Qualitative Study on Coding and Robotics in a Sixth Grade Computer Class

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Chapter 1: Introduction

Background

Grasping worldwide attention in today's global education system is a fusion between coding and robotics in education to drive our 21st-century learners further into the global technological world. In the last few years, and gaining speed and momentum as becoming a core part of a school's curriculum is computer coding and robots (Francis & Davis, 2018). In today's vision in education, the process of writing has taken on a new structure for students to become "better thinkers" by combining robots and coding in the classroom activities (Resnick & Robinson, 2017, p. 48). Resonating on this interesting aligning Cuban (1986) states: "…instruct students in programming, to use the computer as a problem-solving tool, to learn procedural reasoning, and to encourage students to learn new content and skills" (p. 81). Many decades ago, experts realized the value and power of coding, but not until recently has the coding revolution making headway back into the education system (Bers, 2012).

The revitalized energy in the education restructuring stretching across the science, technology, engineering, and mathematics (STEM) fields, with a focus on robotic education combining with the power of coding are fundamental keys to unlocking the unlimited potential with engaging hands-on activities to deliver innovation and different thinking (Alimisis, 2013).

Statement of the Problem

The purpose of this study is to explore the experiences and interactions of students when combining the power of coding within a robotic unit. As a learning tool, robots essentially engage students in activities which use simple block-based coding to perform simple to more complex tasks (Barker, Nugent, Grandgenett, & Adamchuk, 2102). This research study can serve as a necessary inference in the world of education through a cohesive bonding of two technologies which derive meaning from computational fluency and matches to a physical robot unit. Learning and understanding from the students' point of view their flow of ideas, from conception to result, can improve and customize the curriculum activities.

Need and Value

Critical exploration, computational fluency, experiences and interactions with objects by children encompass the ideology of what Piaget and Papert refer to as "constructivism" (Barker, Nugent, Grandgenett, & Adamchuk, 2012). Constructivism theory revolves around children and their interactions with their surroundings, whereas Piaget (1954) states that children who are involved in hands-on activities or manipulating artifacts contribute to explorations which spark the constructive process. The "builder" in a child stems from "Piagetian Learning" which describes children as doing without being taught, the natural process of curiosity and exploring without boundaries or limitations (Papert, 1993). The thought behind constructivism was reconstructed and renamed to constructionism by Papert as to state that the "importance of constructions of the world, most specifically on the computer screen" aligning to the methods of construction of ideas and thoughts to create the knowledge which is part of everyone's brain (Bers, 2012, 14). Creates various opportunities for children to develop their ideas and projects, substantiating the validity of constructionism, computers are power tools combined with other peripherals, such as robots, to provide robust and playful opportunities to foster the designing and constructing ideas.

Coding and robotics fields connections are natural. Whereas children are eager to make a robot to do something, but for the robot to do something, the robot has to be instructed on what to do or coded with simple or complex instructions, depending on the platform. From Logo to Scratch, supported by programming and coding, this intriguing environment offers children chances to further their creativity with digital elements called "blocks" each representing code or transcript to perform a certain task. Accordingly, Papert (1993) concluded once children are involved in this activity, there is an increase in the engagement which lends itself to complex and multifaceted outcomes reflecting their thought process and solutions. This process authenticates the finding from Bers (2012) children become “creators of interactive content, as opposed to consumers of information” (p.15). From simple coding of the Logo Turtle to complex adventures in Scratch; to a drop ‘n drag block coding process to the more complex strings of code, children absorb the action of learning by doing, playing, investigating and uncovering their own thought processes with various applications and platforms which are regarded as computational thinking and problem solving (Papert, 1993).

According to Ber (2012), Positive Youth development (PTD) and constructionism contribute to higher level thinking including learning by doing, one of the best practices for multi-intelligence which crisscrosses into other cognitive skills. Content creation and creativity (two of the four C’s) fall in line with constructionism according to Bers (2012). The C’s are essential areas which PTD framework links, develop, and stretches the human mind. In today’s educational platform the application and expansion to utilize such a powerful tool of the computer as a backbone triggers and nurtures the human cognitive skills to allow for the free flow of new ideas and visions through the process of creating and connecting value between agents of technology such as robotics education through coding and programming. As Cuban (1986) states “learning is largely opportunistic, spontaneous, and unpredictable" (p. 91). The opportunity, spontaneity, and unpredictability in absorbing critical 21st Century skills are evident within the limitless framework if coding and robotics are available in today’s classroom for children to investigate and creative the unknown. The need for today's education system is to integrate coding and robotics into the classroom and provide students with the opportunity to interact in a direction which the youth of today are familiar.

