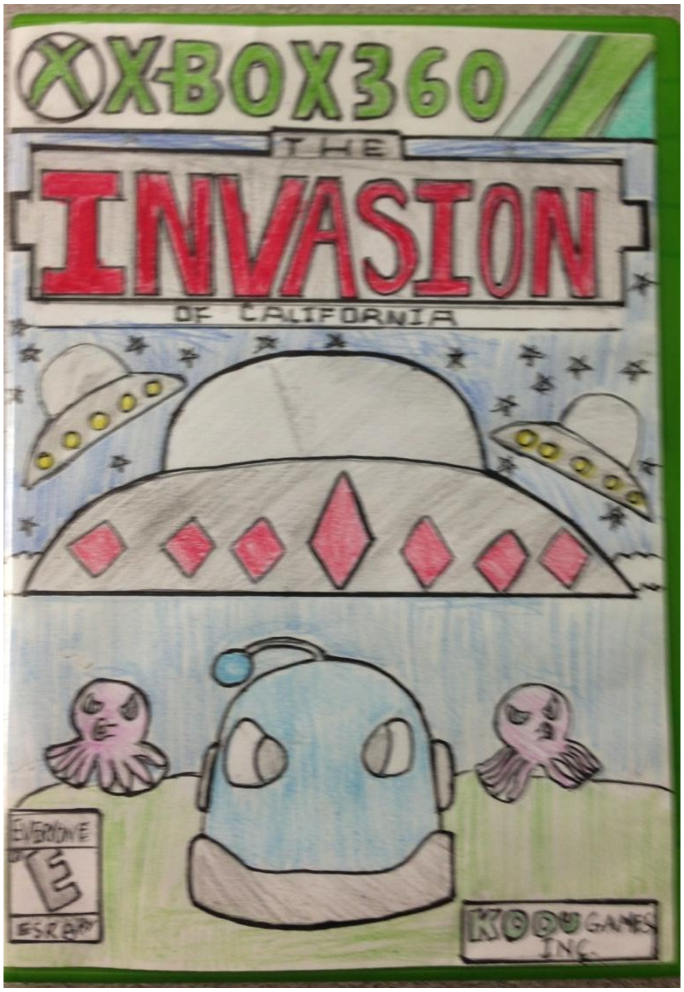
Appendix G: Students' Guide Sheet

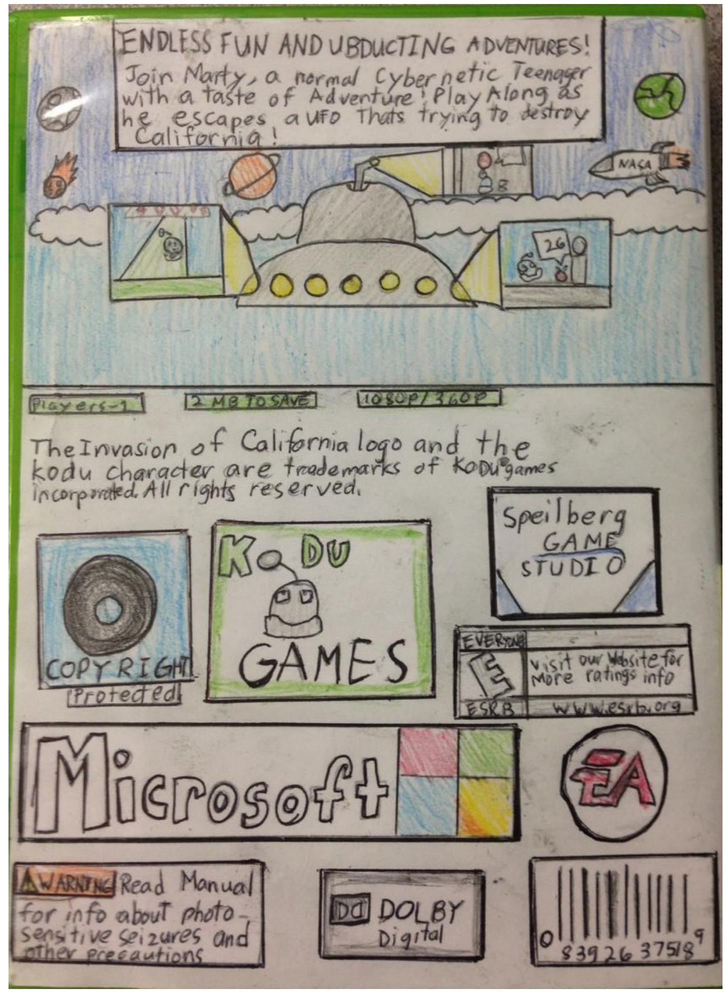


Here are all the different objects and bots you can have in your game. Use this as a reference guide when building your games.

