Evaluation of a Professional Development Workshop on Integration of Robotics into Early Childhood Classrooms

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Abstract

According to the previous research, the lack of knowledge about technology and developmentally appropriate pedagogical approaches to bring it to the classrooms, in addition to the low level of sense of self-efficacy, and positive attitude towards teaching with technology, are among the major impediments to the successful integration of new technologies into early childhood classrooms. The focus of this research as part of a three year long NSF funded project, “Ready for Robotics”, is to seek strategies to be used towards resolving the problem stated above. The current thesis reports a study in which 32 early childhood educators participated in a professional development workshop on the integration of robotics as an educational intervention into their traditional classrooms. Results show a statistically significant increase in the level of knowledge in all the three areas of technology in general, pedagogy, and robotics content, along with non-numerical positive effects of the workshop.

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CHAPTER 1. Introduction and Literature Review

1.1 Introduction

Once upon a time, there was an ongoing debate over the benefit of introducing technology to the children at a younger age. Studies were tailored towards the investigation of the appropriateness of different types of technologies from developmental perspectives. Scientists like Papert needed reasoning if they wanted to convince others about the advantages of entering technology into the children's lives. According to Papert (1980), *"Technology can change the way children think, what they learn, and how they interact with peers and adults. It can also "teach the same old stuff in a thinly disguised version of the same old way"*. Today however, as technology is becoming part of the "*same old stuff*" itself, a disguise seems necessary to help students "*learn technology and produce it*" as opposed to solely "*consume*" it. Children from a very young age are surrounded by numerous technologies that are inextricably intertwined with their everyday lives. This phenomenon proves the necessity of taking advantage of new technologies as developmental opportunities, when possible. Early childhood educators as the main carriers of such responsibility at schools face many challenges in regards to taking educational technologies to their classrooms. Some of these obstacles are related to the nature of the technologies while others are caused by different aspects of early childhood education and classrooms.

The focus of this research is to examine the effectiveness of a summer robotics professional development workshop that aims to help early childhood educators to integrate robotics as an educational intervention into their traditional classrooms. This research is part of a three year long NSF funded project (NSF DRL-1118897) directed by Professor Marina Umaschi Bers from DevTech research lab, called “Ready for Robotics”. The project seeks strategies that can be used towards enhancing the integration of new technologies in early childhood education classrooms. “Ready for Robotics” uses a developmentally appropriate technology called KIWI (Kids Invent with Imagination) throughout different phases and a variety of approaches to accomplish the stated goal.

One goal of this research is to investigate the impact of the professional development workshop on the participating teachers’ levels of knowledge, technology related attitude and self-efficacy as factors that affect the successful integration of technology into early childhood education. In addition, it aims to study different features of the workshop, as possible factors that can affect the outcomes of participation, and take them into consideration towards enhancing the effectiveness of such professional development workshops.

I begin this thesis with a review of the literature on the importance of integration of robotics as an educational intervention into early childhood education and the steps that are necessary to help early childhood educators to accomplish this matter. In addition to that, the rationale for having a new developmentally appropriate technology and the necessity of preparing early childhood educators as the carriers of this movement are covered in the literature section. I will describe the conceptual framework that has informed the current research as well. Moreover, in the following sections the methodology that is used in the current study is discussed in details. After going over the findings of this research, I include a general section on the characteristics of the workshop and the participating teachers' products in forms of curriculums and robotics projects, along with a few points from my visit from one teacher's classroom and her attempt towards technology integration. The discussion section will cover it materials under two subsections of the instruments and the workshop along with more general items.

1.1 Review of Literature

1.1.1 Why Robotics in Early Childhood Education?

Although we are surrounded by different technologies in our lives today, children are taught very little about technology in the early grades. For decades early childhood curriculum has focused on literacy and math, with some attention paid to science. According to Bers (2008), while understanding the natural world is important, developing children's knowledge of the human-made world is also needed. If we want our children to become good human problem solvers, we need to equip them with skills that are founded in technology and engineering as ways of teaching them about the development and applications of tools, machines, materials, and processes.

As stated by Petroski (2003) and Resnick (2007), it is as important to instruct children to learn about the natural world, as it is to begin engineering instruction and the development of technological literacy by building on children's natural tendency to design and build things, and to take things apart to see how they work. Early childhood education needs to seek opportunities that can teach young children about their everyday experiences with technologies as an effective way to help them understand our today human-made world as a mixture of different elements such as electrical, mechanical, and chemical structures.

In order to address the challenges discussed above, it is important to note that the educational tool to be used needs to provide the potential required for the increasing mandate to make early childhood education more academically challenging, while it also acknowledges the importance of play in the developmental path. Recent studies show that robotics can successfully bridge the academic content with meaningful projects in early childhood education (Bers & Horn, 2010; Bers, 2008b; Bers, 2007; Horn, Bers, & Jacob, 2009; Kazakoff & Bers, 2012, Clements, 2003; Judge, 2002). In addition to that, considering the fact that the content areas in early childhood education need to be broadly blended into classroom curriculum in order to achieving a more successful approach of teaching, robotics can serve as integrator of curricular contents (Bers, Ponte, Juelich, Viera, & Schenker, 2002) .

Robotics can also provide opportunities for children to learn about applied mathematical concepts, the scientific method of inquiry, and problem solving (Rogers & Portsmore, 2004). Furthermore, as stated by Resnick (2003), robotic manipulatives invite children to participate in social interactions and negotiations while playing to learn and learning to play in a creative context.

As the research also suggests that the educational interventions beginning in early years are associated with lower costs and more durable effects both from economic and developmental standpoints (e.g., Cunha & Heckman, 2007; Heckman & Masterov, 2004), the National Science Board urged the Obama administration to make STEM education a priority in early childhood education, with the hope to make children more comfortable with technologies later on in their lives (National Science Board, 2009).

1.1.2 The Need for a Low Cost Developmentally Appropriate Kit

According to the research studies, children as young as four years old can understand the basic concepts of computer programming and can build and program simple robotics projects (Bers, 2008; Cejka, *et.al.* 2006; Bers, *et.al.* , 2006). Nonetheless, computer programming has its own challenging for beginners of any age due to syntax and conceptual difficulties (Kelleher and Pausch; 2005; Ben-Ari, 1998; McKeithen, *et.al.*, 1981). In addition to these challenges faced by all novice programmers, we must also consider the developmental needs and capabilities of young children (Hourcade, *et.al.* 2004; Beals & Bers, 2006).

Based on these considerations, NSF funded a tangible interface for computer programming for young children called CHERP that was developed at DevTech under the supervision of Professor Marina Umaschi Bers (DRL-0735657). Rather than writing computer programs with a keyboard or mouse, Bers and her team created a system that allows children to practice *constructing* physical computer programs by connecting interlocking wooden blocks (see Figure 1). CHERP's wooden blocks contain no embedded electronics or power supplies. Instead, children use CHERP's blocks to create the program for their robot and then take a picture of it using a standard webcam connected to a computer. The picture is converted into digital code using the TopCodes computer vision library and downloaded to LEGO's RCX robotic hardware through infrared (Bers & Horn, 2010).

Figure 1. The CHERP tangible programming language

Although Bers's work was successful at developing a programming platform to teach computer science concepts that could be integrated into the routines of the kindergarten classroom (Bers, 2011), it did not address the teaching of engineering concepts beyond the engineering design process. Although it was feasible to use the LEGO RCX hardware in the classroom, it is not a developmentally appropriate device for young children. Some of the challenges include the difficulty in manipulating the little pieces of the device, the fact that the interface makes it confusing to isolate hardware constraints vs. conceptual difficulties in understanding the role of motors and sensors, and also the challenges that always came up when children wanted to download the computer program into the robot through infrared. In addition, the RCX is expensive and has been discontinued by LEGO and replaced by NXT, which is definitely not suitable for young children.

After RCX was discontinued by Lego and also considering all the limitations of using the RCX with young children, DevTech researchers started using the Lego WeDo education for robotics activities in early childhood classrooms. The software that comes with the kit is not developmentally appropriate and designed for young learners. Therefore, the CHERP programming language was modified to be used with the Lego WeDo Education hardware. Although, children were able to make fascinating programs and came up with great ideas for their robotics projects using the combination of the Lego WeDO Education kit and CHERP, there were some limitations to this combination as well. The most important restraint was the fact that the Lego WeDo robot needs to stay connected to the computer at all times. At this age, it is difficult and sometimes unpleasant for children to deal with this aspect as it requires them to focus on caring for the wires that get all tangled up or for the laptop that they need to be carrying after their moving robot.

Based on all these limitations and considerations, and the extensive studies of young children using LEGO Mindstorms RCX and LEGO WeDo, the following aspects need to be considered for designing a low-cost developmentally appropriate robotic kit for early childhood education:

- ***Robotics parts should be physically and intuitively easy to sturdily connect.*** Children should spend the least amount of time dealing with the breaking the robot into the pieces or figuring out how to connect the different parts including the motors and sensors. Color coordination would be an example of ways for helping children to attach the different parts correctly.

- ***Programming the robot:*** Regardless of the programming environment used, it should be simple to get a program onto the robot. A minimum of computer equipment is desirable.
- ***Aesthetics and Motion:*** Children should be able to attach a variety of crafts and recycled materials to the core robotic parts. Different types of creations should be possible, both stationary and mobile.
- ***Low-cost***. The robotic construction kits should be as low-cost as possible without sacrificing the core functionalities.

1.1.3 Early Childhood Educators and Technology

Despite the proved importance and the increasing desire of having technology and engineering in early childhood education as educational interventions, there are still obstacles that make such process challenging. According to Bers (2008) and Haugland (2000), early childhood educators, do not possess the required knowledge about technology and engineering, and the pedagogies that are developmentally appropriate to bring these into their classrooms. Thus, new professional development models and strategies seem to be necessary for preparing early childhood teachers in order to overcome such obstacle. Second, there is a need for new technologies that are both affordable and developmentally appropriate for young learners. Without these, the results of the investment on professional development will not scale as it will be difficult for teachers to integrate the use of technology into their classrooms. This research and the strategies to be studied are driven by all of these needs.

In the following sections, I will review what the current literature suggests to be the most important factors for establishing an effective movement towards designing a successful solution to overcome the challenges proposed in the earlier parts of the literature review.

1.1.4 Professional Development Workshop on Educational Technology

Professional Development Workshops can be an effective approach to provide early childhood teachers with the first steps of facing the difficulties of integrating education technology into the classrooms, if it includes both technology and pedagogical knowledge (Shulman, 1986, 1987).

Building on Shulman's work (1986, 1987), Mishra and Kohler proposed a Technological Pedagogical Content Knowledge (TPCK*)* framework that studies the various elements of the art and science of teaching with and about new technologies (Mishra and Kohler, 2006). According to that framework, teachers need to gain familiarity with the chosen technology, with the particular content, and the proper pedagogy in order to integrate technology into their classrooms. Therefore, an effective professional development workshop, should take into account the interrelation of all these three factors as pictured below (Figure 2)

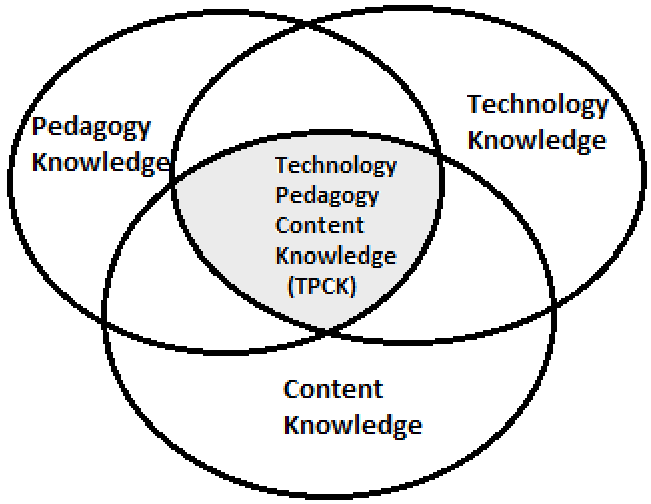


Figure 2. The TPCK framework (Mishra & Koehler, 2006)

This research project considers Mishra and Kohler's presentation of TPCK as a framework to work around, by focusing on robotics as a domain that integrates technology and engineering. Each of the three areas can be defined briefly as follows:

- Content Knowledge (CK): Teachers need to learn the content they want to teach to their students. Therefore, they should gain enough knowledge about robotics as a subject matter, the engineering aspects of building an artifact that can move and sense its environment on its own, and the programming aspects that determine the sequence of its behaviors.
- Pedagogical Knowledge (PK): Similar to what teachers need to know prior to teaching any subject matter in their classrooms, they need to gain knowledge about the processes and practices and methods of teaching engineering and technology content with developmentally appropriate pedagogies that take into account cognitive, social, and emotional and other developmental aspects of

learning in early childhood. For example, it is important to prioritize the collaborative and cooperative aspects of learning in teaching robotics to younger children, as opposed to have them participate in robotics competitions, as an important aspect of a proper pedagogical approach in early childhood education. (Bers, 2008).

- Technology Knowledge (TK): It is important to note that platforms change rapidly. However, if teachers learn about the benefits and challenges of robotics technologies in addition to the knowledge and skills required to work with such technologies, the chance of successful integration of technology into their traditional classrooms will increase. For instance, they need to understand that problem solving and debugging are part of the Technology knowledge although they seem like challenges at first glance.

Successful integration of any technology into the traditional curriculum of early childhood classrooms can happen if teachers gain the ability to adapt their teaching practices. Special considerations are required in order to use particular educational technologies to address specific content areas given the unique characteristics of their classrooms and students, having all three domains in mind. The understanding of the relationships among the three domains of Technology, Pedagogy, and Content provided through the Professional Development Workshops, should help the early childhood educators choose the right tools for the right content with the right pedagogy as it gives them a better chance to avoid the technologies that are mostly driven by commercial goals rather than educational ones.

1.1.5 Passage from Knowledge to Action; what else is required?

It is essential to note that for successful integration of education technology into the classrooms, there are other important factors to be considered that help early childhood educators with their passage from knowledge to action. Providing professional workshops can resolve some of the obstacles that teachers might face due to their limited knowledge of a specific technology, but it is also important to examine how much of teachers' perception towards teaching with technology relates to their knowledge, and whether there are other elements that influence the process of technology integration through affecting the teachers' characteristics

According to the literature, barriers for integrating technology into the classrooms include equipment-related issues such as limited access, technical problems, and failures (Hadley & Sheingold, 1993; Rocheleau, 1995; Sandholtz et al., 1997), skill-related anxieties such as lack of educator training and limited knowledge (Becker, 1994; Becker & Ravitz, 2001), and attitudinal issues such as educator anxiety and concerns about the change to the social structure in classrooms (Anderson, 1996; Demetriadis et al., 2003; Rosen & Weil, 1995; Schofield, 1995).

Research shows that in order to design teacher preparation experiences that help teachers to learn how to use technology to create engaging and effective classroom environments, both knowledge and beliefs are important factors to be considered. Additionally, beliefs and attitudes seem to be determining elements in explaining and predicting classroom technology uses for both in-service and pre-service teachers (Albion, 1999; Anderson & Maninger, 2007; Bull, 2009; Lee, Cerreto, & Lee, 2009;

Marcinkiewicz, 1994; Vannatta & Fordham, 2004). Beliefs and attitudes, however, fall short of explaining all that is necessary to support effective and successful technology integration in teaching and learning.

According to Ertmer and Ottenbreit-Leftwich self-efficacy beliefs, knowledge, pedagogical beliefs, and cultural contexts are all factors that influence the technology integration. According to them, “although knowledge of technology is necessary, it is not enough if teachers do not also feel confident using that knowledge to facilitate student learning” (Ertmer & Ottenbreit-Leftwich, 2010, p. 261). This statement addresses the connection between knowledge and self-efficacy beliefs.

In addition, according to Wood, early childhood education settings have features that make them different from higher grade level environments. For instance, levels of independence and basic skills in young children might result in requiring more help from teachers within the same amount of limited class time. Such unique characteristics of early childhood education environments add to the challenges that teachers face as they pursue the integration of technology into their traditional classrooms and curriculums. (Wood et al., 2008). Therefore, even if the early childhood teachers carry good attitude towards technology (both personally and professionally), they always have to prioritize making sure that the more important aspects of learning for their young pupils are being met. Thus, in addition to investigating the attitude towards teaching with technology, it is also necessary to investigate the participating teachers’ level of self-efficacy since as noted by Bandura (1993), “self-efficacy is a perception of one’s own human agency, or in other words, it is the perception of our own ability to deal with a situation”. The teachers’ self-efficacy can determine how teachers approach accomplishing a goal (technology integration in this case) in their classrooms.

Bandura (1997) described perceived self-efficacy as “beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments”. Additionally, he explains that self-efficacy beliefs affect many aspects of behavior, including the choice of a course of action, the amount and duration of effort put forth, and the emotional response to the success of an endeavor . In general, it is expected that higher self-efficacy beliefs will function as a positive support for action, whereas lower self-efficacy beliefs can have result in holding back when one makes the decision to continue a particular course of action.

In this research, the two characteristics of the participating teachers including their attitude towards technology and their sense of self-efficacy towards using it in their classrooms will be studied in addition to the knowledge they might gain as the result of participation in the summer institute. In order to address this task, the four formulated research questions along with the details of the used methodology will be discussed in the following chapter. In chapter three, the findings of the research will be discussed. Some characteristics of the workshop and its after math in the case of one participant will be overviewed in the fourth chapter. The discussion on more aspects of the findings, along with the limitations and implications for the future research will be included in chapter five.

CHAPTER 2. Methodology

2.1 Problem Statement

“Ready for Robotics”, is a three year NSF funded (NSF DRL-1118897) research project led by Professor Marina Umaschi Bers from DevTech lab that focuses on the components of STEM, the “T” of technology and the "E" of engineering, that have been overlooked the most in early childhood education. The project develops, implements and evaluates strategies for integrating the use of a new educational technology (a developmentally appropriate and low cost robotics construction kit) in the context of a professional development institute where early childhood teachers learn about different areas of the required knowledge by designing, implementing and evaluating a curricular unit integrating engineering and programming into their early childhood classrooms. The participating teachers will then take the technology to their classrooms and implement the curriculums they have designed during the institute as they receive continuous support from the researchers throughout the implementation of their curriculums.