Research Questions

The purpose of this study is to explore the experiences of students when combining the power of coding with robotics in a sixth-grade classroom in a suburban town in Central New Jersey. The essential research questions for this qualitative study is:

1. How do sixth grade students interact with a robot while coding in computer class?
    a. How do sixth grade students describe their experiences when coding a robot in a computer class?
    b. What are the sixth-grade students’ perceptions of coding a robot?

Chapter 2:

Literature Review Outline

Reviewing the literature for this qualitative study, robotics curriculum and coding are the drive forces in the STEM initiatives within today's future-driven classroom. A vast majority of the literature overlaps coding and robotics and the learning methodologies based in constructivism and constructionism, PTD, active learning, creativity, hands-on learning, and problem-solving including motivation and cognitive skills. Referenced in the literature, Papert, Piaget, Resnick, and Bers concurring that students learn best by constructing and doing; not by sitting at a desk in rows and being spoken to. This plays right into back into robotics and placing emphasis in curriculum and activities that are student-driven.

According to Kazez & Genc (2016) "between 1991 and 2014 there were 45 master's theses and doctoral dissertations published mention Lego, robotics and first Lego League", as focal points within the study (para. 1) with coding and programming referenced further in the study. The overwhelming majority of the research design studies were quantitative featuring surveys, followed by qualitative and then mixed methods (Kazez & Genc, 2016). Concepts and skills referenced as a critical part of the studies were: "(a) computational skills; (b) constructivism; (c) problem-solving; and (d) critical thinking (Kazez & Genc, 2016, para. 2). Within the education system, noted many years ago was the importance of balancing a mindset which caters to the use of physical hands-on skills that just now are a topic of discussion in many districts, the 21st century skills mindset in education. The robotics program was and still is LEGO robotics (Kazez & Genc, 2016).

Creative chaos, excitement, non-traditional learning, encouraging new ideas and "active participants in a learning community" are stirred up when children are actively involved in coding a robot (Barker, Nugent, Grandgenett, & Adamchuk, 2012).

The partnership of coding, robots, and the curiosity of children creates interesting and unique different connections and fuels the appetite for more knowledge. Robots and coding produce creative chaos and excitement into any level classroom and emerges as the key components in any field of study. The initiative behind coding allows for diversification of programming from a very young age to the life-long learner. According to ISTE (International Society for Technology in Education) (2018) coding has many applications including robotics and creates "natural extension" to 21st-century skill focal points in computational thinking, creativity, and innovative designer.

Chapter 3: Methodology

Research Design

A qualitative research study warrants the exploration of the coding and robotic experiences of participants in a computer classroom. According to Creswell (2015), a qualitative research study permits "in-depth exploration" about the main phenomenon (p. 204). With an exploratory study, the researcher will focus on a "purposeful sampling" which is essential when a researcher wants to study a specific phenomenon or experience (Creswell, 2015). Using a purposeful sampling method, the researcher will obtain an understanding of the factors which influence the engagement of students within the specific coding and robotic activities. In a qualitative study, the central phenomenon is developed using particular instruments such as observations, in-depth interviews, and questionnaires (Patton, 2015; Creswell 2015). A qualitative study features an exploration of fieldwork observations and interviews, in contrast, the quantitative research design focuses on surveys which utilize numbers, statistics, and measurements within a relationship between two variables and tests out theories (Creswell 2015).

The researcher of this study is not creating or testing out theories, instead collects data and observes the patterns from the coded data to help explore and possibly challenge the concept. Also, Nastasi (n.d.) argues that a quantitative approach will not be suitable because of the quantitative description of the design which includes a goal as “empirical generalization to many” (para. 2). With a qualitative goal targeting a specific group of people concludes with a goal of “in-depth understanding” (Nastasi, n.d., para. 3). Mixed method approach requires quantitative part in which data collected in two phases which would not be feasible for this study, concluding that the method which best suits this research study is the qualitative approach.