	Kodu is a little slow and has trouble getting up steep slopes.		The **Apple** tastes great and they're fun to launch		**Flyfish** hovers and turns quickly - great for snappy action.
	Cycle is quick, can climb steep hills, and jump		**Saucer** is the fastest and most nimble character. They can change direction instantly		The **Blimp** flies around slowly
	Jet cruises along close to the ground, it can Move Up and Down		**Balloon** floats slowly in the air watching over everything. This makes it a good referee for games		**Sub** works best under water
	Cannon is big and slow but very powerful		The **Puck** is great for fast games since it flies around with no friction and can bounce without losing speed		The **Wisp** moves fast leaving glowing trails behind
	The **Turtle** can fly through the air and can hide in its shell using the Open and Close actions. When the turtle is closed it is invulnerable to attack		The **Pushpad** is big and strong		The **Sputnik** makes a great companion to the Saucer
	Stick doesn't move but can hide underground by closing. Invulnerable when closed		When other characters jump on the **Drum** they get launched into the air		The **Mine** has spikes which can be exposed or withdrawn. Use the Open action to show the spikes and the Close action to hide them
	The **Cloud** is in honor of our Redmond weather.		The **Fish** does best in water. On land its just stranded		**Ship** is a boat that can float on top of water, but can't move on land
	The **Light** moves fast and can light up the world		**Rock**s can be programmed just like everything else		**Star**s can be programmed just like everything else
	Coins are a "must have" for every classic arcade game		Program it or just kick it around. Either way, it's just a **ball**		The **Castle** doesn't move much
	The ACME **Factory** makes a great landmark for any game		The **Hut** makes a great landmark for any game		**Heart**s work great for health packs
	Ammo works great as ammo packs		**Tree**s can also be programmed		Rover

Appendix H: Student Example of Jacket Cover for Video Game





Appendix I: Curricular Guide

Using Kodu to Demonstrate Learning in Language Arts, Math, and Health:
Grade 6 Curriculum Outcomes

<u>Materials Required:</u>

Kodu Game Lab Software (free download).
Sustained computer access is a must when investigating games and programming Kodu Game. Computers with mouse input are highly desired but not absolutely necessary.
Sample stories and sample games to deconstruct and use as a model.
Rubrics that will be used for assessment should be shared with students prior to grading student work.

1.5 hours	LA: 1a, 1c, 3a, 6a, 7a, 9b, 9d, 11a, 21b, 22a	**<u>Introduction: What is Kodu?</u>** **Inspire and engage students by demonstrating program and sample finished games.** Provide students time to interact with and explore the Kodu digital environment	Observational checklist of student participation and interaction with classmates and teacher
2 weeks Approx. 1-1.5 hours per day	LA: 1a, 1b, 1c, 2a, 3a, 5a, 7a, 7b, 8a, 9a, 9b, 9c, 9d, 10a, 10b, 11a, 12a, 21a, 21b, 22a, 22b Health: 6.4, 6.9	**<u>Exploring the concept of Story in Games:</u>** **What makes a good game?** - engage student background knowledge of what makes a good game - provide students with 4 criteria of what makes a good game: a) pleasantly frustrating b) just in time information c) cycles up/level up d) well-ordered story **Review of story and story planning** - **Review and model** story writing - demonstrate how to use visual organizer/story map by deconstructing The Paper bag Princess by Robert Munsch. - story plan format: Somebody, Somewhere, Wanted, But, Then, So, Finally - model deconstruction together - review and model writing reflection writing Analyze games looking at story and if it is a "good game" as measure by established criteria - play a series of mini games (known as "Not Games") - students deconstruct the games story/action using story plan (individually or in groups) - students to individually respond to reflection questions/prompt - "Not Games" used were: Icarus Need, Sprout, 40X Escape, Muck and Brass - students worked in groups of 3-4 sharing one computer per group	Students to demonstrate understanding by writing in their own words what they think each means and provide an example for each one Model part of plan together (Somebody, Somewhere, Wanted, Finally); Students to complete rest of story plan individually Story plan deconstruction of games in small groups or partners. Written response rubric for reflection questions about each mini "Not Game" played.
1 week Approx. 1-1.5 hours per day	LA: 2a, 5a, 9b, 9c, 9d, 10c, 11a, 11b, 12a, 12b, 13a, 13b, 15a, 16a, 17a, 18a,	**<u>Game Formation: Story</u>** **Create a story that acts as a framework to build the game around. Students will incorporate concepts from math unit to use as challenges for characters to overcome.** - Reviewing and modelling story writing (elements of story such as setting, characters, plot development, sentence fluency, conventions) - Teacher created model story incorporating setting, character and action elements as well as background story for characters to be included in game play. - students use story plan to generate plan/outline for their own story - after reviewing plan with the teacher, students write their story; stories	Stories marked as writing for LA. Using PAT rubric or modified version of PAT rubric Math – problem solving – Do the student created problems in the story make sense? Is