The hope is that having the right technology, the proper education on integration of such technology in early childhood education, and the support throughout the time of such integration will shed light on the strategies that are needed to be developed to take this research to another level and make the discoveries applied and practical.

The focus of my research as the first phase of the “Ready for Robotics” project is to investigate the effectiveness of the summer of 2012 robotics institute from different perspectives. Although some portion of the quantitative analyses that will be considered independently or in relationship with the rest of the collected data in this thesis has been recently published (Bers, *et. al*., 2013), the main goal of my thesis is to focus on an inclusive analysis of the collected materials in order to achieve a more complete picture of all the factors that should be considered while the integration of developmentally appropriate new technologies into early childhood education is being studied.

2.2 Research Questions

1. To what extent, if at all, did the participating teachers in the robotics professional development workshop gain knowledge in the areas of Technology, Pedagogies, and Content as three necessary domains of knowledge required for successful integration of an educational technology into the traditional classrooms?
2. To what extent and how, if at all, did the general attitude of teachers who participated in the robotics professional development workshop improve towards using technology? Also, whether and how did this participation change the teachers' feelings towards teaching with technology in their classrooms?
3. To what extent and how, if at all, did participating in the workshop affect the teachers' sense of self-efficacy towards teaching with technology in their classrooms?
4. In what ways does the summer robotics professional development workshop affect the teachers' movement towards integrating robotics into the traditional curriculums?

2.3 Study Design

Considering the fact that the research questions drive the selection of the research methods, my original plan was to use a number of surveys to assess the changes in the levels of teacher's knowledge, attitude, and self-efficacy. My technical background was another reason for having the tendency towards using more quantitative approaches. However, as I became more familiar with the characteristics of other similar studies in the field of social and behavioral science, I realized the importance of making every effort to capture all the data that can be used towards doing a thorough investigation.

The primary method of data collection was quantitative which was done through four main surveys. However, since the period of the workshop was relatively short and due to the nature of the study that focuses on human social behaviors, I felt the need to have qualitative methods running at the same time, hoping to detect useful themes and trends that would help us answer the first three research questions in a richer way. In other words, I only had the option of examining all the things that would happen throughout the three days of the summer robotics institute and not beyond it and therefore, could not look into the effects of the workshop after teachers go back to their classrooms and in their actions. Therefore, in order to avoid missing anything that could relate to the effectiveness of the workshop, I decided to use a combination of ways that would provide me better insight into the topic of my research.

After reviewing the literature, I learned about the Mixed Methods research, and became familiar with different categories of design that are used in such type of research.

In the following section I will go over the key terms and definitions, and also will discuss my choice of design for the current thesis.

2.3.1 Theoretical Basis

2.3.1.1 Mixed Methods Design

The essential goal of mixed methods research is to tackle a given research question from any relevant angle, making use where appropriate of previous research and/or more than one type of investigative perspective. Sometimes referred to as mixed methodology, multiple methodology or multi-methodology research, mixed methods research offers researchers the best of both worlds: the in-depth, contextualized, and natural but more time-consuming insights of qualitative research coupled with the more-efficient but less rich or compelling predictive power of quantitative research. As Cornell psychologist William Trochim (2001) puts it: *"…[any] kind of polarized debate has become less than productive. And, it obscures the fact that qualitative and quantitative data are intimately related to each other. All quantitative data is based on qualitative judgments; and all qualitative data can be described and manipulated numerically."*

According to Tashakkori and Teddlie's Handbook of mixed methods in the social and behavioral research, the mixed methods design is a design in which mixing of qualitative and quantitative approaches occurs in all stages of the study (formulation of research questions, data collection procedures and research method, and interpretation of the results to make final inferences) or across stages of the study (e.g., qualitative questions, quantitative data).

There are six categories of mixed method research designs (Creswell *et. al,* 2003):

- Sequential Explanatory Design: this design "is characterized by the collection and analysis of quantitative data followed by the collection and analysis of qualitative data. Priority is typically given to the quantitative data, and the two methods are integrated during the interpretation phase of the study."
- Sequential Exploratory Design: this design "is characterized by an initial phase of qualitative data collection and analysis, followed by a phase of quantitative data collection and analysis. Therefore, the priority is given to the qualitative aspects of the study."
- Sequential Transformative Design: It has two distinct data collection phases, one following the other. However, in this design, either of methods may be used first, and the priority may be given to either the quantitative or the qualitative phase.
- Concurrent Triangulation Design: In this design, qualitative and quantitative approaches are used to "confirm, cross-validate, or corroborate findings within a single study".
- Concurrent Nested Design: In this design, a quantitative strand/phase is embedded within a predominantly qualitative study or vice versa. Qualitative and Quantitative approaches are used to "confirm, cross-validate, or corroborate findings within a single study".

- Concurrent Transformative Design: It is guided by a specific theoretical perspective and the Quantitative and Qualitative data are collected during the same phase.

Among the categories listed above, the Concurrent Triangulation Design is what I had considered to design my research around. Based on the definition, the qualitative and quantitative data collection are concurrent and happen during one data collection phase, priority could be given to either of them but ideally the priority between the two methods would be equal, both methods are integrated in the interpretation phase, and finally the integration focuses on how the results from both methods are similar or different, with the primary purpose being to support each other.

2.3.1.2 Data Collection Methods

Note that the process of integrating qualitative and quantitative research needs to be well thought out prior to the study is designed. The qualitative portion needs to be constructed in a way so that more novel information can be discovered. Since the period of the workshop in the current study was relatively short and teachers should not have been overwhelmed with the data collection approaches, I decided to carefully select those methods that provide a higher chance of collecting data related to any of the quantitative data including the participants knowledge in the area of technology, pedagogy, and content, in addition to the feelings and confidence that the teachers would experience prior or throughout the summer institute. The qualitative methods that have been used in this study include collecting the blogs containing questions tailored towards capturing specific data, the drafts of curriculums designed by the teachers, the participants final robotics projects, and a debriefing session that happened on the last day of the workshop to give all the teachers a chance to express their thoughts, concerns, feelings and feedbacks.

According to the literature, the qualitative portion can be exploratory or confirmatory. When the qualitative portion is exploratory, the purpose is to identify other dimensions that the quantitative portion is missing. On the other hand, when the qualitative portion is confirmatory, the purpose is to support the quantitative findings. Qualitative results can also be used to explain why there wasn't a statistically significantly differences in the numbers (Tashakkori and Teddlie, 2003). Early on in my research, I did not make a decision on what type of qualitative data collection (exploratory or confirmatory) I was going to have, as my main goal was to collect the as much useful data while I could, and make any possible connections or confirmations as well as any justifications for the missing or expected findings and relations later.

2.3.1.3 Presenting the Results

After the primary rounds of examinations of the data that was collected through the quantitative assessment tools (Teachers' Knowledge Survey, Teachers' Sense of Technology Self-efficacy Survey, Teachers' Attitude Towards Technology Survey, Background Survey), I was able to discover a set of correlations between different set of variables. The quantitative analyses section for each of the research questions contains detailed description of the analyses along with the findings.

After the first phase of the investigation was complete, I needed to make some changes in my research assessment tools due to facing some level of disappointment which was the result of the quantitative findings not meeting my original expectations. At that point I started the examination of the qualitative portion of the data and was able to track down interesting themes and trends in teachers' curriculums, blogs, and debriefing session comments. My first thought after finishing this phase was to present the results of the surveys and the interesting and more extended findings from the qualitative materials in different sections. My primary understanding of the application of the mixed methods design to my study was to look for trends and categories in teachers' blogs and comments and then, find reflections of them in their attempts towards the integration of technology in forms of curriculum drafts and robotics projects.

However, after going through both the quantitative and qualitative findings over and over again and referring to some examples I found in the literature, I realized that my design could benefit from building a connection between the quantitative and qualitative portions of data. According to the literature (Tashakkori and Teddlie, 2003), presenting the results using the mixed method approach is an important task and if done well can result in stronger and better defined insight into the investigation. I slowly understood that although writing-up quantitative research is very well defined, qualitative research is more often about discoveries.

My plan to present the findings in this study is to have different sections on the results of the analyses of the data collected through the knowledge, attitude, and sense of self-efficacy surveys with both the quantitative and qualitative finings combined. In each section, first I will state the results of the quantitative analyses and then, go over the related qualitative material that would shed some light on better understanding the quantitative findings. Additionally, I will go over the data retrieved from the background survey, and use investigating the qualitative data to make richer arguments.

2.3.2 Variables

As discussed in the previous section, due to the fact that the current research aims to investigate the changes that happen in some social characteristics of human subjects, and also considering the fact the timeline of such investigation is very short (three days), the selected variables are going to be examined from both quantitative and qualitative perspectives. My goal is that by having a mixed methods design, I get the chance to understand the "Whether" and "How" of the possible changes that happen to the level of knowledge, sense of self-efficacy, and attitude of the early childhood teachers as the result of participation in the summer robotics institute

The variables that are being investigated include:

a) Teachers' knowledge in three areas of Technology, Pedagogy, and Content using the TPCK framework while considering "teaching robotics" with "KIWI";
b) Teachers' sense of technology self-efficacy;
c) Teachers' attitude towards teaching with technology.

The stated variables were chosen based on what according to the literature seem to be the major impediments to teachers' attempts towards integrating new technologies into their traditional classrooms. Although I primarily examine the stated variables independently, I use both the statistical methods (investigating correlations) and the existing qualitative material to investigate the possible existing dependencies. In other words it is possible that one or more of the research questions are instrumental to the others. This will be a matter to be discussed in more details in the discussion section.

2.3.3 Recruiting the sample for research-sample demographics

As the focus of this research is to find new strategies for more successful integration of new technologies in early childhood education, all the subjects in the study‘s sample are among early childhood educators. A self-selected sample of early childhood educators (N=32) from across the United States participated in this study. Participants responded to online advertisement for a free three-day professional development institute and completed a screening application to ensure they met the criteria for participation (i.e. they were actively teaching in a Pre-K- 2nd grade classroom and could be present for the full duration of the institute). Applicants who met the criteria were accepted on a first-come first-serve basis.

Participants varied widely in their experience teaching ranging from 4 to 38 years of experience (mean=15.12, SD=8.2). The majority of teachers (73%) were attending with a colleague from their school or district and all teachers (100%) said that were planning to collaborate with a colleague on implementing their robotics curriculum upon returning to their schools. Teachers represented 7 different states and several geographic regions of the US, however more than half (56%) were local to Massachusetts. Almost all participants were female, with only one male participant. Prior to the institute, the majority of teachers (58%) considered themselves average users of technology, while 39% considered themselves expert users and only 3% considered themselves novices. In terms of *teaching* with technology, only 39% of teachers considered themselves experts, while 31% considered themselves average and another 31% considered themselves novices.

Of the 32 participants in the study, data is presented for a final sample of N=25 teachers (whom for we had the complete sets of data collected). As opposed to the pilot professional workshop held several years ago that was used in order to design the curriculum for the workshop being studied in the current research, the participating teachers were not required to have any certain level of expertise or experience with technology or robotics. This characteristic of the study sample provided us the chance to investigate the effect of the robotics development workshop on early childhood teachers with a variety of personal and professional (the profession of teaching) technology backgrounds.

2.3.4 The workshop

In order to develop the curriculum for the summer institute studied in this project, a pilot experience was conducted several years ago with 21 early childhood teachers participating in an intensive robotics institute followed up by classroom implementation by DevTech, at Eliot-Pearson Department of Child Development. The CK of the pilot institute focused on the two aspects of robotics: mechanical and programming explorations. Teachers left with a ready-to-implement robotics curricular unit that they had designed and tested to bring back to their classrooms during the upcoming fall semester.

A unique challenge and opportunity of early childhood education is that classroom activities typically center on multidisciplinary thematic units that may carry on for a week or longer. Thus, the pilot institute encouraged participating teachers to identify a thematic unit to integrate their robotics unit. For example, two first grade teachers working in the same school explored the concept of "machines that serve to automate manual tasks", and chose to integrate it into their Fall semester unit on New England heritage with a focus on apple picking.

Observational and qualitative results showed that the pilot institute was successful in increasing TPCK for participating teachers. During the fall, teachers reported back on results of their classroom work. Most of them reported that they decided to pre-build the robotics artifacts for their children because the Mindstorms LEGO kit available at the time was not developmentally appropriate for young children. This needed change to make the project feasible, interfered with the curricular goal of having students explore engineering concepts by building the artifacts themselves. Therefore, for the research study reported in this project, it was decided to use the KIWI robotics kit, specifically designed to be developmentally appropriate, in order to address some of these challenges.

This previous pilot experience, informed the development of the institute described in this – project. The institute described here consisted of three days of robotics and programming (a total of 18 hours) focused on professional development activities for 32 early childhood educators, for which these teachers had the opportunity to earn professional development points. The overarching goal of the three days was to show teachers how new robotics technologies can be used with young children and integrated with content areas that are fundamental to early childhood education.

A combination of lecture, large and small group discussions, and hands-on work with the KIWI robotics construction sets and CHERP programming software were used. Both of these will be described in the following sections. Teachers were also introduced to LEGO WeDo robotics construction sets to serve as a comparison to KIWI in terms of the appropriateness of each to an early childhood setting. A pedagogical overview was given on the first day of the institute and pedagogical tools and strategies were modeled and demonstrated throughout all aspects of the hands-on work.

Each day of the institute was primarily spent with hands-on work completing curricular activities with the technology, both individually and in small groups. The institute's curriculum focused on two central themes in early childhood: *Sensing as tools for observation* (including human and animal sensory systems, technology that extends human senses, and engineering robots that can "see"), and *How Things Move* (locomotion of humans and other animals; exploring physics and engineering with rolling, sliding, and ramps; engineering transportation robots; comparing and contrasting human, animal, and robot parts and movement).

In addition, teachers completed a culminating project curriculum called *Dances from Around the World,* which integrates foundational social studies, culture, and history subject matter with designing and programming robots to perform a dance using advanced programming instructions. In this final project they integrated the knowledge gained about motion and sensing. These modules address content and skills mandated by the state of MA.

After experiencing the stated curricular units and gaining skills and pedagogical knowledge about using KIWI and LEGO WeDo during the first day and a half of the institute, the teachers spent the last day and a half working on designing their own robotics curricular units to be implemented in their classrooms during the upcoming academic year. Furthermore, teachers were introduced to the *Early Childhood Robotics Network (*http://tkroboticsnetwork.ning.com), a website designed and developed by DevTech researcher Amanda Sullivan, that provides early childhood educators with useful information about teaching with robotics in the classroom in addition to ways to connect them with a network of professionals who are taking the same approaches. Teachers used the robotics network to upload and share their curriculum drafts and blog about their experiences at the summer institute using a journal template. (see Appendix F for the Robotic Journal). The Robotics Activities Journal includes a number of structured sections focused on specific questions in addition to a section to include open ended comments and thoughts.

Additionally, teachers shared and learned ideas about the types of teaching tools and strategies, as well as assessment techniques that might be effective when implementing their curriculum with young children. During this time, teachers collaborated with other participants, tested out their activities, and received feedback on their curriculum and teaching tools. By the end of day 3, all teachers left with a plan for the robotics curriculum they wanted to implement.

The workshop was free for all the participants. Teachers who came from out of state paid for their own travel and stay expenses but were provided with guidance on how to look for stay options. Each teacher was provided with one set of programming wooden blocks and parameters along with a packet that included useful material for implementing the technology integration in the classroom throughout the coming year (see Appendix A for the teacher's packet materials).

2.3.5 The KIWI Technology

During the institute teachers utilized the KIWI (Kids Invent with Imagination) robotic prototype developed by the DevTech research group, in collaboration with MODKIT team, with funding from the National Science Foundation. The KIWI construction set enables young children (5-7) to engage in robotics activities in a developmentally appropriate way. The KIWI set contains different elements including two motors, a sound sensor, a distance sensor, a light sensor, a light output, and a USB cable (Figure 3). There are three different spots for the motors to attach to the robot body. Two are on the side of the robot, one on the top. The robot can be mobile or stationary. If the motors get attached to the sides and attached to wheels, the robot will be mobile. If one motor gets attached to the top spot, the robot will be stationary. KIWI includes three different types of sensors: a sound sensor (with the shape of an ear), light sensor (with the shape of an eye), and distance sensor (with the shape of an arrow). The sound sensor is used to differentiate the two concepts of "Loud" and "Quiet". Using the Sound Sensor, the robot can be programmed to do something when it is loud, and do something else when it gets quiet, or vice versa. The light sensor is used to differentiate the two concepts of “Dark” and “Light”. The robot can be programmed to do something when it is light out, and do something else when it gets dark, or vice versa. Finally, the distance sensor is used to detect whether the robot is getting near or far from something. The robot can be programmed to do something when it gets near something, and do something else when it gets far from it. The light output is shaped with the form of a sun and is made of a different color plastic, than the sensors, so children do not get confused between the concepts of inputs and outputs.

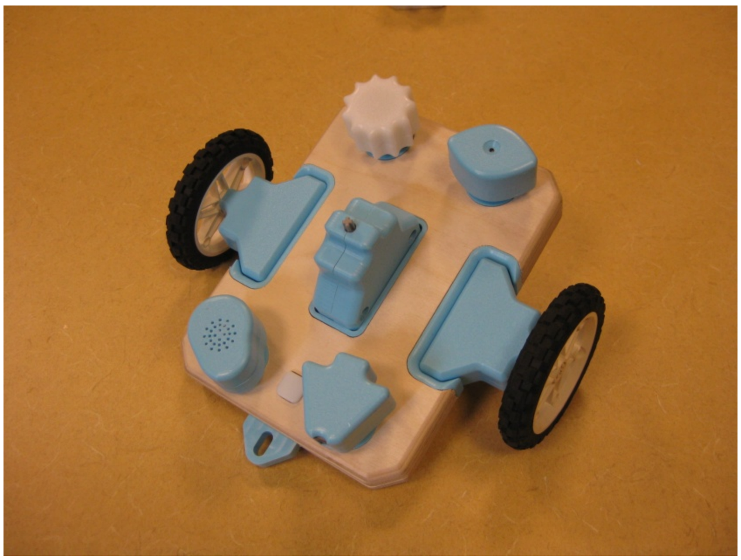


Figure 3. The KIWI Robot with its modular sensors, motors and light output

KIWI was developed to address the lack of developmentally appropriate tools for young children. Very few commercially available robotic kits have been explicitly designed for young children. For example, the Bee-Bot (http://www.terrapinlogo.com/bee-botmain.php) is a small plastic robot with a shape of a bee that has directional keys on its back that are used to enter up to 40 commands which send Bee-Bot forward, back, left, and right. However, although this product is reminiscent of the first Logo floor turtle developed by Seymour Papert in the 60's (Papert, 1980), children do not have opportunities to engage in the building of the robotic artifact and thus explore engineering ideas, neither can they explore programming concepts beyond sequencing.