This study is designed as a qualitative research study using the exploratory method. This method will explore the practices and understandings of students when combining the power of coding with robotics in a sixth-grade computer classroom. As Creswell (2015) explains the qualitative method reasoning for the researcher to “…explore and understand one single phenomenon” (p. 128). The focus is on a process of gathering of data by observing participants in their natural setting to determine the characteristics of students when engaged in coding of the robots in the classroom.

Population, Sample, and Sampling

For this research study, the population is a heterogeneous sixth-grade computer class with a population of 24 students, eleven females and 13 males. The participants will be observed during their regularly scheduled computer class. With access to the computers, iPads, robots, and other peripherals, the landscape of a computer lab class is the balanced and efficient place to implement this specific kind of research study. The typical age range of sixth-grade students is eleven to twelve years old. This age group, according to GCISD - Curriculum Guides and Developmental Characteristics (2002) relates the finding things out, hands-on activities, idealist, and problem-solving which are all attributes which substantiate the selection of this age group. Both Creswell (2015) and Patton (2015) state that purposeful sampling is necessary when a researcher wants to study a certain phenomenon or experience. Patton (2015) reiterates this type of sampling utilizes inquiry approach to enhance the gathering of rich and valuable data for the study. Using a purposeful sampling method, the researcher will obtain an understanding of the student experiences within the specific coding and robotic activity. The idea behind a purposeful sampling method is the small number of participants meet a specific criterion provides a rich and in-depth data for the study's phenomenon (Patton, 2012). This research study will last for six months of the school year. The computer class has a specific time allotment of 30 minutes and meets once a week on a Tuesday.

According to Patton (2012) "Qualitative inquiry collects data from in-depth interview, focus groups, open-ended questions on surveys, posting on social media, direct observations in the field and analysis of documents" (p. 255). Observational checklist, memo writing, and note-taking by the researcher during the observations carries a huge impact within the qualitative research study. Making notes, keeping a record of the student attitudes, conversations, questions, the process of coding the robot, and the act of carrying out the program are vital data. Interviews with open-ended questions. In regard to the sample size, Mason (2010) concludes qualitative studies are based on the understanding or meaning of the topic not hypothesis, so less data collected is sufficient and that saturation has been established within the collection of data. Along with Mason (2010), Creswell (2015) points out that sample size for this type of study is in the range of five to 25, and in this case the class size is 24. There will be six interviews included in this study, which falls in the average range according to Creswell (2015) and Mason (2010).

This is a purposeful sampling study allowing for intentional selection of students who have practiced the key concept being explored in this study (Creswell & Plano Clark, 2018; Patton 2015).

Researcher's Position

The researcher's position in this study will be to observe and collect data during regularly scheduled computer class times. One limitation is the researcher as the prime receiver of the data from the observations, the researcher has to be extremely careful not to prejudice or bias the collected data (Creswell, 2015). Other limitations with this research study are the data collection takes place in a regular computer classroom setting, and the precise equality is very unlikely within this specific context. Another limitation is the inexperience with the essential functions of the robot, communication access, and iPads which can limit some of the activities and skew the data in the classroom. The instructor's familiarity or unfamiliarity with the lesson structure and content can affect the participants' outcome(s). Additional limitations are the time allotment for activity and participant attendance (Patton, 2015).

Procedures

The researcher will have to obtain permission for all parties involved including parent(s) or guardian(s)of the participants, district administration, classroom teacher, principal, and board of education, and then submit an IRB and wait for approval. Participants notified about the procedures in the classroom such as video and audio taping, photography, observer, and interviews. Also discussed will be the option to "opt out" of the study. Once approved and secured, the review will begin.

Triangulation and validity are essential elements to consider in the collection and analysis of data. In this research study, triangulation addressed in various selections of data collection. With Fieldwork and observations being documented not only in notetaking and visual perceptions, but the sessions will also be audio and videotaped for cross-referencing of the evidence. Patton (2015) notes that each type of data collection has strengths and weakness, in which utilizing a combination of all collection methods provides cross checks, in which the "triangulation… increases validity as the strengths of one approach can compensate for the weaknesses of another approach" (p. 390).