	20a, 22a, 22b Math: M-P 1, 2, 3, 4, 5, 6 M-SLO 1, 2, 3, 4, 5, 6 Health: 6.4	used to reinforce concepts on conventions, sentence fluency, voice - Comparison between traditional story and game story – games stories do not need the same level of detail as a traditional story because games have audio and visual elements to them - modeling using teacher created model: highlight elements that would be included in a game. Leave out some descriptive elements that will be dealt with by game play - students then highlight own stories and make a list of what parts of their stories will be a part of their game (setting, characters, action/problems/challenges)	there enough information for them to be solvable? Venn diagram comparing the two (generated as a class) Student reflection on comparisons between game story and traditional story (Pick the most important 2 or 3 differences)
1-1.5 weeks Approx. 1.5-2 hours per day	LA: 4a, 5a, 6a, 7a, 7b, 12a, 12b, 13a, 13b, 14a, 15a, 16a, 17a, 18a, 19a, 20a, 21a Math: M-P 1, 2, 3, 4, 5, 6 M-SLO 1, 2, 3, 4, 5, 6 Health: 6.3, 6.4, 6.7, 6.9	**Game Creation: Programming** **Create the setting and program the action for your game using student generated story as the motivation and source of game challenges.** - review Kodu with the class. Go over how to manipulate the land, what is possible, what is not possible, investigate how programming can impact various lighting and land features - take student questions and demonstrate if what they are asking is possible or not; if possible demonstrate, if not possible show some alternatives - allow students time to do some research on Kodu research lab site and view tutorials Planning – before being permitted to go onto the computer students will create a map on paper; this is what the students will use to create their world. Specific land colors and landforms are very important here as this can have an impact on programming Once maps have been approved by the teacher students may go on the computers to create their games. Students need to create the landscape before they can begin adding game characters and programming the game action. Students had the opportunity to work in partners or on their own. After students have finished programming their games, have a game day where student work is celebrated and students are permitted to play each other's games.	Student participation: observations and checklist/participation rubric observations and checklist/participation rubric Problem solving and participation rubric Game Rubric
1-1.5 hours	LA: 1a, 1c, 3a, 6a, 9a, 9b, 10a, 16a	**Project Reflection** **Class discussion and individual reflection about the successes and challenges of the project.** - class discussion with teacher and student generated questions and discussion - individual reflection based on teacher provided prompts	Class participation rubric Written response rubric

Teaching Considerations:

Some classes will need more explicit instruction in the areas of writing reflections, story planning, and story writing than others. Teachers may want to spend more time front-loading this information depending on the specific needs and background experiences of the students in the class.

When programming try to keep students on the same computer each time. This reduces the chance of student work being incorrectly saved, lost, or incorrectly processed by the local network. Having a computer with a mouse is highly desirable. Desktop machines that are

hardwired to the network are also more desirable than wireless machines for processing speed and reliability, although both will work.
Programming options could include spending 2-3 focused days programming vs. spreading out programming over several days.

Mathematical Processes (M-P)
There are critical components that students must encounter in a mathematics program in order to achieve the goals of mathematics education and embrace lifelong learning in mathematics. Students are expected to:

1. Communicate in order to learn and express their understanding
2. Connect mathematical ideas to other concepts in mathematics, to everyday experiences and to other disciplines
3. Develop and apply new mathematical knowledge through problem solving
4. Develop mathematical reasoning
5. Select and use technologies as tools for learning and for solving problems
6. Develop visualization skills to assist in processing information, making connections and solving problems.

Math Specific Learner Outcomes (M-SLO)

1. Demonstrate an understanding of place value, including numbers that are: greater than one million
2. Demonstrate an understanding of factors and multiples by determining multiples and factors of numbers less than 100
3. Identifying prime and composite numbers
4. Solving problems using multiples and factors.
5. Demonstrate an understanding of integers, concretely, pictorially and symbolically.
6. Explain and apply the order of operations, excluding exponents, with and without technology (limited to whole numbers).
7.

Language Arts Outcomes

1. Express ideas and develop understanding

a) use prior experiences with oral, print and other media texts to choose new texts that meet learning needs and interests
b) read, write, represent and talk to explore and explain connections between prior knowledge and new information in oral, print and other media texts
c) engage in exploratory communication to share personal responses and develop own interpretations

2. Experiment with language and forms

a) experiment with a variety of forms of oral, print and other media texts to discover those best suited for exploring, organizing and sharing ideas, information and experiences

3. Express preferences

a) assess a variety of oral, print and other media texts, and discuss preferences for particular forms

4. Consider others' ideas

a) select from others' ideas and observations to expand personal understanding

5. Combine ideas

a) use talk, notes, personal writing and representing, together with texts and the ideas of others, to clarify and shape understanding