Taking this into consideration, several research labs have developed robotic kits for STEM education. In some cases, these tools became the seeds for commercial products. For example the MIT Media Lab's pioneering work with the "red brick" evolved into LEGO products such as the Mindstorms RCX and NXT and most recently WeDo (Resnick et al, 1998; Rusk et al, 2008), independent companies that developed the PicoCricket (http://www.picocricket.com/) and the HandyBoard (http://handyboard.com/) and non-profits that created the GoGo board (http://www.gogoboard.org/cocoon/gogosite/home.xsp?lang=en). However, none of these robotic kits have been explicitly designed to meet the developmental needs of young children and the classroom challenges of early childhood education. Although they could be adapted to be used in pilot work, they do require major technical expertise and lots of support in the classroom (Beals & Bers, 2006). Thus, the development of the KIWI technology, that involves hardware (the robot itself) and the software used to program KIWI, called CHERP (Creative Hybrid Environment for Computer Programming).

2.3.6 The CHERP Programming Language

Robotics involves making physical artifacts that come to "life" by programming their behaviors. KIWI utilizes a software called CHERP that allows young children to program it. Previous research has shown that children as young as four years old can understand the basic concepts of computer programming and can build and program simple robotics projects (Bers, 2008; Cejka, Rogers, & Portsmore, 2006; Rogers, Beals, Portsmore, Staszowski, Cejka, Carberry, Gravel, Anderson, & Barnett, 2006). Furthermore, early studies with the text-based language Logo, have shown that computer programming, when introduced in a structured way, can help young children with variety of cognitive skills, including number sense, language skills, and visual memory (Clements, 1999). Nonetheless, computer programming is difficult for novices of any age due to syntax and conceptual hurdles (Kelleher and Pausch; 2005; Ben-Ari, 1998; McKeithen, Reitman, Rueter, and Hirtle, 1981). In addition to these challenges faced by all novice programmers, we must also consider the developmental needs and capabilities of young children (Hourcade, et al. 2004; Beals & Bers, 2006).

Based on these considerations, CHERP provides a system that allows children to *construct* physical computer programs by connecting interlocking wooden blocks (Figure 4). CHERP's wooden blocks contain no embedded electronics or power supplies. Instead, children use CHERP’s blocks to create the program for their robot and then take a picture of it using a standard webcam connected to a computer. The picture is converted into digital code using the TopCodes computer vision library and downloaded to LEGO’s RCX robotic hardware through infrared (Bers & Horn, 2010).

CHERP is inspired on early ideas from tangible programming (Perlman, 1976) that were revived nearly two decades later (Suzuki & Kato, 1995). Since then, a variety of tangible languages for children have been created in a number of different research labs around the world (e.g., McNerney, 2004; Wyeth, 2008; Smith, 2008; Horn & Jacob, 2007). Instead of relying on pictures and words on a computer screen, tangible programming uses physical objects to represent aspects of computer programming. They exploit the physical properties of objects, such as size and shape, to express and enforce syntax.

Figure 4. The CHERP Tangible and Graphical Programming Interface

For example, the interlocking wooden blocks shown in Figure 1 describe the CHERP's language syntax (i.e. a sequential connection of blocks). In fact, with this language, while it is possible to make mistakes in program logic, it is impossible to produce a syntax error. In moving away from the mouse-based interface, pilot studies conducted with kindergartners in the Boston area, suggest that tangible languages might have the added benefit of improving collaboration between students (Lee & Bers, under review). The process of constructing programs is now situated in the classroom at large—on children's desks or on the floor— thus children's code can be open and visible and they can engage in discussing ideas for debugging and literally "sharing" the code (Figure 5).

Figure 5. Kindergarteners using CHERP to program their robots

2.3.7 Data Sources

2.3.7.1 Teachers' Knowledge Survey

In order to design a survey for capturing the data that would be useful according to the TPCK framework, I went through rounds and rounds of revisions. My original plan was to adopt a survey while considering the criteria of the research. However, after spending some time reading and searching the literature, I realized the need to start designing a customized survey since there has not been done much in regards with the integration of technology into early childhood education, let alone surveys and assessment tools that can be useful for researches in such field.

I started the design of the survey by looking at a TPCK survey that was directly developed based on the TPCK framework in order to measure pre-service teachers' self-assessed development of TPCK (Schmidt et al., 2009). Additionally I used Sullivan & Moriarty's work on investigating the conflict between the educational technologies' designer's pedagogical beliefs, and the teachers' pedagogical beliefs, which may affect the teachers' ability or desire to use the technology integration in their classrooms (Sullivan & Moriarty, 2009). Their study contributes to "understanding this issue by examining teachers' reflection on teaching and learning robotics through discovery learning methods" (Sullivan & Moriarty, 2009). This study informed the design of a number of the questions in the pedagogical section of the knowledge survey. Another helpful source was the "TICKIT" program (Keller *et. al,* 2008). "TICKIT" that stands for *Teacher Institute for Curriculum Knowledge about Integration of Technology* program is a year-long technology integration program that helps the rural Indiana teachers with the integration of educational technologies into their classrooms.

Three separate sections were considered in designing the knowledge survey. The first section of the survey called "Robotics Knowledge" focuses on assessing the content of robotics through questions which relate to more general definitions of robot and engineering. The second section of the survey called "Teaching Robotics" focuses on assessing the pedagogical approaches and beliefs that teachers might take and have while integrating robotics into early childhood classrooms. This examination includes assessing the ways of teaching along with students' learning when integration of robotics takes place in the classroom. The remaining two sections of the survey focus on evaluating the technology knowledge of the participants. In this study, the technology consists of two parts of software and hardware. The "CHERP programming skills" section of the survey aims to study teachers learning in regards with the programming language of CHERP (and if they are familiar with it at all). Teachers' understanding and knowledge of the device that is called KIWI, gets assessed using the questions in the "KIWI Robotics Technical Skills".

The 28 survey items used the Likert scale that is described in the analyses section, and contained questions in all three domains of Technology, Pedagogy, and Content. After the design of the survey was complete, two other researchers from the lab went over all the questions and rated their relatedness to the topic of this study. The questions that were rated as unrelated were discussed among me and the other researchers. As the result of this discussion, a number of those questions were removed from the survey. The rest of those questions were modified and were agreed upon to be included in the survey (see Appendix B for the Teachers' Knowledge Survey).

2.3.7.2 Teachers' Sense of Technology Self-efficacy Survey

In order to design this survey, I looked at a number of surveys available to assess the sense of self-efficacy in different fields, including the ones available for assessing teachers' sense of self-efficacy. Originally I was not sure whether to adopt a survey that was already developed, or develop one based on the requirements of my research. Meanwhile, as I was researching the topic, I discovered a widely used and cited survey called "Computer Technology Integration Survey (CTIS)" that is used to measure changes in pre-service teachers' sense of technology self-efficacy (Wang, Ertmer, and Newby, 2004) which I decided to use in my study. However in order to extend it to use with my study subjects who are in-service teachers, I included a number of fields such as *Total number of years teaching*, or *Total number of years teaching at current institution* in a separate survey called the Background survey. The CTIS survey contains 21 items that assess different aspects of technology self-efficacy with regards to the integration of technology in their classrooms, using the Likert scale described in the data analyses section (see Appendix C for Teachers' Sense of Technology Self-efficacy survey).

2.3.7.3 Teachers' Attitude towards Teaching with Technology Survey

As previously discussed, teachers' level of comfort or anxiety towards using technology (both personally and when teaching in the classroom) is another factor to be investigated while studying the likelihood of successful integration of technology in the classrooms. Similar to the approach I took with the other two surveys, I went over numerous surveys that related to assessment of teachers' feelings. However, I had a difficult time finding a source to refer to if I wanted to develop a survey that would focus on examining early childhood teachers' feelings towards teaching with technology. Therefore I decided to use an already developed survey that was frequently referred to in a number of literatures published on the topic of teachers' professional workshops.

The "Attitudes towards Computer Technology is a widely used survey introduced by Kinzie's work on studying the attitudes and self-efficacy across undergraduate discipline (Kinzi, *et. al,*1994). The ACT instrument assesses perceived usefulness of and comfort/anxiety with computer technologies (such as word processing, electronic mail, spreadsheets, database programs, etc.) The ACT survey contains 17 items and uses the Likert scale described in the data analyses section (Appendix D: Teachers' Attitude towards Teaching with Technology survey).

2.3.7.4 Background Survey

In the background surveys, teachers were asked different questions including the ones about their age, total number of years teaching, total number of years teaching at their current institute, their personal experience with technology, their experience teaching with technology, and types of technology that they have previously used in the classrooms. Including the background survey in the study was done to capture any information that could affect the topic of the study in any way. For example, knowing the types of technologies used by the teachers in the past, their experience teaching with technology, or their age, can provide a broader perspective while the other groups of data from both the qualitative and quantitative materials are being investigated (see Appendix E for Teachers' Background survey).

2.3.8 Data Analyses

After rounds and rounds of seemingly endless juggling of the data I had collected throughout the workshop, I finally decided to take the approach that will be explained below. Although using a mixed methods approach seemed challenging at first, I feel confident that my attempt takes into consideration the limitations and goals of the current study, as much as possible. Figure 6 shows all the materials that were collected and what teachers did throughout the summer institute in addition to the collection timeline. In the following section I will go over the investigation conducted to answer the proposed research questions.

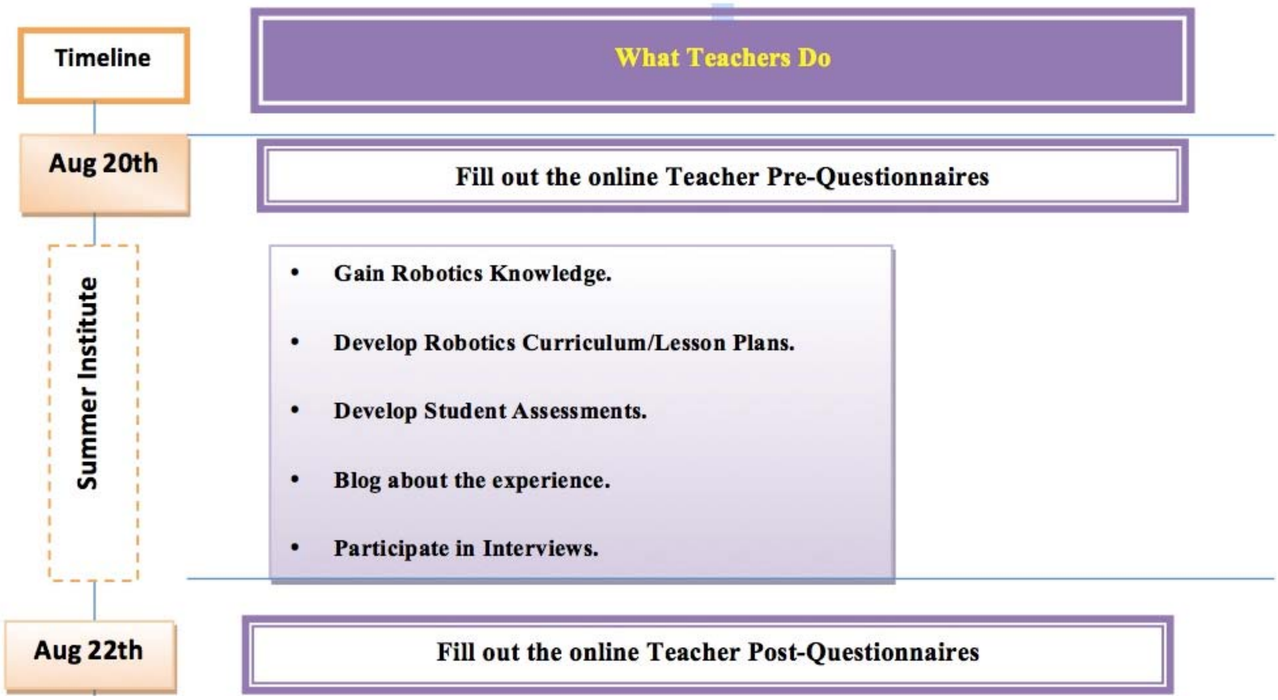


Figure 6. Ready for Robotics Research Timeline

I collected sets of data through a number of self-report surveys including a background survey, a knowledge survey, a sense of self-efficacy survey, and an attitude survey prior to participation and on the last day of the institute. Additionally, teachers blogged about their experience at the workshop on the second day of the workshop. The participants were given a curriculum template (designed at DevTech), and were asked to design their own curriculum drafts while having what they had learned from the workshop in mind. We gave them a sample of our lab's student assessment form in case they wanted to use it or create new student assessment forms. Once each group finished a robotics project, they put a video of their project online as to practice a method of documentation. On the last day of the institute, we gathered to go over some highlights of the workshop. Teachers gave answers to a set of questions and discussed their thoughts, concerns, and interests. This discussion session was videotaped for later analyses. Teachers also filled out the three surveys (knowledge, sense of self-efficacy, and attitude) prior to leaving the institute.

In order to answer the first three research questions, I conducted quantitative data collection. The variables to be measured using a pre-post method were knowledge, sense of self-efficacy, and attitude. Since our main goal was to examine the effect of the workshop on the participating teachers' knowledge, sense of self-efficacy, and attitude, we looked at all the answers given by all the teachers looking for any significant changes. A 5-point Likert scale was used for answering the questions in all three surveys (pre and post). For all questions, teachers could choose to: Strongly Disagree, Disagree, Neither Agree/Nor Disagree, Agree, or Strongly Agree with the statements in all of the surveys. Since a Lickert scale was used, the study variables are ordinal in nature. We used matched pair analysis for all the surveys. We also looked at the histograms plotted for the mode, or most often answered choices given to the questions of each of the surveys. Also, since paired t-testing was used, it was not required to do any sort of normalization.

The data that teachers entered through different surveys, was collected in form of Google documents. After that, all the documents were converted to excel files for further investigations. Out of 32 participating teachers, 25 teachers had completed data sets for all the surveys that were conducted throughout the workshop. I filtered the excel files to only include the data for 25 teachers who became the subjects of the study.

In order to assess the data entered for different surveys, different considerations were taken into account. For example, the background survey included both numerical fields as well as more descriptive fields (i.e. answering the “explain why” part of the questions). Also, I decided to call a person who rated her personal or professional experience with technology as “3” in the Background survey an average person, the one with a “4” or “5” an expert, and finally the one with a “1” or “2” a novice. In order to assess the answers given to the Attitude survey, I had to do a round of score assessments prior to using the scores towards further investigations. The reason for that was that there were two categories of questions on both topics of “comfort” and “anxiety” in the survey. Therefore, in order to interpret all the questions towards one’s attitude in terms of her comfort level towards technology in this case, I had to map the given score prior to using it in the analyses. In order to do this, while investigating the anxiety questions, I kept the “3”s, converted the “1”s to “5”s, the “2”s to “4”s, and vice versa. This was the method used by developers of the survey in the literature.

Qualitative data from interviews and blogs were also examined in relationship to teachers’ knowledge. The curriculum template that was given to the teachers had been developed at DevTech and tested with children in the classrooms. The reason for providing the teachers with the curriculum is to give them a start point to practice their newly learned skills in the institute in addition to some level of confidence when they start the implementation in their classrooms. Teachers can use the same curriculum or customize it based on their students’ needs and status. The blog was designed in a way that provides the participants the chance to reflect on their feelings and thoughts (both negative and positive), at the same time that it provided me valuable information for the research. The last day’s debriefing session was another round of capturing teachers’ feedback, statements, feelings, and comments within the group of their peers. Teachers’ final robotics projects were another ways of expressing their learning from participation in the institute.

2.3.9 The application of the Mixed Methods approach to my analyses

2.3.9.1 My Original Plan

I started the data analyses by having the following steps in mind:

1. I thought first I would examine the changes in the level of teachers' knowledge quantitatively. Then I would look into the pool of the qualitative data (curriculums, blogs, debriefing session, and robotics projects) searching for all the evidences that could show why the increase, if any, happened in any of technology, pedagogy, or content areas. Then I would categorize the quantitative findings based on some aspect of the participants (i.e. their pre level of knowledge or level of change in the knowledge). Further, I thought I would look for more indirect effects of increase in knowledge, if any, on other areas of this study (sense of self-efficacy and attitude).
2. I thought I would examine the change in the level of teachers' sense of self-efficacy quantitatively. Similar to what stated in the previous step, I would look at the qualitative data to find any evidence that could either support the quantitative findings or reflect on those things that might have not been captured by the survey. Again, I considered categorizing the quantitative findings based on some certain aspects, after the quantitative analyses were done.
3. I thought I would do the same thing for investigating the teachers' attitude towards teaching with technology.

4. Finally I thought I would categorize the teachers based on certain aspects of the participants using the data retrieved from the background survey and try to make a richer argument around the findings from the assessments on knowledge, sense of self-efficacy and attitude.

2.3.9.2 The Modifications to the Plan

In order to conduct the quantitative analyses of the survey data, I looked at all the answers given by all the teachers to all the questions in each survey. After the result of this step was determined, I wanted to categorize the participating teachers based on a number of their characteristics which I could examine the qualitative data based on. I was not able to categorize the teachers based on either the PRE or POST levels of sense of self-efficacy or attitude, since the numbers were not diverse enough to provide sufficient number of categories. For example the PRE attitude values were in the range of 3-4.2 and the Post attitude values were in the range of 3.5-4.5. Similarly, the PRE and POST levels of sense of self-efficacy values were both in the range of 3-5.