Potential Instruments, Data Collection and Coding. For this study, the possible instruments are observations with fieldwork and interviews. According to Patton (2015) fieldwork is a significant and comprehensive area of critical data collection which participants observed in the natural setting. Observations are essential to the research process. A checklist used for notetaking during the observations (see Appendix A). Participant activities, collaboration, and engagement yield significant evidence of the interactions of the participants, as part of this study, is vital in the overall outcome(s). Observations and notetaking are important data collection instruments to validate the findings in coding (computational thinking), decoding as per what complications, solutions, resolutions, etc. the students experienced during the activities. Rich in details, the observations and fieldnotes captive the natural behaviors of the students when engaged with the coding process and then applying to the robot. The reactions are important collected data through the final output of the robot, success or redo. The researcher will observe students engaging in coding and applying that code to the robot, and in turn, the robot will follow the code to perform a particular task. "Fieldwork descriptions of activities, behaviors, actions, conversations, interpersonal interactions, organizations or community process….data consist of field notes: rich, detailed descriptions… (Patton, 2015, p. 14). As additional evidence, video and audio taping of the activities during the observations will help to assign the code(s) to the collected data. The classroom structure set up will be conducive to group work.

The second method of collecting data, after the observations completed are the interviews. The interviews will be conducted individually and will last approximately 30 minutes with a recommended five to ten questions is an optimal number for the interview (Creswell, 2018). Six participants from the first grouping will be selected to participate in the individual interview (see Appendix C). The interview will be video, and audio taped for transcription and additional confirming collected evidence.

A few potential risks involved in this study are: (a) time allotment; (b) researcher bias; (c) excessive absenteeism which would skew the sample size and collected data; (d) hardware and software issues; (e) lack of knowledge by teacher in this area to troubleshoot issues; (f) unfamiliarity of the equipment by participants; (g) delayed IRB approval; (h) opt-out during the study by participants; and (i) research unfamiliar with classroom culture.

Proposed Timeline.

Task	Timeframe
• Research, literature reviews of articles, studies, and dissertations • Dissertation proposal • Prepare with evidence and documentation the IRB application for approval by NJCU Board	Now-May 2019
• Notify the appropriate administration of the potential study---make sure have evidence and backup documents to explain the purpose • Notify parents of potential participants for approval	May-June 2019
• Present to the District Board for approval to conduct study • Make sure all permissions are in place (NJCU IRB & Board) • Make sure have all parenteral permissions	July 2019
• Continue preparing for observations, site and classroom visit	August 2019
• Organize and proceed with site visits	September-October 2019

• Collection of all data; code and analyze themes	Late October 2019-January 2020
• Present and defend dissertation at NJCU	March 2020

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Appendix A
Observational Class Checklist

Homeroom #: _______ **Date: _________________**

# of Participants: ______ **Class Time--Start: _________ End: _______**

Objective of the Day: ____

Reflection on Class: ____

- [ ] All students in attendance
- [ ] All students stay for the entire period
- [ ] Students worked independently or as a group
- [ ] Disruptions such as drills, announcements
- [ ] Understanding of the mission (direction of robot)
- [ ] Fully engaged or off track, not focused
- [ ] Classroom lends itself for the activities (equipment, room/space to run the program with interference from other robots)
- [ ] Problems with equipment, connectivity, coding, if so, how was it handled
- [ ] Teacher's role, active, passive, authoritative, facilitator vs. dictator
- [ ] Smiles on faces, interactive and collaboration with everyone, not only group
- [ ] Open to change
- [ ] Activity of coding and running the robot, success or struggling
- [ ] Project finished or give up

Appendix B
Observational Theme Codes

Theme	**Code**
Engagement	ENG
Coding Use	CDU
Robot Use	RU
Equipment Problems	EQUIPP
Problem Solving	PS
Disruptions	DS
Teacher's Role	TR
Classroom Environment	CE
Technological Issues	TECHI
Student Collaboration	CB

Appendix C
Interview Questions

1. How do you feel about coding?
2. How do you feel about using robots?
3. How do you feel about coding a robot in class?
4. What are your thoughts about creativity?
5. What do you think about coding a robot to perform specific tasks?
6. How do you feel when your robot was coded correctly to successfully perform the assigned task?
7. How do you feel when your robot was coded incorrectly and did not successfully perform the assigned task?
8. What are your thoughts about using coding and robots as part of class?
9. What are your thoughts about having fun with coding and robots?