6. Extend understanding

a) evaluate the usefulness of new ideas, techniques and texts in terms of present understanding

7. Use prior knowledge

a) combine personal experiences and the knowledge and skills gained through previous experiences with oral, print and other media texts to understand new ideas and information
b) apply knowledge of organizational structures of oral, print and other media texts to assist with constructing and confirming meaning

8. Use comprehension strategies

a) identify, and explain in own words, the interrelationship of the main ideas and supporting details

9. Experience various text

a) explain own point of view about oral, print and other media texts
b) make connections between own life and characters and ideas in oral, print and other media texts
c) discuss common topics or themes in a variety of oral, print and other media texts
d) discuss the author' s, illustrator' s, storyteller's or filmmaker's intention or purpose

10. Construct meaning from texts

a) make judgements and inferences related to events, characters, setting and main ideas of oral, print and other media texts
b) comment on the credibility of characters and events in oral, print and other media texts, using evidence from personal experiences and the text
c) discuss how detail is used to enhance character, setting, action and mood in oral, print and other media texts

11. Understand forms and genres

a) identify key characteristics of a variety of forms or genres of oral, print and other media texts
b) discuss the differences between print and other media versions of the same text

12. Structure texts

a) determine purpose and audience needs to choose forms, and organize ideas and details in oral, print and other media texts
b) express the same ideas in different forms and genres; compare and explain the effectiveness of each for audience and purpose

13. Appraise own and others' work

a) work collaboratively to revise and enhance oral, print and other media texts
b) ask for and evaluate the usefulness of feedback and assistance from peers

14. Enhance legibility

a) experiment with a variety of software design elements, such as spacing, graphics, titles and headings, and font sizes and styles, to enhance the presentation of texts

15. Enhance artistry

a) experiment with several options, such as sentence structures, figurative language and multimedia effects, to choose the most appropriate way of communicating ideas or information

16. Attend to spelling

a) edit for and correct commonly misspelled words in own writing, using spelling generalizations and the meaning and function of words in context

17. Present information

a) use various styles and forms of presentations, depending on content, audience and purpose

18. Enhance presentation

a) emphasize key ideas and information to enhance audience understanding and enjoyment

19. Celebrate accomplishments and events

a) use appropriate language to participate in public events, occasions or traditions

20. Use language to show respect

a) demonstrate respect by choosing appropriate language and tone in oral, print and other media texts

21. Cooperate with others

a) assume a variety of roles, and share responsibilities as a group member
b) identify and participate in situations and projects in which group work enhances learning and results

22. Work in groups

a) contribute to group knowledge of topics to identify and focus information needs, sources and purposes for research or investigations
b) address specific problems in a group by specifying goals, devising alternative solutions and choosing the best alternative

Health

Relationship Choices

6.3 Develop personal strategies for dealing with stress
6.4 Identify, analyze and develop strategies to overcome barriers to communication
6.7 Apply a variety of strategies for resolving conflict
6.9 Make decisions cooperatively

Appendix J: Students' Initial Stories and Game Stories

<table>
<tr><td colspan="2">Grade Six</td></tr>
<tr><td>Initial Story Idea</td><td>Game Story</td></tr>
<tr><td colspan="2">Stella
Story changed completely, from the main character to the setting of the story. Stella made significant changes when she replayed Kodu at home and reworked both her story and her partner's story to construct a video game.</td></tr>
<tr><td>So my story so it is about Claire - Claire Delamoon and some Sun Delasun. So the whole idea of it is clear -it is a nice one peaceful calm and then the sun is like the crazy one, the evil one and the one that does all that stuff. So there's like two worlds and there's a path in the middle. And it's the mysterious mountain mesmerizing Math problems. So in order to get to the other one because there's Mooresville and Sun City and so in order to get to the other one, you have to cross this Math path. So Sun is trying to invade Boonville and then here's what here's. What's going on, so than the game will start out - it's at the beginning of the past and then you have to get to the path?</td><td>Hello, Dean. Welcome to the mysterious, magical path of Math problems. The princess has set up this path to keep you from taking her. At the end of this pass is the Crazy Castle where the princess lives. Your goal is to kidnap the princess by correctly answering each math problem in order to reach the end. For every right answer, you get a point, but if you get a question wrong, you lose a point.
In order to get the questions, bump into me every time you see me at each path. Use the arrows to move and click when you want to exit a speech.
Your first questions is, what are the first three common multiples of two, three and six?</td></tr>
<tr><td colspan="2">Aiden
Aiden's story remained relatively consistent in both written and game design. Aiden's game had undertones of Civilization, a game he often plays.</td></tr>
<tr><td>My video game's about this blue, it's going to be a blue Kodu but it's blue, it's a blue guy named Harrison, who is very clumsy. And he is a senator part of the Cool Empire, which has taken over their entire galaxy. So and then the whole senate gets together to try to make, tell people or General Quad, the big king in charge, what's wrong on their planet. And then for Harrison, there's like this disease spreading on his planet. So he has to get the money to</td><td>Your name is Harrison and you're the senator of this planet and this city. You are trying to cure a disease. Go meet General Claude in the yellow house.
Hello Harrison. Go find some apples and we'll decide if we want to cure you to give you the money.</td></tr>
</table>