Additionally, I looked at those 5 questions in both the technology self-efficacy and attitude survey that had significant changes in their answers to see if I could categorize the participants based on those. That did not become an option either. Finally I decided to look at the pool of the qualitative data and find evidences for some increase in the level of knowledge, sense of self-efficacy and attitude, in the qualitative format. The result of this investigation will be presented later.

Furthermore, after examining the data that was retrieved from the background survey, I realized that I could categorize the participating teachers based on their self-reported levels of "experience teaching with technology" which were sufficiently distributed. Teachers were nicely distributed into five categories with two teachers having had rated themselves as "1", seven teachers rated as "2", six teachers rated as "3", seven teachers rated as "4", and three teachers rated as "5". I looked into the qualitative data related to these teachers (their blogs, curriculums, and statements in the debriefing sessions) searching for useful themes and trends.

One reason for mixing the data retrieved from the background survey and the qualitative material was the fact that we did not consider having some level of expertise in teaching with technology or robotics as a factor while recruiting the sample for this study. Therefore, studying teachers with different levels of experience with using technologies or teaching with them became another area of investigation itself.

CHAPTER 3. Results

Of the 32 teachers participating in the summer professional development institute, data was included in analysis for a final sample of N=25 teachers who completed and submitted all pre and post survey responses. In order to determine changes in teachers' knowledge and attitudes as a result of participation in the institute, pre and post comparisons using paired two-tailed T-tests were used. Qualitative data from the curricula drafts, blogs, and debriefing session were also examined in relationship to teachers' knowledge. Results show statistically significant increases in the level of knowledge in all the three areas of technology, pedagogy, and content knowledge after participation in the institute. Additionally, results show significant increases in several aspects of technology self-efficacy and attitudes toward technology. Analyzing the qualitative materials also shows signs of improvement in the participants' feelings, sense of self-efficacy, and knowledge, in more indirect ways.

3.1 Technology, Pedagogy, and Content Knowledge

3.1.1 Survey Results

Questions from the 28-item TPCK survey were used to determine whether or not teachers made significant gains in their knowledge of technology, pedagogies for teaching with technology, and/or knowledge of robotic content. On average, participating teachers had significantly more knowledge in the three areas of Technology, Pedagogy, and Robotics Content after participating in the summer robotics institute. Teachers' average level of knowledge was significantly higher *after* participating in the summer robotics institute (M= 4.2, SD=0.4) compared to *before* the institute (M=2.1, SD = 0.6);

t(24)= 2.06, p<0.05). For each of the 28 questions in the Teacher Knowledge survey, paired two tailed t-tests were used to compare teachers' pre and post responses. The average scores given to all of the 28 questions were significantly higher after participating in the institute (see Table. 1 for complete list of questions).

Table 1. Significant Increases in Knowledge after Participation in the Institute

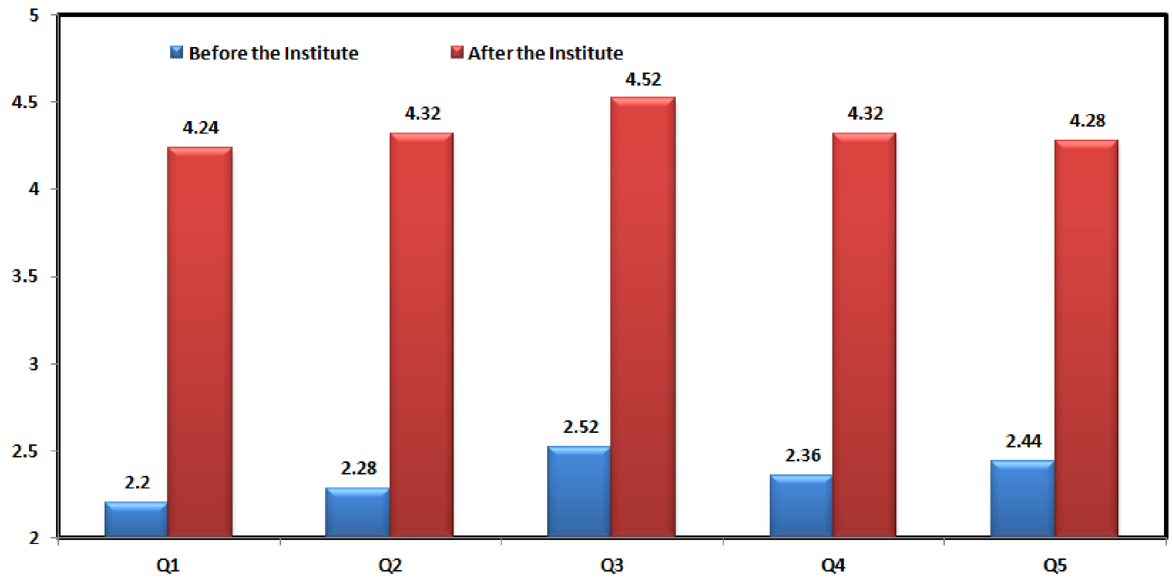
Knowledge Survey Items	**Mean Knowledge (Pre)**	**Mean Knowledge (Post)**	**Mean Difference in Knowledge**
Knowledge of what makes a device a robot.	3	4.6	1.6***
Knowledge of the main components of a robot.	2.6	4.5	1.9***
How a robot is given instructions.	2.8	4.6	1.8***
Stages of the Engineering Design Process.	2.4	4.4	2.0***
How to apply the Engineering Design Process in robotics activities.	2.2	4.2	2.0***
Effective teaching approaches to guide students' thinking and learning in robotics.	2.6	4.2	1.6***
How to teach the construction aspects of robotics.	2.2	4.2	2.0***
How to teach the programming aspects of robotics.	2.4	4.3	1.9***

How to teach robotics in a developmentally appropriate way for young children.	2.4	4.3	1.9^{***}
How to integrate robotics into other traditional content areas (i.e. math, literacy, science).	2.5	4.5	2.0^{***}
How to use robotics to enhance students' problem solving skills.	3.5	4.5	1.0^{***}
How to use Engineering Design Process to teach robotics.	2.3	4.3	2.0^{***}
How to use robotics to enhance students' collaboration skills.	3.4	4.6	1.2^{***}
How to plan student-centered robotics projects in the classroom.	2.9	4.5	1.6^{***}
To implement student-centered robotics projects in the classroom.	2.9	4.2	1.3^{***}
How to assess students' learning in robotics.	2.6	4.0	1.4^{***}
How to assess students' learning when integrating robotics with other traditional content areas (i.e. math, literacy, science).	2.7	4.0	1.3^{***}
Have used CHERP in the past.	1.4	1.6	0.2
How to program a robot using CHERP	1.4	4.2	2.8^{***}

(any kind of robot, i.e. a WeDo robot, a LEGO RCX robot, etc.).			
How to program with CHERP, using both the tangible and graphical versions.	1.3	4.4	3.1^{***}
Understanding of the different messages (including the error messages) given by CHERP.	1.2	4.1	2.9^{***}
How to access all rows of programming blocks (to use Repeats, Sensors, etc.) in the graphical version of CHERP.	1.2	4.2	3.0^{***}
Able to construct a sturdy KIWI robot.	1.2	4.3	3.1^{***}
Knowledge of the power source of KIWI is.	1.2	4.5	3.3^{***}
How to program KIWI using CHERP.	1.2	4.5	3.3^{***}
How the CHERP program gets transferred to the KIWI robot.	1.1	4.4	3.3^{***}
How to build a moving robot using KIWI and CHERP.	1.2	4.5	3.3^{***}
How to build a sensing robot using KIWI and CHERP.	1.0	3.9	2.9^{***}

$^{***}p<.001$

The areas in which the most significant increases in knowledge were found were from the Technology section of the TPCK survey (KIWI/CHERP). However, there were also highly significant differences in teachers' pedagogical knowledge of *teaching* robotics and programming (Figure 7).



- Q1: Knowledge of teaching the construction aspects of robotics.
- Q2: Knowledge of using the Engineering Design Process to teach robotics.
- Q3: Knowledge of how to integrate robotics into other traditional content areas (i.e. math, literacy)
- Q4: Knowledge of teaching the programming aspects of robotics.
- Q5: Knowledge of teaching robotics in a developmentally appropriate way for young children.

Figure 7. Five Pedagogy Knowledge Questions with the Most Significant Increases in Scores

3.1.2 Investigation of the Qualitative Materials in relation with Teachers' Technology, Pedagogy, and Content Knowledge

While looking into the qualitative materials in relation with the participating teachers' knowledge assessment, I had two main goals in mind. One was to find more obvious cases of the learning processes that had happened at the workshop. Secondly, I wanted to know whether there were evidences of any changes in teachers' sense of self-efficacy and attitude that although not captured by the surveys and in form of numbers, still happened as the result of gaining knowledge in different areas of technology, pedagogy, or content.

I was able to find many cases where teachers' explicit statements on what they had learned from the institute, could be easily mapped to one of the area of knowledge proposed by the TPCK framework. An example set of teachers' statement and their relation to the TPCK framework follows below:

- "Also, I noticed from observing other creations that the motors can be placed in different positions. " (Technology Knowledge).
- "I learned that robotics can be key in teaching concepts like sequencing in deeper ways than we've tried before."(Content Knowledge).
- "Robots can stimulate language and social interaction. They can also help with learning self-regulation because the children must control impulses in order to build the robot and make it operational." (Content and Pedagogical Knowledge).
- "I saw many creative ways to implement robotics in my room using literacy, math, art, etc. I loved seeing everyone's product." (Content Knowledge and Integration in general).
- "Really excited about playpen vs. playground. Can't wait to bring it back to my district. It's exciting to think about children as Producers of technology vs. consumers of technology" (Content Knowledge and Integration in general).

In addition to more direct statements on teachers learning in regards with technology (both CHERP and KIWI), robotics, and ways of teaching it as no-numeric evidences of increase in Knowledge, I have considered another way of interpreting the teachers' expression of what they have learned. In my opinion, the hands on nature of the workshop, provides teacher another level of understanding in regards to the actual implementation. When teachers experience different feelings and senses of capability as the result of participation in the workshop, it is more likely that they will take their experience into consideration when they are getting prepared for the integration (i.e. designing the curriculum), or the actual implementation in the classrooms. In other words, as teachers get to know more about the technology integration by being students themselves, they will have better feelings and more confidence towards taking the phenomenon to their students and becoming teachers again. I have listed some examples of these cases below with more explanation on how they can relate to better sense of self-efficacy and attitude.

- *"Collaborating and documenting were the most useful to me*."- Knowing this pedagogical approach helps this teacher to come up with better ways of handling the integration in her classroom, resulting in improvement in her sense of self-efficacy.
- *"When using robotics you must feel comfortable to make mistakes. It is all about trial and error. You may try something one way and after you watch it a few times, it may not be what you want."*- This is another pedagogical approach that increases a teachers' sense of self-efficacy and could improve her attitude towards both using technology and teaching with it. A teacher who announces

such thing after trying it herself, will consider it to design a more effective curriculum and not as a sign of failure in her approach.

- *"Having time to explore the program and how it connected to the hardware was very useful. I think this kind of time will be vital to the children feeling comfortable as they begin their own engineering process."*- Considering the fact that time is always a challenge for educators, this can result in designing a more doable and realistic curriculum, higher sense of self-efficacy and possibly more successful integration in the classroom.
- "*Strategies we used were based on communication of what we could bring to the project, dividing the necessary tasks, collaborative problem solving (again communication was key) and synthesizing information to figure out how to improve our work together."*- A teacher who can summarize her learning in this way is more likely to remember the importance of having all the stated features while getting prepared for taking technology to her classroom, and enter the process with more confidence (higher sense of self-efficacy).
- *"The whole process of planning and designing and the fact that mistakes are learning opportunities for teachers as well. We view them that way for children but sometimes we want to be experts."*- This is another example of improvement in feelings towards teaching with technology (and possibly sense of self-efficacy) which has happened as the result of becoming learners first and teachers next!
- *"I think that allowing us to figure this out by trial and error will help us in the long run."* – It seems that as this teacher talks about her learning, she has her

students and their free learning in mind. The word "us" is likely to be representing the students in her class. Making such conclusion can be a sign of improvement in the sense of self-efficacy towards technology integration and meeting its requirements.

- *"I had to think about my curriculum, create and problem solve. I had to test and improve as I worked"*- This teacher thinks about her work as a teacher as she learns as a student. She seems to have gained enough confidence as a learner that she can think about teaching what she had learned at the same time.
- *"Collaborating with my peers when I was stuck/confused or when they were stuck/confused."*- After feeling good about something that has worked for her, this teacher might consider having the same thing in her classroom in order to have better integration.
- *"I think that I learned most from talking to the group members so I would definitely set up stations for kids to collaborate with one another. Also Planning is very important when creating robotic activities. Students should be given multiple chances when working on their projects*."- A teacher who has learned more as the result of collaborating with others or having multiple chances to try her ideas, will not become anxious about having the same things and the challenges that they might bring along, in her classroom.

In general according to qualitative data from teachers' blogs and interviews, teachers often related their gains in knowledge to the amount of time devoted to each curricular activity and the hands-on nature of the institute. One teacher explained that, "*it was great to touch and manipulate things, explore, make mistakes, and take the time to* *do all these. As teachers, we are not always given the resources we need, including time, to prepare to engage our students in learning adventures such as robotics.*" Several teachers also related their gains in knowledge to the collaborative nature of the activities. For example, one teacher stated that, "I think I learned most from talking with my group members" while several others described working with a partner and/or learning from looking at other participants' projects. Interactions amongst teachers were particularly rewarding since we had a heterogeneous group with teachers coming from both private and public institutions, urban and suburban locations and across 7 states in the US. The group diversity allowed teachers to expand the range of educational experiences they were used to.

3.2 Attitudes towards Teaching with Technology

3.2.1 Survey Results

The "Attitudes towards Computer Technology (ACT)" instrument assesses perceived usefulness of and comfort/anxiety with computer technologies. In order to investigate the possible changes from a different perspective than looking at all the questions at the same level, I divided the questions into two categories. The first category included the questions that are tailored towards more general feeling towards technology. The second category includes the questions that are aiming towards examination of feelings towards technology used by the participants in their profession. The two categories of questions are shown in Table.2.

To measure teachers' attitudes towards teaching technology and engineering matched pair analysis was used for both groups of general and specific questions on the

"Attitudes towards Computer Technology (ACT)" instrument. Increases were significant for only one question from the general category and four questions from the questions more specific to the profession. The changes include : teachers' attitudes regarding the necessity of using computers on a daily basis ($t(24) = 2.06$, $p < .08$), attitudes regarding using computers to communicate with others and to be effective at work ($t(24) = 2.06$, $p < .07$), attitudes regarding use of computers to create materials that can enhance job performance ($t(24) = 2.06$, $p < .08$), and finally, attitudes regarding the use of word processing software to be more productive ($t(24) = 2.06$, $p < .08$)

Table 2. Two Categories of Questions used in the Attitude Survey.

Questions about feelings towards using technology in general	**Questions about feelings towards using technology in profession**
I am confident about my ability to do well in a course that requires me to use computer technologies.	Using computer technologies to communicate with others over a computer network can help me to be more effective in my job.
I feel at ease learning about computer technologies.	Using computer technologies in my job will only mean more work for me.
I am not the type to do well with computer technologies.	I do not think that computer technologies will be useful to me in my profession.
The thought of using computer technologies frightens me.	With the use of computer technologies, I can create materials to enhance my performance on the job.
I am anxious about computers because	I could use computer technologies to access

I don't know what to do if something goes wrong	many types of information sources for my work.
I feel comfortable about my ability to work with computer technologies.	Computer technologies can be used to assist me in organizing my work.
I don't have any use for computer technologies on a day-to-day basis.	Knowing how to use computer technologies will not be useful in my future work.
If I can use word-processing software, I will be more productive.	
Anything that computer technologies can be used for, I can do just as well some other way.	
I don't see how I can use computer technologies to learn new skills.	

3.2.2 Investigation of the Qualitative Materials in relation with Teachers' Attitude towards Teaching with Technology

In order to examine the qualitative materials for this section, all the qualitative materials were investigated. I specially looked at teachers answers given to two blog questions that were about the "challenges" and "success stories" of the day. When we included those two questions in the blog, we wanted to investigate how much frustration, anxiety, excitement, and positive feelings teachers experience while attending the workshop. Therefore, the answers given to those questions can give us an insight towards doing a better analysis of the participants' attitude. In my analyses for this section I looked for explicit words that related to feelings (terms such as "Feeling", "Excited", "Frustrated") in the participants' answers and comments, and also captured those statements that seem to be reflecting teachers feeling indirectly.

One teacher has stated that "*I learned that even though my school has been working with robotics for over a year feeling new is part of the process.*" Additionally, "Collaboration" is specified as the success story of the day by many teachers who had expressed their excitement for having the chance to work with others. When teachers talk about their successes throughout the day, it is very likely that what they have felt good about comes to their mind. Therefore, there is a higher chance that their feeling towards the matter (in this case collaboration that is part of robotics in nature) becomes a motivation for them to take it to their students and classrooms. On the other hands, statements given by a few teachers showed some level of frustration experienced by them while they had tried to work with the other members of the group. They had not got the chance to work with computers or the other materials either due to the lack of time or because someone else in the group who seemed to be better at the job, had taken over.

One teacher expresses her feelings in the form of frustration. She says "*I feel a little frustrated after seeing the more complex projects that were presented. I will feel better if I have some time alone to experiment, I think.*" In a different statement another teacher states: "*I feel I may need a lot more training. Practice makes perfect! Right?*". Interestingly, a number of teachers have said that the success story of the day for them has been "*seeing other people's creative projects*".

In conclusion, it seems that participation in the workshop and having the chance to observe others at different levels of expertise can trigger different feelings in individuals based on their personalities or the environment they are put in. What I have discussed here confirms the possibility that although we did not observe changes in the level of attitude in a considerable number of questions in the survey, obviously participation in the summer institute has been effective on the participants' attitude towards technology (and teaching with it) to some extent.

3.3 Sense of Technology Self-Efficacy

3.3.1 Survey Results

To measure changes in the teachers' sense of technology self-efficacy, teachers' responses to the 21-item "Computer Technology Integration Survey (CTIS)" were examined. Results show that, although their level of technology self-efficacy has improved in general (increases in scores given to most of the survey questions were found), the level of improvement was only statistically significant on 5 of the questions. For the assessment of this survey's data I did not categorize the questions into two groups of personal and professional as I did for the attitude survey since all the questions in this survey focus on teachers' sense of self-efficacy towards technology integration.

Two tailed t-tests were used to assess the significance of teachers' increases on all 21 items from pre to post. The five areas that demonstrated significantly higher scores after the institute were: confidence in understanding computer capabilities well enough to maximize in the classroom ($t(24) = 2.06$, $p < .05$),confidence in ability to use correct computer terminology when directing students' computer use($t(24) = 2.06$, $p < .05$), confidence in ability to motivate students to participate in technology-based projects ($t(24) = 2.06$, $p < .05$), confidence in ability to mentor students in appropriate uses of technology($t(24) = 2.06$, $p < .03$), and confidence that ability to address students' technology needs will continue to improve($t(24) = 2.06$, $p < .02$).

3.3.2 Investigation of the Qualitative Materials in relation with Teachers' Sense of Technology Self-efficacy

In my search for any qualitative signs of improvement in teachers' sense of self-efficacy towards technology integration, I looked for terms such as "confident" or "confidence" that could directly relate to one's self-efficacy. No statement containing such words was detected. In addition, I carefully investigated those statements that I thought were indirectly related to the topic of self-efficacy. For instance, one teacher stated that "Robotics requires free exploration, flexibility, imagination and can be done by a beginner". Using the word "beginner" shows that the participants had been considering herself a novice at robotics prior to trying robotics. Such perception can be a source of anxiety or result in lack of confidence. However, it seems that trying robotics firsthand has given the teacher a chance to realize that she can learn robotics by engaging in free exploration, flexibility and imagination. It is very likely that after going through this learning process, this teacher makes the same conclusion for her beginner students. Knowing what robotics is like and what its requirements (both technical and pedagogical) are, can result in a higher sense of self-efficacy towards robotics.

Additionally, I discovered a number of different looking comments that contain similar trends. For example, one teacher said that "*The success of the day was the* *willingness of others to help out. We did see that we all had some weakness*". Another teacher had stated that "*I loved observing the other groups working on their projects. I was so impressed with their comfort level and expertise. I hope to get there soon*". Although these two comments seem to be coming from different perspectives (for one seeing other's weakness is a source of comfort and probably better confidence and the other one is impressed and motivated from seeing more expert participants' projects), it seems that they both are benefiting from their involvement in the workshop towards building more confidence and better sense of self-efficacy.

The variety of the statements given by teachers in relation with their sense of self-efficacy helped me realize that although the numbers retrieved from the analyses of the technology self-efficacy survey do not reflect considerable amount of change in the level of teachers' confidence towards doing robotics in their classrooms, their exposure to the new experiences in relation to their self-efficacy benefited them in some ways. In another comment given by a teacher I read "*Collaboration is essential; it's okay to let go of an original idea; I gained a better understanding of the possibility of robotics in the classroom; documentation is essential in this project*". In my opinion this teacher is summarizing her learning (about collaboration, documentation, or letting go of an original idea) in order to be able to take it into consideration when thinking about doing similar activities in her classroom. It is important that according to the teacher, she has gained an understanding of the possibility of robotics in the classroom since that is an essential step in building an educator's confidence towards integration of robotics.

The participants have gained some clear ideas about different approaches that would make “doing robotics” more successful as the result of trying it firsthand themselves. This again increases the chance of integration since teachers’ newly formed ideas can help their students and make robotics more doable. An example of the statements on such matter is: “*I learned the importance of keeping the projects simple and expanding them in small steps so that I can figure out where the problems originated*”. Another example would be “*I also learned that small steps and small successes are good because they can build up to larger successes*”. Teachers who become learners first, are more likely to design curriculums and plan activities that are more realistic and can be successfully implemented by students.

3.4 Teachers and their Background

3.4.1 Survey Results

When asked about their personal experience with technology (On a scale from 1-5, please describe your personal experience with technology), out of the 25 participants being studied in this thesis, except for one person who rated herself as novice, all the other teachers rated themselves as average or expert. When asked about their experience teaching with technology in their classrooms (On a scale from 1-5, please describe your experience teaching with technology), eight teachers rated themselves as novice, while the rest rated themselves as average or expert.

18 out of the 25 participating teachers stated that they were participating in the institute with another teacher or colleague from their school or school district while the rest were attending the workshop alone. When teachers were asked about whether next

year, they were planning to collaborate with a colleague in the implementation of their robotics curriculum, six teachers gave "Maybe" and the rest gave "Yes" as answers. Three of those "Maybe" answers were given by those teachers who had participated in the institute alone. Two out of the other three teachers with "Maybe" answers were participating in the institute with another teacher, had stated that the circumstances of their schools and also the availability of the materials required make them doubtful in feasibility of implementing robotics in their schools/classrooms. One teacher who was participating with another teacher however, stated that "Maybe" she will collaborate with another colleague. The reason given by her was: "*I hope I am knowledgeable and comfortable enough with the curriculum by next year so that it doesn't feel so new*".

When teachers were asked to select all the technologies that they had taught with, except for one teacher who had not used any type of technology, every one stated that they had at least used "computer" as a technology that they have taught with. In addition to that, many had reported use of other types of technologies including Robotics, IPads/Tablets, and Smartboards in their classrooms. Seven Out of the 25 teachers in the study listed "Robotics" as a technology that they had taught with.

3.4.2 Investigation of the Qualitative Materials in relation with Teachers' Background

In order to investigate teachers sense of self-efficacy and attitude from other points of view, I categorized the participants based on their self-reported experiences in regards with teaching with technology (on a scale of 1-5), and then looked at different groups' comments and statements from the blogs, and the debriefing session. One teacher who had rated herself as novice with regards to technology and teaching it, stated: "*I learned that even though my school has been working with robotics for over a year feeling new is part of the process*". It seems that although this teacher has rated her experience teaching with technology as low as a novice person, that does not necessarily reflect on her sense of self-efficacy or attitude towards the technology. This case shows that lower numbers do not necessarily provide us a broad perspective on some matters. This teacher's acknowledgement of feeling new as part of the process proves that she takes that feeling as a positive step towards building more confidence and improved knowledge and not as a negative feeling.

Another teacher who had previously used robotics in her classroom rated herself as novice while reporting her experience with technology. She also stated that "Maybe" she will collaborate with a colleague next year, although she attended the workshop with another teacher/colleague. This is the same person who has stated in her blog "*I may need a lot more training. I will feel better if I have some time alone to experiment, I think .Practice makes perfect!".* It might be that collaboration makes learning robotics more challenging for this teacher. In this case giving enough time to the teacher to become fluent in the knowledge she needs to have according to the TPCK framework, might help her overcome the obstacle of dealing with the collaborative aspect of robotics. If she gets to such point, she will have the confidence to take it to her classroom and manage the challenges that the collaborative nature of robotics activities would bring to the classroom while tried by her students. During the debriefing session, a teacher said: "*Ultimately, becoming comfortable enough to use the technology to feel like we could be creative and collaborate is the goal*". Therefore, having sufficient knowledge helps the teachers benefit from other features of robotics, feel better about it, and finally help their students benefit from it.

Finally, I would like to summarize this section by bringing a statement from one of the participants. She said: "*Whether you are novice or experts at using these materials, you will always learn something new!*". Teaching and learning in any field including robotics can tremendously benefit from such motto.

3.5 Relationships between Variables

In addition to looking at the changes in the level of knowledge, self-efficacy, and attitudes, relationships between these variables as well as relationships between these variables and teachers' background information were investigated using the Pearson-product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of normality and linearity of all data sets (see Appendix G for statistical analyses).

Results show a moderate positive correlation between teachers' personal experience with Technology and teachers' pre-test level of technology self-efficacy ($r = 0.36$; $n = 25$;$p<0.005$). Additionally, a moderate positive correlation was detected between the teachers' experience teaching with technology and pre-test levels of technology self-efficacy ($r = 0.37$; $n = 25$;$p<0.005$). However, teachers who had less knowledge in different areas of TPCK before starting the institute, gained more knowledge after completion of the workshop, compared to the ones who started their experience with more knowledge. A strong negative correlation was detected between the teachers' pre level of knowledge and the difference in the level of knowledge ($r = -0.75$; $n = 25$; $p<0.05$)

Teachers who started the institute with a lower level of self-efficacy, experienced more improvement in their level of self-efficacy after the institute, compared to the ones who began the workshop with a higher level of self-efficacy. A strong negative correlation was detected between the teachers' pre level of self-efficacy and the difference in the level of technology self-efficacy ($r = -0.82$; $n = 25$; $p<0.005$)

Furthermore, teachers who began the institute with more negative attitudes towards computer technologies improved their attitudes more so than teachers who started with highly positive attitudes towards technology. A strong negative correlation was detected between the teachers' attitude levels before the workshop and the difference in their level of attitude from pre to post ($r = -0.69$; $n = 25$; $p<0.05$)

Looking at the background survey showed no specific pattern in how teachers with different ages feel about technology, both personally and professionally. There are older teachers with higher numbers of years teaching who have rated themselves high in regards with their personal and professional experience with technology, as well as younger teachers with lower numbers of years teaching who have rated themselves lower in regards with their personal and professional experience with technology. However, there is a strong positive correlation between the personal experience with technology and the experience with teaching technology in the classrooms($r = 0.79$; $n = 25$; $p<0.05$). Teachers who generally have had better experience with technology, reported a higher level of experience teaching with technology as well.

Moreover, a moderate positive correlation between the teachers' Personal Experience with Technology and Pre level of technology self-efficacy was detected. ($r = 0.36$; $n = 25$; $p<0.005$). Also, A moderate positive correlation between the teachers' Experience Teaching with Technology and Pre level of technology self-efficacy was discovered ($r = 0.37$; $n = 25$; $p<0.005$). Additionally, the analyses show a moderate negative correlation between the teachers' Experience Teaching with Technology and the difference in the level of technology self-efficacy ($r =-0.39$; $n = 25$;$p<0.005$).

Finally, we investigated the correlation between the number of years teaching and experience with teaching technology, the age and personal experience with technology, the age and experience with teaching technology. No correlations were detected after theses last investigations.

CHAPTER 4. A Few Notes on the Workshop, Curriculums, Final Projects, and Classroom Implementation

4.1 In what ways the workshop was appreciated?

Since the topic of this research focuses on the effectiveness of the summer robotics institute that was held for helping teachers integrate robotics technology into their classroom, I decided to include a number of the participants' statements which are related to the characteristics of the workshop itself. The general features of a professional development workshop should be carefully designed and planned before strategies are put in place to customize it towards fulfilling a special goal which in the case of this research, was to help early childhood educators with the integration of technology into their classrooms.

In a workshop like the summer institute which aims to provide teachers all the opportunities to better understand how the integration in reality will be (and therefore improve their sense of self-efficacy and attitude), the balance of theory and practice is an important factor to consider. Many teachers stated their satisfaction about the inclusion of the right amount of theory and practice during the three days of workshop. One teacher said: "*I enjoyed the structure of the day. I appreciated the theory and lecture in the a.m. and the time to explore and create in the afternoon*". Observing such combination and benefiting from it, might result in improvement in the teachers' level of confidence since they can plan the structure of their integration program in a more effective way.

Additionally, teachers appreciated the fact that although they participated in a professional development workshop, they were able to learn and try everything as adult learners while considering their students' perspective, due to the structure of the institute. Many enjoyed the two phases "free exploration" and "more intentional work" as it provided them both the chance to learn robotics and also a better sense the structure that might work in their classrooms as well. One teacher stated: "*I appreciated that you focused on us as adults instead of putting us in the mindset of a child using it. You recognized our learning as an important first step. So the activities mixed with the time to chat, mixed with this kind of time to hear from each other, and your availability, made it really powerful".*

Another important characteristic of the summer institute that was noted by many teachers in their statements both in the blogs and the debriefing session was "*the instant feeling of familiarity and comfort when entering the workshop*". This is an interesting matter since although not captured by any of the surveys, teachers were experiencing good feelings throughout the workshop which made learning robotics pleasant for them. One reason for such atmosphere could be the shared interest among the participants. In other words, most of the teachers who participated in the workshop had been actively looking for learning opportunities such as this institute, and had common goals in terms of moving towards technology integration into their classrooms. During the debriefing session and when asked to reflect on positive and negative feelings experienced throughout the institute, a teacher gave the following statement: "*[There were] lots of exchange, and the expectation not being about expecting bugs, expecting problems, [but instead] don't worry if your robot isn't, you know, top quality functioning. You know* *there's all this other process learning along the way. [I] loved being part of this community of learners*". Interestingly, the term "community of learners" was repeated a number of times in the blog and the debriefing session statements and comments.

Finally, knowing that they can still collaborate after the workshop was over made teachers feel confident and motivated to maintain their interest and enthusiasm. For example one teacher noted: "*I liked the diversity of the group. I really liked the idea of being able to communicate. Not just here within the three days, but the ongoing communication for the next year and beyond. I like that, and I really like the website that you have designed for us to upload curriculum, talk about lessons, and to share and discuss some ideas.*" As I noted before, this thesis is only the first step of a three years project. After the workshop teachers will continue receiving support from DevTech researchers during implementing the technology curriculums in their classrooms. They can also communicate and share ideas with the rest of participants using the early childhood robotics network that was previously introduced in the workshop section.

4.2 Curriculums Drafts and Final projects; moving towards technology integration!

Part of the qualitative materials that were used towards more thorough analyses in this study were the curriculums that the participating teachers designed as the first draft of the technology curriculums they were going to implement in their classrooms. Curriculum templates were given to teachers in order to give them a basic idea to build around (or even fully implement in their classrooms if they wanted). Also, they completed robotics projects within multiple groups. As these robotics projects and curriculums can be used to show examples of what teachers learned through the institute and as the first step towards integrating technology into their classrooms, I decided to include a number of interesting points from a few cases of those here.

After teachers received the two curriculums developed at DevTech (the Motion and Dancing curriculums), they were given a Robotics Curriculum “Big Picture” Planning Sheet to design a draft of their technology curriculum (see Appendix A).

A number of themes stated by teachers for their curriculums include Children of the World, Fundamental Human Needs, Life Cycle of the Butterfly, and Animal in their Habitats. According to all the curriculums, different subjects can be integrated into the unit. A few examples include:

- Literacy (i.e. becoming familiar with engineering and robotics terms, reading and writing non-fiction texts, questioning, and vocabulary development, and storytelling both oral and written)
- Art (i.e. making maps, dramatic arts: acting out plays about animals in the winter, visual arts: designing and constructing an animal home, drawing and making collage)
- Math (i.e. timeframes for animal hibernation and migration, working with numerical facts comparisons)
- Science (i.e. animal adaptation and behavior, seasonal changes, natural and man-made resources, land masses and ocean)
- Social Studies (i.e. self-regulation, cooperative play, understanding and taking on roles in community)

Many teachers have considered structuring the robotics sessions in their classrooms according to the needs of their students. Fine motor, speech, abilities to express ideas in different ways such as writing, drawing, movement, using clay and play dough to hold LEGO small pieces together while using them with pre-school and kindergarten children, and finally accommodation for children with special needs and considerations are among the factors that teachers considered to make the curriculum fit their classrooms and students characteristics the best.

A number of final project proposed by the participants are brought here as examples of the summer institute participants attempts for having an age appropriate technology integrated into their early childhood classrooms:

- "The focus will be on animals in their habitats/biomes. Children can create biome with art materials and program robotic animals to interact with environment."
- "Each child builds something that represents chosen country that can be attached to Kiwi. Each child writes a program to move robot on map from MA to that country using a sequence of commands that includes moving forward, a spin or turn, a beep or song, and a sensor to stop."
- "Children will build a motorboat that will travel across an ocean and return to the dock (forward and backward motion)".
- "Children will use robotics to create an example of a need… nourishment, communication, art, defense, or shelter within a culture of a given culture, expressed with art materials and enhanced by movement. This is to help them

internalize that all humans are connected through basic needs. To allow them to express their unique vision of what that means using art supplies and robotics."

- "The students will build a female monarch butterfly robot who must find her way through a path of hazards (trees, bushes, buildings, etc.) to a milkweed plant so that she can lay her eggs and allow the life cycle to continue."

Teachers mostly chose the dancing robot as the theme to create their final project based on. Different types of dances were implemented by the groups. Dances include Square dancing, Mexican hat dance, and Hula dance. One interesting project was done by a group of teachers who wanted to use two robots to implement the dance. While all the other groups preferred having mobile robots, this group made stationary robots that were holding hands by using motor boxes in the top motor slot, attaching pipe cleaners to the motors, and connecting the pipe cleaners of one robot to the other's while they used repetitive motions of forward and backwards to demonstrate dancing moves while holding hands.

4.3 Robotics in a Classroom; following up with a Participant

Right prior to finishing the writing of my thesis, I had the chance to go to the classroom of one of the participating teachers in the institute. Although I was not involved in the observation and support provided by the researchers of the DevTech lab, I wanted to take this opportunity to observe the implementation and talk to this teacher about her experience. This was a first grade classroom with one teacher and eleven students. The teacher was extremely enthusiastic (and I remember the same attitude from the institute as well) and the children were very much excited about the robotics sessions and their products. There were five groups of two and in each group a girl was paired with a boy.