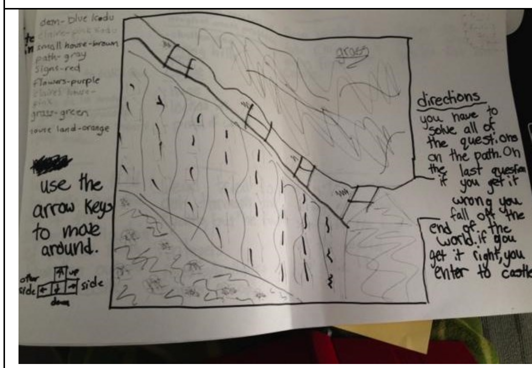
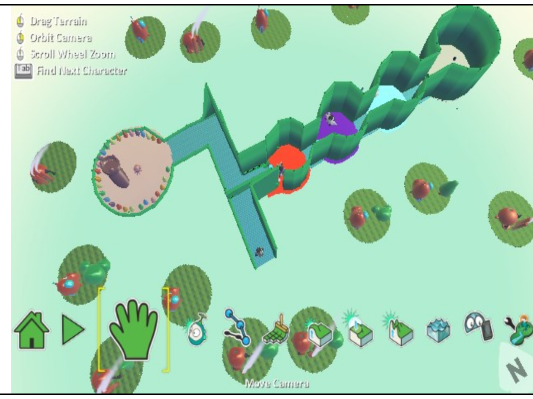
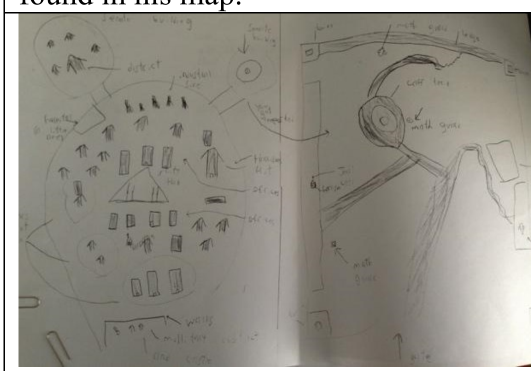
<table>
<tr><td>build hospitals there and try to find out a cure.</td><td></td></tr>
<tr><td colspan="2">John
John’s video game is relatively similar to his original story idea. The Rover Genie is absent from his video game, due to the complexities John faced in building his game. His overall pathway exploration remained consistent, where Freddie had to answer questions in order to prove his ability.</td></tr>
<tr><td>There’s this boy, Freddie that always brags in school, he’s so smart in math and everything, well it’s a robot. And his friends think oh you’re so smart. [But he’s in this hard world full of Math] and it’s across this bridge to this whole new world. And he’s like oh yeah I’ll make it out in now cause I’m so smart. But when he enters it, he’s lost, he’s scared, and he has no clue what to do. Then he meets – it was all abandoned houses and factories until he meets this rover named Genie. He’s a genius. He’s the guy that helps Freddie if he’s stuck on Math, he can ask one question to the genie and so he starts this – all these questions, it’s like a multiple choice task. You go wrong one way, it brings you back to the start, you go the other way, it’s the right and you keep going. And if you don’t get it right you have to go back to the start.</td><td>Welcome to Robotopolis. All the other kids that live on Robotopolis all will make fun you for not being good at Math. Can you prove them wrong? If you think so, go across the bridge on the left to start the math journey. If you get all the questions right, the other kids will never make fun of you again. The object of the game: The object of the game is to get all the questions right. After each question, if you get it right, you will get a coin.</td></tr>
<tr><td colspan="2">Clara
The initial game story was more complex and detailed than the video game. Clara had to take certain details out of the game because they weren't working. The overall story is apparent in her video game, whereas Tilly just blew up the town hall and now must prove herself in the Land of Forgotten Terror in order to return to Marineoplois.</td></tr>
<tr><td>It takes place in this ocean underwater city called [Marineopolis] and there's this king called King Octo and he lives in this giant castle. And one day his guards brought to him this turtle named Tilly and she always gets into trouble and she does little mischief and stuff, but the last thing she did was a very bad thing, cause she blew up the town hall which has all the records in it of</td><td>Land of Forgotten Terror. So you just blew up the town hall and now you must suffer by answering three questions in order to get back to Marineopolis. The King Octo has just sent you here. Use a WASD to move, the spacebar to jump.</td></tr>
</table>