She described her whole experience as a great and fascinating one. When asked "What has been challenging and what has been easy?", she stated that "Time" has been the most challenging. According to her, she decided to use the curriculum that had been developed at the lab "*because the theme is kid-focused and I like the deliberateness and flow of the challenges*". She has placed the robotic curriculum in place of Math and Writing period in order to devote more hours to it each week. Additionally, she stated that "*Resources, specifically computers from which to run CHERP*" had been another challenge for her. This is aligned with some of the impediments that were discussed in the literature review section of the thesis. Since her school computer lab does not have enough space for all the students to work on the computers, she needs to arrange the schedule "to allow students to spend one period building, and another period to program." On the other hand, she also stated "*The easy part is getting children and families excited about this project. We all enjoy it so much! Thank you!*"

She explained her decision for using the curriculum developed at DevTech instead of creating a completely new one as follows: "*It was a practical choice for me to use the WeDo Playground curriculum developed by DevTech as basis for the robotics adventure I am embarking with my students. I am so glad I decided to use this curriculum as a way to get into the business of teaching robotics to young children. It allowed me to learn along with the children, sometimes just a step ahead of them, sometimes at level, and sometimes a step behind them (like with the "until near/far" instructions). It is a very* *helpful document. Thank you!*" This is interesting since her statement is well-aligned with our intention of providing teachers with useful materials including the curriculum and student assessment form samples. My immediate thought after hearing her choice for using the DevTech curriculum was to find out why she had made such choice, and whether and in what ways her choice had met her classrooms' specific needs the best. Before I got the chance to ask my questions in that regard and as she went on to talk about her experience, I realized that she had only used the curriculum as a base to initiate her work and make the transition to the implementation phase of the integration smoother.

According to her, these children had asked the other first grade classrooms' student to tell them about the needs they had observed in the community and thought needed to be addressed. After receiving multiple "orders" from their "clients" they had decided on a final project and designed a robot to address a specific need in the community. Children made videos of their activities and projects to use in Show and Tell (A creative idea!). Since her focus of work this year has been on the people of the community, she has introduced engineers as "community helpers" as another way to get students motivated about learning engineering and robotics (Another creative idea!). Additionally, although she happens to be able to pair a boy with a girl, she wanted to investigate who dominates the other person within a group. According to her almost in all the groups the girls dominated the boys, as they tend to jump in to initiate the project and give ideas as boys tend to stand back and think more before taking any action. This is interesting especially considering the fact that four out of the five boys are heavy Lego builders.

Prior to starting the unit and building any robot, she had her students to use the classroom materials to build chairs in order to understand the concept of “Sturdy” better. For instance, they talked about the structure of a brick wall and practiced making one to recognize the matter some more. This was also to help them get a better idea about how to work within a team and what to consider for successfully collaboration with their peers. According to the teacher, this was important as some of the pieces in the Lego kits were new to some and could result in too much excitement which would take over the whole experience and all the required considerations. She asked the teams to come up with team names, and consider team stations for themselves. In order to prevent losing the small pieces of the Lego kits, she gave each team a shelf and called it a garage! She stated that looking at the curriculum that was already developed gave her the chance to look through it and determine what pieces are required for her classroom and what changes would make it work better for her classroom.

From this teacher’s perspective teaching CHERP is very similar to teaching Literacy. As you start a sentence with an upper case letter and finish it with punctuation, you need to have a Beginning and an End for a program to have the right syntax. Also the idea of having a string of words to make sense in literacy relates to having a string of commands that give meaning to a program. She stated that in her welcome letter to the parents she had included: “*We will be learning different languages this year!*”

It seems that this teacher has been able to take advantage of robotics as a way to help some of her students with their behavioral challenges. According to her, a few students in her classroom who would very often get frustrated while experiencing failure in their traditional classroom activities, benefited from robotics activities as wonderful opportunities that provided them the chance to develop and use strategies to face mistakes and disappointments, and take risks. Since the first day of the school “Making Mistakes” and “Taking Risks” have been part of the classroom’s conversations. Robotics provided the student ways to practice their learning about these topics in action as they gradually became able to “*to feel bad about failed attempts, and immediately try to find ways to fix the mistakes and construct a robotic artifact that works the ways they wanted it to. They stayed positive and focused on their end goal. They also like being videotaped and telling how they figured it out*”.

From the set of pedagogical tools that were used during the workshop, the collaboration web was used by this teacher due to its relation with the classroom’s discussions on community and collaboration topics. According to the teacher, “*The collaboration web concretely allowed the children to see that indeed they help and inspire each other. Nobody said, “You copied me.” Instead, they said, “I helped you.” Or “You helped me.” The idea of collaboration has always been a part of our classroom culture, but having the collaboration web up on the wall raised children’s awareness of each other’s actions and their impact on others.*”

Finally, it seems that different aspects of robotics and its free learning and explorative nature have been used nicely in relation to this classroom’s traditional contents and its structure. As this teacher stated: “*The exploratory, open-ended, and hands-on nature of the learning environment facilitates children’s willingness to take risks and trust in their ideas and decisions. That is what I am able to provide to the* *students during this period I have named "Technology and Engineering." The big words alone make children know that this is a really special time. I think the children are fast becoming chicks who are outgrowing the nest. They dove into this curriculum with so much enthusiasm and now they are ready to take risks and meet the challenges more independently.*" I am very happy that I got the chance to talk to one of the summer institute before closing up the writing of my thesis.

CHAPTER 5. Discussion, Conclusion, and Future Research

5.1 Discussion

This study contextualizes the different elements of Mishra and Koehler' TPCK framework for early childhood educators by focusing on robotics as a domain that integrates technology and engineering. The goal of the work reported here was to evaluate if the early childhood teachers participating in the professional development institute would gain TPCK. Results highlighted the general efficacy of a three-day professional development institute in increasing teachers' technology, pedagogy, and robotic content knowledge as well as several aspects of teachers' technology self-efficacy and attitudes toward technology. Mean scores on all 28 items on the survey developed to assess teachers' Technology, Pedagogy, and Content knowledge improved statistically significantly. This may be due to the amount of time devoted to each of these areas over the course of the 3-day institute. It may also be due to the structure of workshop and the materials that were introduced to the teachers throughout the course of the institute. In their interviews and blogs, many teachers commented on the hands-on and collaborative nature of the institute helping them learn particular concepts.

In examining teachers' technology self-efficacy, the widely used and cited survey called "Computer Technology Integration Survey" (CTIS) was used. This survey contains 21 questions that assess different aspects of teachers' technology self-efficacy in regards to the integration of technology in their classrooms. Results from this survey show a general increase in self-efficacy after participating in the workshop. However, of the 21 questions in this survey, statistically significant increases were only found for five of the questions in the survey. This may be because teachers were asked to complete this survey directly after the workshop and prior to having a chance to actually integrate the new content knowledge they have acquired in their own classrooms.

Finally, by looking at teachers' attitudes towards teaching technology, results show that on approximately 76% of the items (13 out of 17), there was an increase in mean scores from before the institute to after the institute. However, increases were only statistically significant in five areas. This 17-question survey was designed to target teachers' level of comfort and confidence towards technology, meaning a more general usage of computer technologies, not robotics specifically. It was hoped that participating in the summer institute would result in a more positive attitude towards technology in general for all or some of the teachers. Our results indicated that while attitudes improved a little bit overall, there were specific areas in which this institute was able to change the way teachers feel about teaching with technology. Once again, it is important to note that teachers answered these questions directly after participation in the institute and before they have had the opportunity to actually teach technology in their own classrooms. It is possible that after actually implementing the curriculum in their classrooms, their responses to these 17 questions will change.

One of the most interesting findings was that institute was most beneficial for teachers who started the institute with *lower* levels of knowledge and self-efficacy, and more negative attitudes toward technologies than teachers who began with higher levels of each of these. This might be due to the fact that these levels were measured on a 5-point Likert scale. Therefore, teachers who started out lower on this scale had more room to grow than those who began the institute at 4 or 5. This may also be because teachers were provided with many opportunities to play with materials, ask questions, and collaborate with peers. Teachers with less experience and confidence could learn from those who began the institute with a greater experience. Finally, in their interviews and blogs several teachers mentioned that the activities in the institute were fun and/or that they could see that robotics would be fun to bring into the classroom. Given that playfulness is an important aspect of early childhood curriculum, these remarks are positive indicators. After the first day of the institute, one teacher blogged that she had a "fun day" and she was now "*excited to use [robotics] with [her] students and her children at home*". Meanwhile, another teacher blogged that they were having a fantastic time at the institute. By having fun using technology (perhaps for the first time), novice teachers may have changed some of their preconceived attitudes and conceptions about technology.

Additionally, there were some negative changes in the level of technology self-efficacy and attitude for some of the participants. This could be due to a new level of understanding in regards to the self-efficacy and attitude towards technology that teachers achieve after participating in a robotics institute. After completion of the workshop, teachers might have a better understanding of the challenges and the requirements of a successful integration of technology into their classrooms (especially after they know more about the technology, the content, and the necessary pedagogies), that they might answer the questions with lower scores when answering the technology self-efficacy and attitude surveys. Although this was observed through negative numbers, it can be interpreted as a positive accomplishment of the robotics summer institute. Teachers understood how much they did not know before and how much they still need to learn.

5.1.1 The Instruments

After analyzing the data retrieved from the surveys, no considerable amount of change was noticed for both teachers' technology sense of self-efficacy and their attitude towards teaching with it. It is important to note that the short period of the workshop is a determining factor in the amount of change that happens to any of the variables in this study. However, after I went over all the material collected throughout the study (both qualitative and quantitative), I realized that both the attitude and self-efficacy surveys might not be targeting the changes correctly. It would be better to consider the ACT instrument as a base for measuring the changes in the general feelings of the participants towards computer technology. However, we cannot make analyses or conclusions in relation to "teaching", "classrooms", "students", or "educational technology" since there are no questions tailored towards investigating these matters but only a few that are stated in relation to one's "profession".

Also note the context that a survey is used within needs to be considered while designing the survey and analyzing its collected answers. Although sometimes the goal is to assess some general characteristics of the participants in an event (a professional development workshop in our case), people tend to focus on the reason for the presence in the place/event or relate every question to the event itself. Therefore the participants' answers are influenced by these perspectives and are not given in the direction that the researchers might be looking for.

For instance a question like “I am anxious about computers because I don’t know what to do if something goes wrong” seeks for the participants’ general feelings towards using technology. However, since the participants are teachers and are in the institute to receive some education on educational technologies and their use in the classrooms with students, they might immediately think of something that would go wrong while trying technical activities in the classrooms and in the presence of their students. So instead of stating their general feelings, they are actually expressing their feelings towards using technology in their classrooms.

Additionally, something to avoid while designing a survey is to have questions which can be interpreted differently by different people. For instance, a question like “Computer technologies can be used to assist me in organizing my work.” can be interpreted in different ways. Multiple interpretations can happen due to the fact that the participants tent to relate everything to their presence in the environment, or wording of the sentence. The word “work” here can relate to related to one’s personal life or profession. Another example is “I don’t see how I can use computer technologies to learn new skills.”, since a teacher (in our case) might think of the skills in his daily life or the ones that are required or used as part of the profession in the classroom.

Moreover, we should avoid designing questions that gives the possibility of having the participants being assessed for something other than what researchers aim for by asking that question. As it was previously mentioned it is important to be careful about wording of the sentence. By asking a question like” Using computer technologies to communicate with others over a computer network can help me to be more effective in my job. " from the technology self-efficacy survey, we really want the teachers to freely think of the cases that apply to them. However, a teacher who is participating in the summer institute might think of "emailing", "blogging", or "using the early childhood robotics network" as different ways of working with computer network while answering this question.

5.1.2 The Workshop

It was previously mentioned in the section of the workshop characteristics and effectiveness, that experiencing good feelings about cooperating and collaboration with others might result in improvement in teachers' technology sense of self-efficacy as they can consider it a key factor to plan their classroom technology integration around. As an example one participant noted: "*In our desire to build a car and to use sensors, we had lots of problems. We were short on the artistic merit, but we were both on the same page in terms of goals, so it was really fun to work with her*". However, it is essential to remember that there is the need to consider aspects of having collaborative robotics activities in the classroom. For instance, the combination of free exploration and collaboration might result in different situations than what happens with adults as self-regulation is still in the process of developing for children in the age range being studied in this research (preK-2nd).

As previously discussed in the result section, some aspects of the workshop such as "Collaboration" have been given as both the success story and challenge of the day. Examples of such statements follow here. One teacher said: "*It was a good **challenge** to collaborate with someone I just met, and I think we quickly found our strengths and* *communicated well*". Another comment states: "*I feel that the day's greatest* ***success*** *story stemmed from seeing everyone's robots operating and hearing the variety of approaches to developing story lines*". In my opinion, different views being raised about a feature can be a sign that teachers need to pay extra attention and make further effort while taking that feature into consideration in order to prevent additional challenges to happen in the future.

Finally, it is hard to determine in what order the changes being studied in this research happen and whether and how one causes the other. Statements like "*Ultimately, becoming comfortable enough to use the technology to feel like we could be creative and collaborate*", makes us think whether the level of comfort using the technology (sense of self-efficacy) affect the capability of collaboration for adults or children and therefore their feelings towards doing collaborative activities such as robotics? Knowing that any of the research questions in this study can be instrumental to the other one/s is one source of complexity in a thorough investigation.

5.2 Limitations and Future Research

The study presented in this thesis looks only at short-term results assessed directly after teachers had participated in the three-day institute. These results cannot be generalized to assume that teachers maintain the new knowledge they have gained or retain the same attitudes towards teaching technology and levels of technology self-efficacy. In fact, it is very likely that depending on their experience implementing these technologies into their own classrooms, these scores will change. Longitudinal research that follows up with teachers after participation in professional development and throughout the school year are necessary to truly determine how effective this institute was. Our research study will explore that in the upcoming iterations.

Two of the surveys, the Teachers' Technology sense of Self-efficacy and Attitude towards technology surveys were adapted for use in this research. In my search for surveys I looked into numerous available assessment tools for teachers' self –efficacy and attitude. However, I did not specifically take into consideration the early childhood aspect of the study which could be a very strong determining factor. One reason for that is the fact that there is very limited number of studies in the field that are focused on the early childhood education and technology. Therefore, both instruments focus on teachers and technology in general instead of early childhood educators as the main ambassadors of the new movement of technology integration in the early childhood education. Thus, both surveys can benefit from a set of questions that are more tailored towards investigation of teaching developmentally appropriate technologies in lower level grades.

Moreover, in the Teacher's Attitude towards Technology survey, almost all the questions can be categorized as focused on the teachers' general attitude towards computer technologies. Thus, no considerable amount of change was observed in the attitude after the participation in the workshop. The short period of workshop can be the main reason for this, since such short period of time cannot change the participating teachers' general attitude towards computer technology. However, the teacher's attitude towards the specific technology used during the institute is likely to change. Accordingly, inclusion of some questions that would capture the change in the participants' attitude towards the type of technology used during the workshop seems necessary.

Additionally, this study focuses solely on self-report from teachers. It does not look at data from the children in their classrooms. Without classroom data, it is difficult to determine the effectiveness of the pedagogies and strategies that were taught during the workshop, in real school settings. The next phases of Ready for Robotics project need to focus on such investigations, once teachers begin to implement robotics into their classrooms.

The study described in this thesis is only the beginning of a three-year research grant. In the next phase of the NSF funded *Ready for Robotics* project, the participating teachers described here will implement the robotics-based curricular units that they developed during the institute in their own classrooms. Research assistants will keep in close contact with these teachers throughout the year and a combination of qualitative and quantitative data will be collected and analyzed from the teachers and the children in their classrooms. After all the teachers have completed their work in the classrooms, there will be an open house for teachers to share their robotics units, student's experience, and implementation strategies.

5.3 Conclusion

Despite the growing interest in the field of robotics as an educational tool, little effort is focused on the foundational schooling years. For decades, early childhood curricula have focused primarily on literacy and math, especially with the educational reforms of No Child Left Behind (Zigler & Bishop-Josef, 2006). Only recently has educational reform across organizations begun to address technology learning standards and best practices for integrating technology into early childhood education (Barron, et.

al., 2011; International Society for Technology in Education (ISTE), 2007; National Association for the Education of Young Children (NAEYC) & Fred Rogers Center, 2012; United States Department of Education (U.S. DOE), 2010). Considering this, it is not surprising that early childhood educators generally demonstrate a lack of knowledge and understanding about technology and engineering, and about developmentally appropriate pedagogical approaches to bring those disciplines into the classrooms (Bers, 2008; Haugland, 2000). New professional development models and strategies, such as the institute described in this thesis, are needed to prepare early childhood teachers for the task of implementing best practices for integrating technology into their classrooms.

Both qualitative and quantitative approaches were used in form of a mixed methods design to provide a deeper insight into the effectiveness of the robotics workshop. Quantitative analyses were done on the data retrieved from the surveys. Qualitative analyses were done in relation with the quantitative findings in order to both determine supporting findings and also justify some of the unexpected quantitative results. Different aspects of the research including the characteristics of the workshop were discussed towards gaining better understanding of the effectiveness of this approach as part of the strategies used towards integrating educational technologies into early childhood education. One of the participating teachers in the summer institute stated: “Technology can be integrated and used in a purposeful, meaningful way. Children need to be able to explore technology with opportunities to play, explore, problem-solve, and make things their own.” Hopefully, this research will be among the first steps in the field that will be used towards making age appropriate educational technologies part of the positive and helpful materials used in educating young children.

Appendix A: Teachers' Packet Materials for the Summer Robotics Institute

1. Positive Technological Development (PTD) Teaching Tools

The 6 C's of PTD	Tools
1. ***Content Creation*** Designing, making, and programming a computationally-rich project while developing competence with new technologies	▪ Design Journals ▪ KIWI materials for building a robotic artifact ▪ ▪
2. ***Creativity*** Developing personally meaningful project ideas and approaching problems in creative ways thus promoting a sense of confidence in one's potential	▪ Different media to experiment with (crafts, recyclables, KIWI parts) ▪ ▪ ▪
3. ***Choices of Conduct*** Making choices about behaviors, experimenting with "what if" situations and considering potential consequences in order to develop a moral compass that will help develop a strong sense of character	▪ Expert badges ▪ ▪ ▪
4. ***Communication*** Exchanging thoughts, opinions or information by using technologies to connect with others.	▪ Technology Circle ▪ ▪ ▪
5. ***Collaboration*** Working in teams, sharing resources, and cooperating towards a shared task while caring about one another	▪ Collaboration Webs ▪ ▪ ▪
6. ***Community Building*** Using technology to enhance the community and contribute to society.	▪ Open House/ Showcase ▪ ▪ ▪

What kinds of tools or materials will you use in your classroom to promote the 6 C's of PTD? Fill in the chart above.