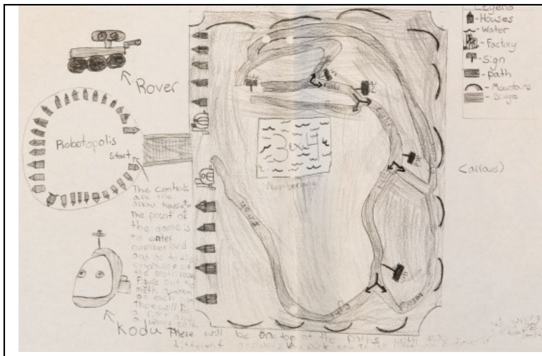
like the history and stuff which they all burned all the papers, set the fire, so all that history was gone. So she was sent to the opposite of their word, which is like this lava filled [terrain] and in order to like go back to Marineopolis, she would have to answer three questions. And there would be rocks and they would have two answers, one is right and one is wrong. If you go on the right one the rock will stay and if you go on the wrong one it will fall into the lava and so there would be like little lava fish that would tell her the questions and she would answer them. And when she gets to the last question and she finishes it, but there is this giant … This larger lava fish and it tells her that there is now four questions and it's like a very complex one that took Tilly a long while, but when she finally defeats the [Math fish], he'll blow up into sparks and she can return to her home.	
Beth The initial story idea and final video game are similar, including the underwater setting and the overall purpose of the main character to answer the Math questions and locate the treasure. The treasure map is absent from the video game and the underlying story that Calvin is someone that brags to others.	
So there's a fish, a catfish. And he always brags to everyone that he wants everything and he's so good. And then he found this treasure map and he was determined to find a treasure box. So he went to the Coral Canyon and he has to get through all these Math obstacles to get the treasure.	Coral Canons. Guide Calvin through each questions the clams give you to get the treasure at the end. Bump into the clam that says the answer. If you bump into the wrong clam you'll lose a point. If you bump into the right clam you will score a point. By the time you reach the end you will need three points or the game is over. What factors of 64 are composite numbers? Blue clam is 16, 4, 64, 8, 32. Purple clam is 64, 32, 16, 6, 4, 8. Green clam is 8, 32, 2 and 16.
Robert The backstory that Robert created in his initial story is absent from his video game. Robert does not mention that Michelangelo is a scientist and that he is in jail because his lab blew up. Also, Robert does not mention his robot dog in the video game.	
There is a guy, he's a scientist and his lab	You have to help Michelangelo solve all

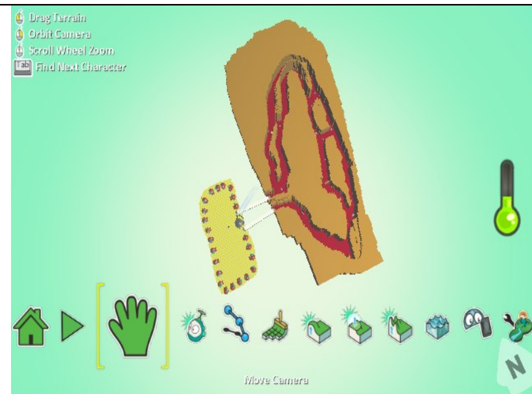
blows up and his robot dog was in there. And he has to try to fix his dog but he gets sent to jail and the only way he can fix his dog is by solving these Math questions to get out and fix his dog at the same time like part by part.	three questions to get out of this world. If you fail the question, the world will restart, the red saucer will say the question and the other will say the answer once. You have the choice to step on like any of like the coloured lines that it says and then whatever you think the answer is, remember you will have to use the arrow keys to move, you also have to follow the orange path and whatever colour the saucer is, the first letter of the colour for example if the saucer is blue, you press the B key for the question/answer.
Samantha The backstory is missing from Samantha's video game about the 12-year-old boy wanting to cross a bridge to get to the nice side of the island. Samantha simply focused the game around correctly answering questions in order to cross the bridge.	
My story is about a 12-year-old boy and he is on the big Island and he is staying on the side of the island because there are two houses. And he is staying on that side of the island, where the beaches are kind of polluted. There are no industries there. And so you're not allowed swimming on one half, but on the other side it's really nice. It's a really nice beach. So he is staying on the not so nice half. So this one day, he goes to go to the other side of the island and you have to take a like a taxi. And then you end up at this one bridge and there are these three bridges. And there's this troll and he asks you these questions. Finish the Math question or the MapQuest and then you have to get into another van to go to the next bridge.	Hi there *Kodu*! To cross the bridge you have to answer three questions. Bump into the trees and bridges and they will give you the questions. Good Luck! Question 1 … 24 divided by 2 + 19. Bump into the right answer.
Grade Four	
Game Story	
Meghan	

You are Bob or Lily and you traveled to collect Parkland region to collect coins. True or false questions will be asked. Each right answer is worth one coin. Once you reach four coins, you win. Good luck. The green, which would be mostly the star would equal true and then the red would be mostly the heart would equal false. And then you use arrow keys to move. Anything that is standing on the pink path is an object that asks you questions.
Ellen
Rocky Mountain Region. You are a Rocky and you must get 8 points because you have to get to the plane in one hour. You have to answer the questions after you bump into different things that block your way. When you get the point you will pass and if you don't get the point you will go back to the start.
Caleb
You are Fluffy and you are going to the Boreal Forest to get to the Canadian Shield but a cycle blocked his path. Answer all the questions correctly and get to the end without being eaten by a hungry cycle to win. Remember each question takes five seconds to pop up so be quick. The Boreal Forest over one million evergreen trees. True or False? Blue apple for True or bounce the soccer ball for the opposite.
Colin
You are Elmo and you must get each question correct. You are in the Canadian Shield Region. To win this game, I put, you must get five points, which means you have to get every single question right. To move Elmo, you must use the arrow keys.

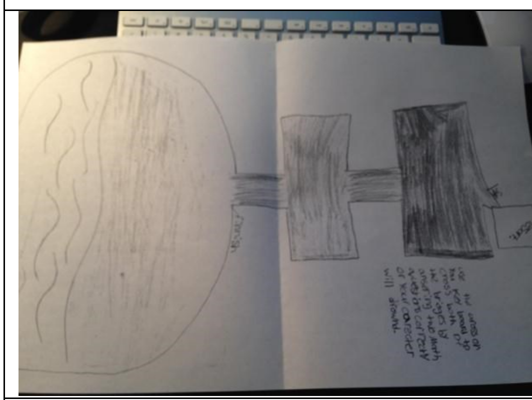
Appendix K: Students' Initial Maps and Final Game Views

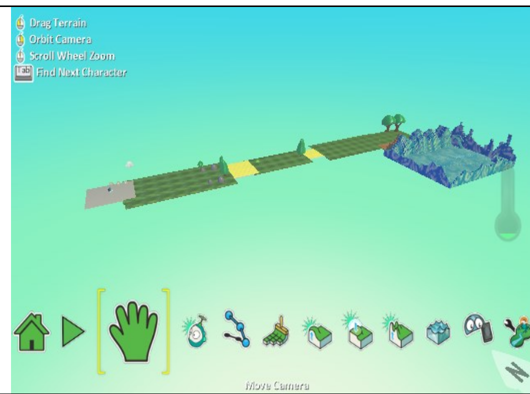
<table>
<tr><th>Intial Map</th><th>Final Game View</th></tr>
<tr><td colspan="2">Stella
Significant differences between the original version and the final game view. Much like her story, she made dramatic changes, as she found it more aesthetically pleasing to have the round circles in her game and that it made it more exciting to play.</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td colspan="2">Aiden
Game looks relatively consistent with the map, however with considerably less detail in the final game version. Aiden wanted to construct multiple levels in his game, but due to time constraints he crafted the one level that is consistent with the details found in his map.</td></tr>
<tr><td></td><td>
</td></tr>
<tr><td colspan="2">John
John's initial map and video game are relatively consistent. John crafted a beginning space, Robotopolis for Kodu to explore, which then led to the Math questions. Once the questions were answered correctly, players would return to Robotopolis.</td></tr>
</table>



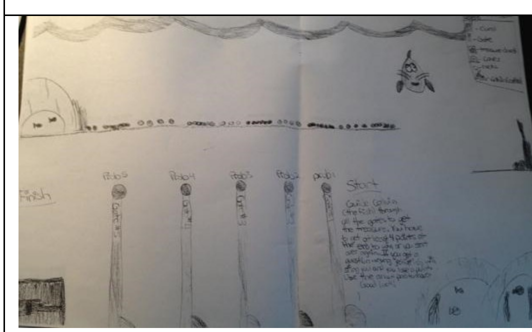


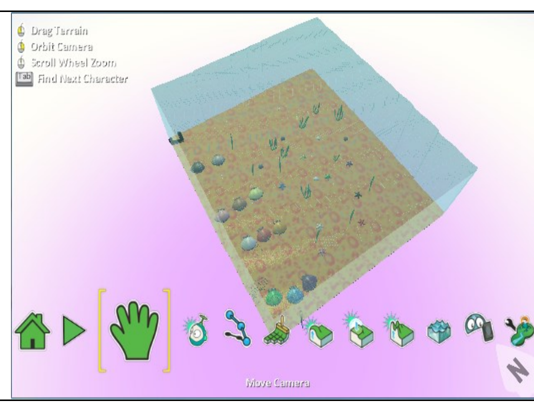
Samantha
Samantha's map view and video game are relatively consistent. The maps are simply flipped with the beginning space on the map located on the right hand side, and the beginning space in the game located on the left hand, grey area. She has created quadrants in both maps, and used yellow land in her game to distinguish the areas.