2. ROBOTICS Curriculum "BIG PICTURE" Planning Sheet

CURRICULUM THEME *What is the theme of your robotics unit?*	**LEARNING GOALS** *What specific learning goals/objectives do you have for this unit?*
SUBJECTS/DISCIPLINES INTEGRATED *Does this unit integrate math, history, science, literacy, or other disciplines?*	**FINAL PROJECT** *What will your class build and program for their culminating projects?*
CURRICULUM TIME FRAME *How many hours will the curriculum take to complete? How will these hours be distributed daily/weekly/monthly?*	
GROUPING THE KIDS *how will the kids be broken into partners or groups?*	**SPECIAL ARRANGEMENTS** *Do any kids need special arrangements to complete the curriculum?*
MATERIALS *What materials will your class need?*	**ASSESSMENTS** *What assessments will you be using & how do they relate to the learning goals?*
LOGISTICS *Any other logistics that need to be planned for?*	

3. Curriculum Template

Curriculum Title: ____

Teaching _______________________________ through Robotics & Programming

A Curricular Unit for Grade__________

Written By: _________________________________

____

____

Lesson 1: The Engineering Design Process

Powerful Idea: The Engineering Design Process

<u>What is the Engineering Design Process?</u>
The Engineering Design Process is a process used by engineers to help them create new things. The Engineering Design Process consists of 6 steps: **ASK, IMAGINE, PLAN, CREATE, TEST & IMPROVE,** and **SHARE.**

<u>Knowledge & Objectives</u>

Students Will Understand That:

- The ***engineering design process*** is useful for planning and guiding the creation of artifacts.
- There are many different kinds of engineers
-
-

Students Will Be Able To:

- Build sturdy, non-robotic structures
- Use the engineering design process to facilitate the creation of their structure
-
-

<u>Materials Needed:</u>

-
-
-
-
-

<u>Warm-Up Activity</u>	**<u>Main Activity</u>**	**<u>Concluding Activity</u>**
Time:	**Time:**	**Time:**

Lesson 1 Vocabulary

- ***Design*** – a plan for a building or invention
- ***Engineer*** – someone who invents or improves things
-
-
-

<u>Assessments To Be Used:</u>

Lesson 2: What Is A Robot?

<table>
<tr><td colspan="3">Powerful Idea: Robotics

Robots have special parts that let them follow instructions. Robots need moving parts, such as motors, to be able to perform behaviors specified by a program. The robotic ‘brain’ has the programmed instructions that make the robot perform its behaviors.</td></tr>
<tr><td colspan="3"><u>Knowledge & Objectives</u>

Students Will Understand That:
• Robots need moving parts, such as motors, to be able to perform behaviors specified by a program.
• The robotic ‘brain’ has the programmed instructions that make the robot perform its behaviors.
• The computer must communicate with the motors for the motors to function.
•
•
Students Will Be Able To:
• Describe the components of a robot, including the ‘brain’, motors, and wires.
• Upload a program to a robot via the tangible blocks or graphical icons
• Build sturdy robots
•
•</td></tr>
<tr><td colspan="3"><u>Materials Needed:</u>
•
•
•
•</td></tr>
<tr><td><u>Warm-Up Activity</u>

Time:</td><td><u>Main Activity</u>

Time:</td><td><u>Concluding Activity</u>

Time:</td></tr>
<tr><td colspan="3">Lesson 2 Vocabulary
• Motor – the part of a robot that makes it move
• Robot – a machine that can be programmed to do different things
•
•</td></tr>
<tr><td colspan="3"><u>Assessments To Be Used:</u></td></tr>
</table>

Lesson 3: What is a Program?

<table>
<tr><td colspan="3">Powerful Idea: Programming- Control Flow by Sequencing and Instructions

What Is a Program?
A program is a sequence of instructions that the robot acts out in order. Each instruction has a specific meaning, and the order of the instructions affects the robot's overall actions.</td></tr>
<tr><td colspan="3"><u>Knowledge & Objectives</u>

Students Will Understand That:
• Each icon or "block" corresponds to a specific instruction
• A program is a sequence of instructions that is followed by a robot
•
•

Students Will Be Able To:
• Point out or select the appropriate block corresponding to a planned robot action
• Connect a series of blocks on the computer
• Transmit a program to a robot
•
•</td></tr>
<tr><td colspan="3"><u>Materials Needed:</u>
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•
•
•
•</td></tr>
<tr><td><u>Warm-Up Activity</u>

Time:</td><td><u>Main Activity</u>

Time:</td><td><u>Concluding Activity</u>

Time:</td></tr>
<tr><td colspan="3">Lesson 1 Vocabulary
• Order – parts of a group arranged to make sense
• Program – a set of instructions for a robot
• Sequence – the order of instructions that a robot will follow exactly
•
•</td></tr>
<tr><td colspan="3"><u>Assessments To Be Used:</u>

</td></tr>
</table>

Lesson 4: What Are Repeats?

Powerful Idea: Repeats- Loops & Number Parameters

An instruction or sequence of instructions may be modified to repeat a particular number of times (or forever) using Repeats, End Repeats, and Number Parameters.

Knowledge & Objectives

Students Will Understand That:

- An instruction or sequence of instructions may be modified to repeat.
- Some programming instructions, like ‘Repeat,’ can be qualified with additional information.
-
-

Students Will Be Able To:

- Recognize a situation that requires a looped program.
- Make a program that loops.
- Use number parameters to modify the number of times a loop runs.
-
-

Materials Needed:

-
-
-
-
-

Warm-Up Activity	**Main Activity**	**Concluding Activity**
Time:	**Time:**	**Time:**

Lesson 1 Vocabulary

- ***Loop*** – something that repeats over and over again
- ***Parameter*** – a limit that a robot will follow
- ***Pattern*** – a design or sequence that repeats
- ***Repeat*** – to do something more than once
-
-

Assessments To Be Used:

Lesson 5: What Are Sensors?

Powerful Idea: Sensors
A robot can feel and see its surroundings with a **sensor**. A robot can react to information it collects by changing its behavior.

Knowledge & Objectives

Students Will Understand That:
- A robot can feel and see its surroundings with a sensor.
- A robot can react to collected data by changing its behavior.
- Certain instructions (like “Repeat”) can be modified with sensor data.
-
-

Students Will Be Able To:
- To use a sensor appropriately with their robots.
- Compare and contrast human sense and robot sensors
-
-

Materials Needed:
-
-
-
-
-

Warm-Up Activity	**Main Activity**	**Concluding Activity**
Time:	**Time:**	**Time:**

Lesson 1 Vocabulary
- ***Sensor-*** *any device that receives a signal or stimulus and responds to it is a distinctive way*
-
-
-

Assessments To Be Used:

Lesson 6: What Are Ifs?

Powerful Idea: Ifs- Sensors & Branches

A robot can ‘choose’ between two sequences of instructions depending on the state of a sensor by using Ifs and If Nots.

Knowledge & Objectives

Students Will Understand That:

- A robot can ‘choose’ between two sequences of instructions depending on the state of a sensor.
-
-

Students Will Be Able To:

- Identify a situation that needs a branched program.
- Make a program that uses a branch.
-
-

Materials Needed:

-
-
-
-
-

Warm-Up Activity	**Main Activity**	**Concluding Activity**
Time:	**Time:**	**Time:**

Lesson 1 Vocabulary

- ***If-*** Used for introducing a situation that may happen**.**
-
-
-
-

Assessments To Be Used:

Lesson 7: Culminating Project

<table>
<tr><td colspan="2"><u>Powerful Idea(s):</u></td></tr>
<tr><td colspan="2"><u>Knowledge & Objectives</u>

Students Will Understand That:
•
•
•

Students Will Be Able To:

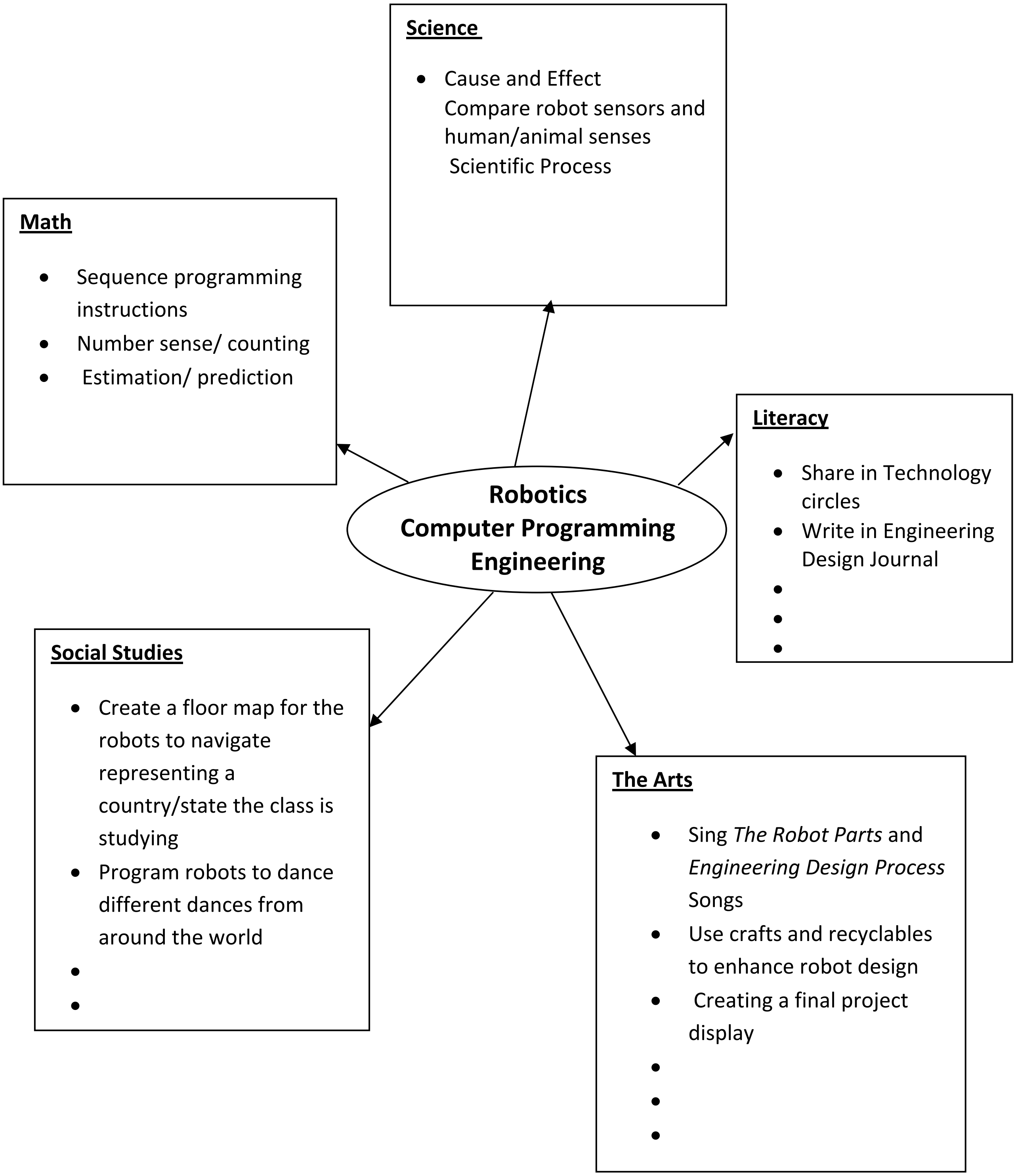
•
•
•
•</td></tr>
<tr><td colspan="2"><u>Materials Needed:</u>
•
•
•
•</td></tr>
<tr><td><u>Final Project Theme</u></td><td><u>Final Project Activity</u>

Time:</td></tr>
<tr><td colspan="2"><u>Vocabulary</u>
•
•
•
•</td></tr>
<tr><td><u>Assessments To Be Used:</u></td><td><u>Final Project Showcase:</u></td></tr>
</table>

4. Final Project Planning Sheet

FINAL PROJECT THEME *What is the theme of your culminating project?*	**FINAL PROJECT SHOWCASE** *How will you showcase the final projects? Will you invite family or other classes?*
SUBJECTS/DISCIPLINES INTEGRATED *Will this project integrate math, history, science, literacy, or other disciplines?*	**LEARNING GOALS** *What specific learning goals/objectives do you have for this project?*
FINAL PROJECT TIME FRAME *How many hours will this take to complete? How will these hours be distributed?*	**FINAL PROJECT PREP** *What kinds of prep, research, building/programming, displays will the kids make/do leading up to the showcase*?
GROUPING THE KIDS *How will the kids be broken into partners or groups?*	**SPECIAL ARRANGEMENTS** *Do any kids need special arrangements to complete the project?*
MATERIALS *What materials will your class need?*	**ASSESSMENTS** *What assessments will you be using & how do they relate to your learning goals?*
LOGISTICS *Any other logistics that need to be planned for?*	

5. Technology & Engineering Curriculum Integration



6. The Early Childhood Robotics Network:
www.tkroboticsnetwork.ning.com

To create an account, click on "sign up"

Click "Profile" to view your profile

On your profile page, you will be able to write information about yourself, change your profile picture, view the groups you are a member of, and view your friends list.

To learn more about different types of robotics kits, click on either the KIWI tab or the WEDO tab

Each page will link you to respective curriculum, helpful information, and software downloads.

Click on the "Videos" tab

"Project Videos" will lead you to videos featuring culminating projects that utilize robotics and computer programming done at various public and private schools

"Teaching Videos" will lead you to a list of short teaching clips, featuring real teachers teaching various engineering, robotics, and computer programming concepts in their classrooms.

Click on the "Photos" tab to see pictures of various robotics projects

Click on the "Resources" tab

You will have access to free robotics teaching materials (curriculum, etc.)

Free computer programming downloads

Relevant websites & online communities

Click on the "Forum" tab

Here you will be able to ask and answer questions, share stories and ideas, brainstorm, and more with your fellow ECRN community members. All members of the community are encouraged to utilize the forum.

Click on "Groups" to see a list of all ECRN groups.

You should become a member of the **Summer Robotics Institute Group**. Click here for a calendar of events, resources, relevant resources, curriculum, and more. This is also where you will find links to surveys, and the link to your blog entries.

Still need help? Contact Amanda.Sullivan@tufts.edu

Appendix B: Teachers' Knowledge Survey

All the information you enter here will be used solely for research purposes and will be kept confidential. This survey is part of our effort to evaluate the impact of the summer institute as an educational intervention. Please answer honestly as this data will be used to help us improve future development new technologies for early childhood education. To answer the following questions, please use the scale described below: Strongly Disagree =1, Disagree=2, Neither Agree/Disagree=3, Agree=4, Strongly Agree=5

* Required

Your Name: *

Robotics Knowledge

1. I know what makes a device a robot. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

2. I know the main components of a robot. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

3. I know how a robot is given instructions. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

4. I know the stages of the Engineering Design Process. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

5. I know how to apply the Engineering Design Process in robotics activities. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Teaching Robotics

6. I know effective teaching approaches to guide students' thinking and learning in robotics. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

7. I know how to teach the construction aspects of robotics. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

8. I know how to teach the programming aspects of robotics. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

9. I know how to teach robotics in a developmentally appropriate way for young children. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

10. I know how to integrate robotics into other traditional content areas (i.e. math, literacy, science). *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

11. I can use robotics technologies to enhance students' problem solving skills. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

12. I know how to use Engineering Design Process to teach robotics. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	StronglyAgree

13. I can use robotics technologies to enhance students' collaboration skills. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

14. I am able to plan student-centered robotics projects in the classroom. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

15. I am able to implement student-centered robotics projects in the classroom. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

16. I know how to assess students' learning in robotics. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

17. I know how to assess students' learning when integrating robotics with other traditional content areas (i.e. math, literacy, science). *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

CHERP Programming Skills

18. I have used CHERP in the past. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

19. I know how to program a robot using CHERP (any kind of robot, i.e. a Wedo robot, a LEGO RCX robot, etc.). *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

20. I know how to program with CHERP, using both the tangible and graphical versions. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

21. I understand the meaning of different messages (including the error messages) given by CHERP. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

22. I know how to access all rows of programming blocks (to use Repeats, Sensors, etc.) in the graphical version of CHERP. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

KIWI Robotics Technical Skills

18. I am able to construct a sturdy KIWI robot. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

19. I know what the power source of KIWI is. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

20. I know how to program KIWI using CHERP. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	StronglyAgree

21. I know how the CHERP program gets transfered to the KIWI robot. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

22. I know how to build a moving robot using KIWI and CHERP. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

23. I know how to build a sensing robot using KIWI and CHERP. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	StronglyAgree

Submit

Appendix C: Teachers' Sense of Technology Self-efficacy Survey

All the information you enter here is used solely for research purposes and will be kept confidential. This survey is part of our effort to evaluate the impact of the summer institute as an educational intervention. Please answer honestly as this data will be used to help us improve future development new technologies for early childhood education. To answer the following questions, please use the scale described below: Strongly Disagree =1, Disagree=2, Neither Agree/Disagree=3, Agree=4, Strongly Agree=5

* Required

Your Name: *

1. I feel confident that I understand computer capabilities well enough to maximize them in my classroom. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

2. I feel confident that I have the skills necessary to use the computer for instruction. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

3. I feel confident that I can successfully teach relevant subject content with appropriate use of technology. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

4. I feel confident in my ability to evaluate software for teaching and learning. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

5. I feel confident that I can use correct computer terminology when directing students' computer use. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

6. I feel confident I can help students when they have difficulty with the computer. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

7. I feel confident I can effectively monitor students' computer use for project development in my classroom. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

8. I feel confident that I can motivate my students to participate in technology-based projects. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

9. I feel confident I can mentor students in appropriate uses of technology. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

10. I feel confident I can consistently use educational technology in effective ways. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

11. I feel confident I can provide individual feedback to students during technology use. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

12. I feel confident I can regularly incorporate technology into my lessons, when appropriate to student learning. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

13. I feel confident about selecting appropriate technology for instruction based on curriculum standards. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

14. I feel confident about assigning and grading technology-based projects. *

1 2 3 4 5

Strongly Disagree ○ ○ ○ ○ ○ Strongly Agree

15. I feel confident about keeping curricular goals and technology uses in mind when selecting an ideal way to assess student learning. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