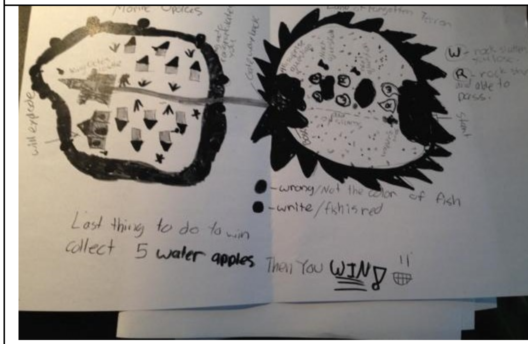
Beth
Beth maintained the underwater setting in both her map and in her game. In the map she indicated her Math problems through gates, which is also similar in her game, as she has used the clams to create these problems. Both the map and the game are similar.

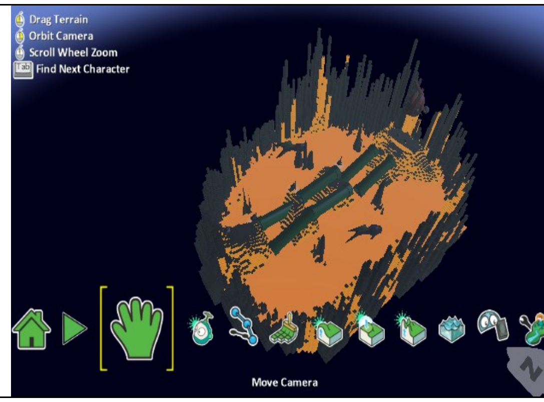




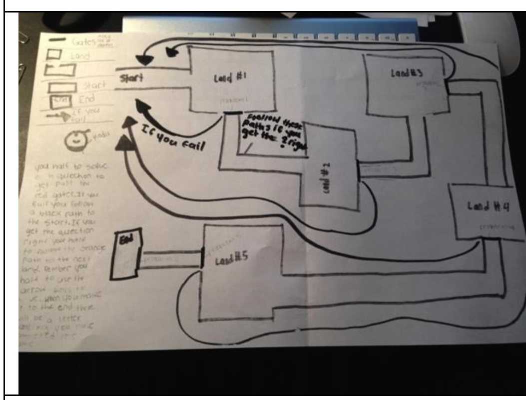
Clara
In her map Clara created two worlds, however due to an array of issues she was only able to create the Land of Forgotten Terror. The visual found on the right hand side of

the map has a similar theme as the video game.

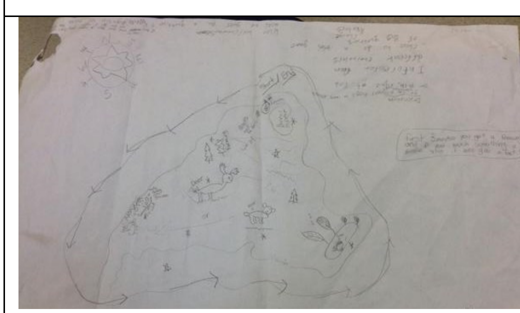




Robert
Robert was able to create a game that was very similar to his initial map. Although his game does not have as many complex paths as indicated in his map, he was able to use different colour paths to provide points, or take away points. These different colour paths are connected to the blue land.

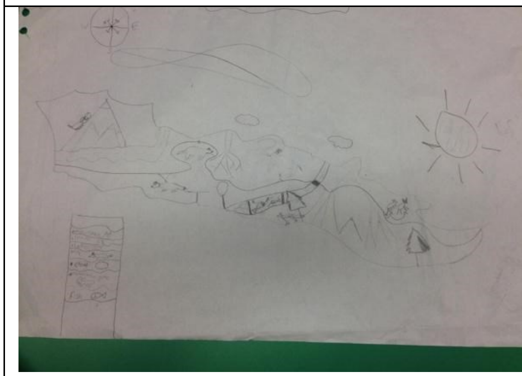


Meghan
The overall shape found in Meghan's video game is similar, but not exact to the design created in the map. The pathway she indicated in her map is similar, as she wanted to have Bob and Lily follow the path to learn more about the Parkland region.



Ellen
The long shape designed in Ellen's map is similar to the shape found in her game.

She used the mountains to section off the different areas in her game.



Caleb
The land that is located on the right hand side of the video game resembles the shape of the map. The land found on the left hand side represents the Canadian Shield. The pathway was not used in the game, as Caleb wanted the game to be an open exploration.

Colin
Colin created different regions in his game, where each region would represent a level. The overall shape found in Colin's map is almost exactly the same as what is found in Colin's game.