16. I feel confident about using technology resources (such as spreadsheets, electronic portfolios, etc.) to collect and analyze data from student tests and products to improve instructional practices. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

17. I feel confident that I will be comfortable using technology in my teaching. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

18. I feel confident I can be responsive to students' needs during computer use. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

19. I feel confident that, as time goes by, my ability to address my students' technology needs will continue to improve. *

1 2 3 4 5

Strongly Disagree	○	○	○	○	○	Strongly Agree

20. I feel confident that I can develop creative ways to cope with system constraints (such as budget cuts on technology facilities) and continue to teach effectively with technology. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

21. I feel confident that I can carry out technology-based projects even when I am opposed by skeptical colleagues. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

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Appendix D: Teachers' Attitude towards Teaching with Technology Survey

All the information you enter here will be used solely for research purposes and will be kept confidential. This survey is part of our effort to evaluate the impact of the summer institute as an educational intervention. Please answer honestly as this data will be used to help us improve future development new technologies for early childhood education. To answer the following questions, please use the scale described below: Strongly Disagree =1, Disagree=2, Neither Agree/Disagree=3, Agree=4, Strongly Agree=5

* Required

Your Name: *

1. I am confident about my ability to do well in a course that requires me to use computer technologies. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

2. I feel at ease learning about computer technologies. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

3. I am not the type to do well with computer technolgies. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

4. The thought of using computer technologies frightens me. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

5. I am anxious about computers because I don't know what to do if something goes wrong.. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

6. I feel comfortable about my ability to work with computer technologies. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

7. I don't have any use for computer technologies on a day-to-day basis. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

8. Using computer technolgies to communicate with others over a computer network can help me to be more effective in my job. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

9. Using computer technologies in my job will only mean more work for me. *

1 2 3 4 5

Strongly Disagree	○	○	○	○	○	Strongly Agree

10. I do not think that computer technologies will be useful to me in my profession. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

11. With the use of computer technolgies, I can create materials to enhance my performance on the job. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

12. If I can use word-processing software, I will be more productive. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

13. Anything that computer technolgies can be used for, I can do just as well some other way. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

14. I could use computer technolgies toaccess many types of information sources for my work. . *

1 2 3 4 5

Strongly Disagree ○ ○ ○ ○ ○ Strongly Agree

15. Computer technolgies can be used to assisst me in organizing my work. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

16. I don't see how I can use computer technolgies to learn new skills. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

17. Knowing how to use computer technolgies will not be useful in my future work. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

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Appendix E: Teachers' Background Survey

DevTech Research Group Eliot Pearson Dept. of Child Development at Tufts University http://ase.tufts.edu/DevTech/ Please answer honestly. Your responses will be kept confidential and will be used for research purposes in order to better develop tools and curriculum for use in early childhood classrooms.

* Required

1. Name *

2. Date of Birth *

3. Gender *

4. Please list all of your higher education degrees and/or licensures: *

5. Please list all levels/grades/subjects you are certified to teach: *

6. Total number of years teaching *

7. Total number of years teaching at current institution *

8. Total number of years teaching in your current classroom *

9. Current Level(s) Taught *

10. On a scale from 1-5, please describe your personal experience with technology: *

	1	2	3	4	5	
Novice	○	○	○	○	○	Expert

11. On a scale from 1-5, please describe your experience teaching with technology: *

	1	2	3	4	5	
Novice	○	○	○	○	○	Expert

12. Please select all of the technologies you have taught with: *

- ☐ Robotics
- ☐ Computers
- ☐ IPads/Tablets
- ☐ Smartboards
- ☐ Other:

13. Are you participating in this institute with another teacher or colleague from your school or school district? *

- YES, I'm attending with a colleague(s)
- NO, I'm attending alone

14. If yes, please explain: *

15. Next year, do you plan to collaborate with a colleague in the implementation of your robotics curriculum? *

- YES
- NO
- MAYBE

16. If yes, please explain: *

17. What are your reasons for participating in this institute (check all that apply)? *

- I consider myself a pioneer of new technologies
- I was required to participate by my school or supervisor
- To advance my professional development
- I don't know very much about teaching with technology and think it is important to learn
- I love robotics and wanted to learn more
- Other:

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Appendix F: Teachers' Robotics Activities Journal

This page is to help you capture the interesting moments and thoughts you have had during the robotics activities in your classroom. There are some pre-defined sections for you to fill out. Feel free to write extra words and sections as you like.

* Required

Name *

What happened today?

What was the success story of the day?

What were the challenges of the day?

What big ideas did you learn today?

What pedagogical tools and strategies did you find most useful today? Why?

Did you want to add anything else?

Submit

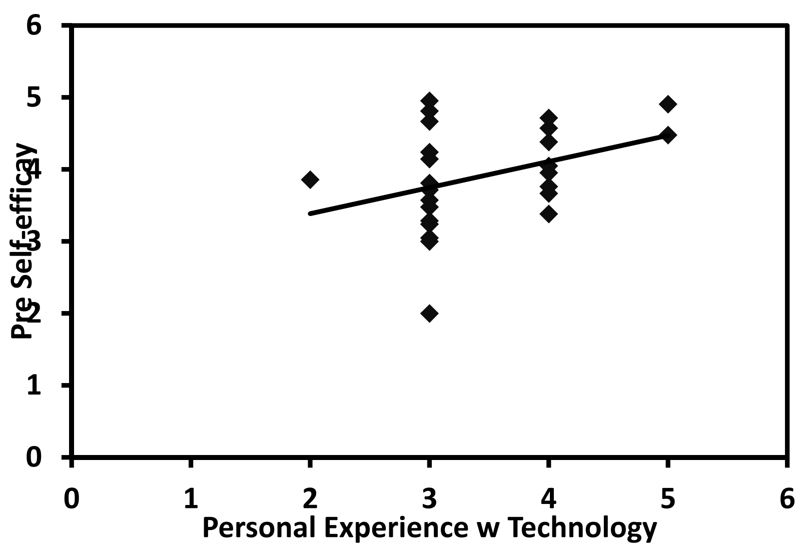
Appendix G: Statistical Analyses

Strength of correlation (Cohen, 1988)

- r = -+ .10 to -+ .29 small (weak)
- r = -+ .30 to -+ .49 medium (moderate)
- r = -+ .50 to -+ 1.0 large (strong)

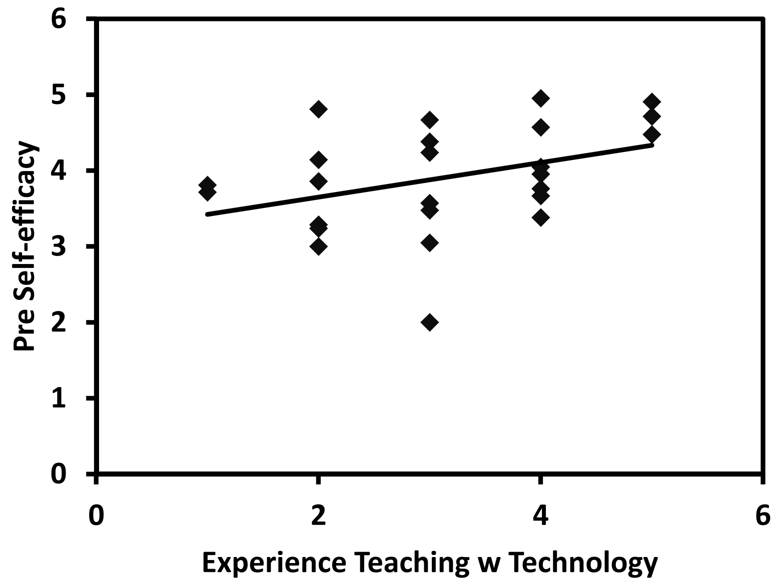
****

A moderate positive correlation between the teachers' Personal Experience with Technology and Pre level of technology self-efficacy ($r = 0.36$; $n = 25$;$p<0.005$)



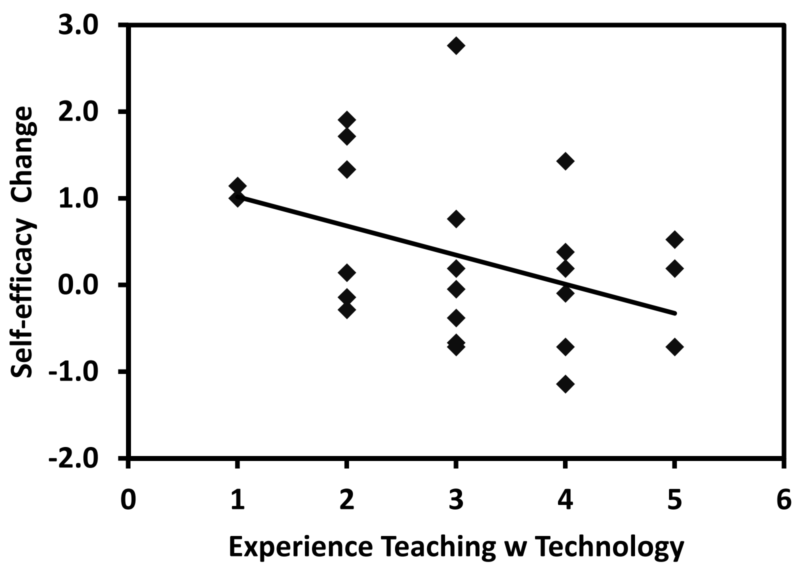
****

A moderate positive correlation between the teachers' Experience Teaching with Technology and Pre level of technology self-efficacy ($r = 0.37$; $n = 25$;$p<0.005$)



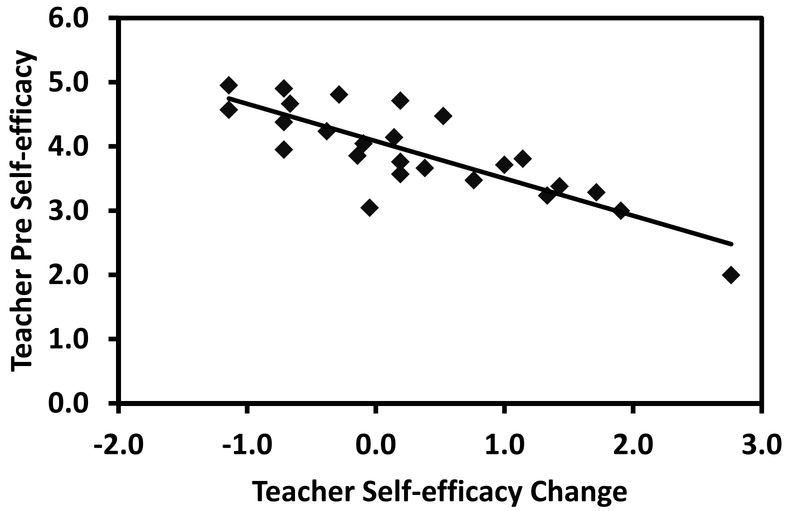
****

A moderate negative correlation between the teachers' Experience Teaching with Technology and the difference in the level of technology self-efficacy (r =-0.39; n = 25;p<0.005)



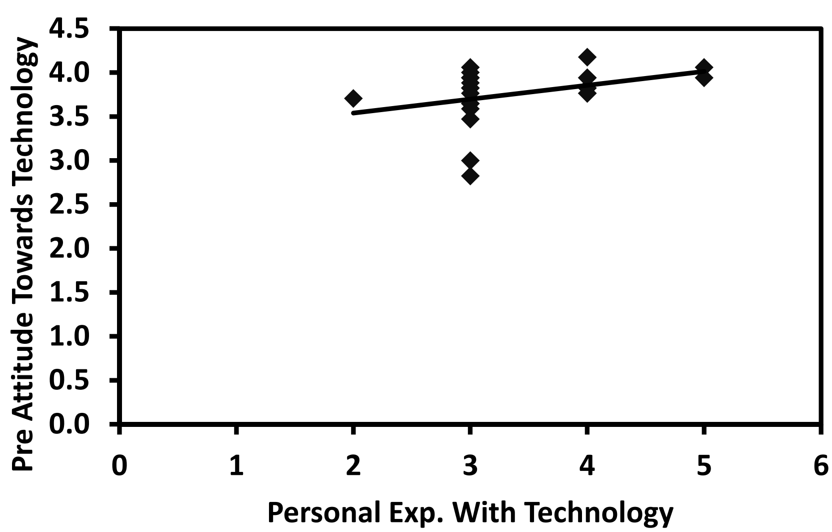
****

A strong negative correlation between the teachers' pre level of self-efficacy and the difference in the level of technology self-efficacy (r = -0.82; n = 25;p<0.005)



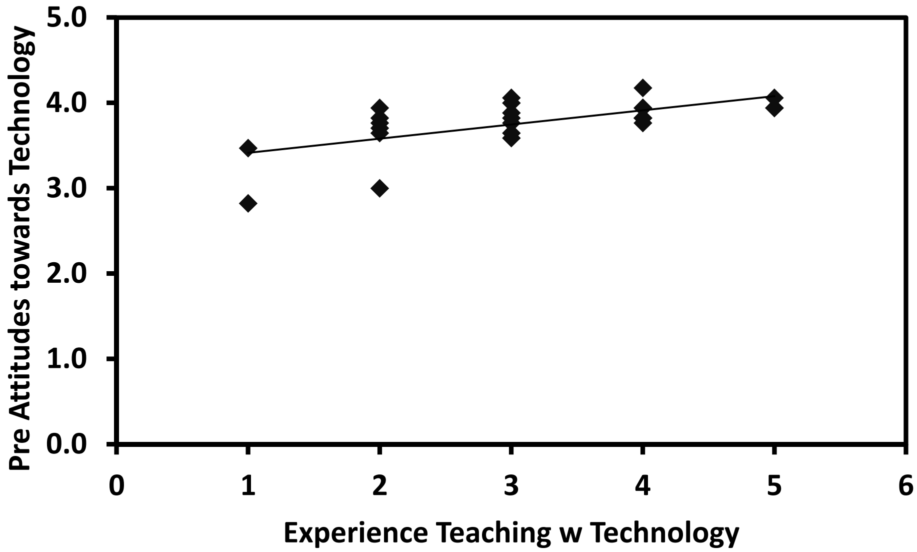
****

A moderate positive correlation between the teachers' Personal Experience with Technology and pre level of attitude (r = 0.37; n = 25;p<0.02)



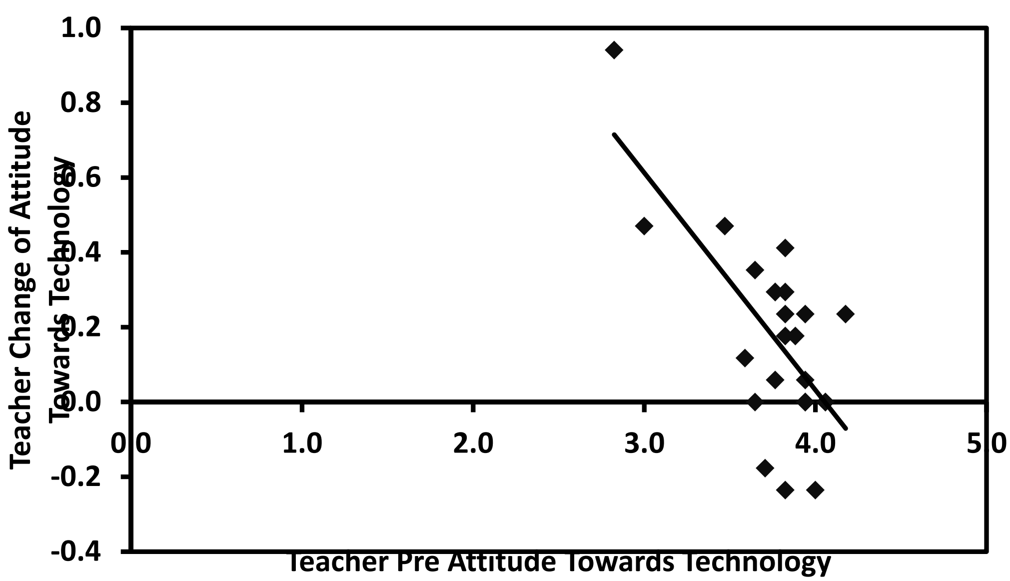
****

A moderate positive correlation between the teachers' Experience Teaching with Technology and pre level of (r = 0.64; n = 25;p<0.05)



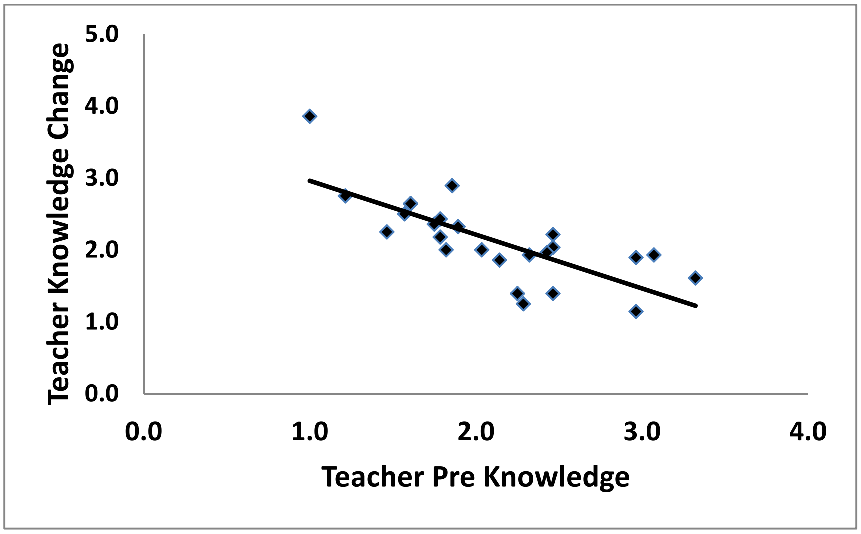
****

A strong negative correlation between the teachers' pre level of attitude and the difference in the level of attitude (r = -0.69; n = 25;p<0.05)



****

A strong negative correlation between the teachers' pre level of knowledge and the difference in the level of knowledge ($r = -0.75$; $n = 25$; $p<0.05$)



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