STUDENT GROUPING STRATEGIES IN TECHNOLOGY RICH LEARNING ENVIRONMENTS AT THE INTERMEDIATE GRADE LEVEL

BY

Jana Craig Hare

Submitted to the graduate degree program in Curriculum and Teaching
and the Graduate Faculty of the University of Kansas in partial fulfillment of the requirements
for the degree of Doctor of Philosophy.

Chairperson Marc Mahlios, Ph.D.

Marilyn Ault, Ph.D.

Bruce Frey, Ph.D.

Phil McKnight, Ph.D.

Suzanne Rice, Ph.D.

Date Defended: April 15, 2011

The Dissertation Committee for Jana Craig Hare
certifies that this is the approved version of the following dissertation:

STUDENT GROUPING STRATEGIES IN TECHNOLOGY RICH LEARNING ENVIRONMENTS AT THE INTERMEDIATE GRADE LEVEL

____
Chairperson Marc Mahlios, Ph.D.

Date approved: April 15, 2011

ABSTRACT

The purpose of this study was to investigate the various student grouping strategies used within the learning environment of technology rich and typical general education classrooms. Participants included technology rich and typical, general education classrooms at the 3rd, 4th, 5th and 6th grade levels. The categories of grouping strategies observed in this study were: independent, pairs, small groups, mixed groups and independent, whole class with attention to the teacher or another student, whole class with attention to media and transition. Cognitive activities in relation to grouping strategies were also explored.

Observation data collected through a momentary time sampling process was analyzed. First, an independent-samples *t* test was conducted for the independent variable, the classroom, analyzed against the observed dependent variable, student grouping strategies. To extend this analysis, a one-way repeated measures ANOVA was conducted. A final analysis calculated the correlation coefficient to examine the relationship between the student grouping strategies and the level of cognitive activities observed in the classroom.

The results indicate that there is a difference in grouping strategies between technology rich and typical classrooms. The quantitative analysis of the data showed few changes in student grouping strategies occurring throughout the school year in technology rich and typical general education classrooms. Although classroom teachers vary the grouping strategies used in the classroom, the differences were not statistically significant throughout the school year. When analyzed between years, technology rich classrooms showed an increase between Year 1 and Year 2 in Mixed Groups. The results of the correlational analysis for cognitive activities and technology rich classrooms indicate that 5 out of 12 correlations were statistically significant; 3 out of 12 correlations in typical general education classrooms.

The research discussed in this study points towards a need for teachers to engage students through pairs and small groups. The presence of computers adds to the potential for engaging students in meaningful learning with authentic tasks in a social setting. Research into how technology rich learning environments are structured and what strategies teachers successfully use to group students is an important issue surrounding educational technology and should continue to be investigated.

ACKNOWLEDGEMENTS

Thank you….these two small words cannot even begin to convey my appreciation and gratitude to so many people who have been instrumental in my personal and professional journey. Completing this dissertation marks a great milestone in my life; an accomplishment shared by those who have believed in me, supported me and mentored me through this process. I would like to express my appreciation to my Doctoral Dissertation Committee: Chairperson Dr. Marc Mahlios, Dr. Marilyn Ault, Dr. Bruce Frey, Dr. Phil McKnight and Dr. Suzanne Rice. Their patience, encouragement and direction inspired me and challenged me all at the same time. I am honored to be among them and humbled by their professional expertise.

A special thank you to Dr. Marilyn Ault and my colleagues at Advanced Learning Technologies. The opportunities available through ALTEC have been the cornerstone for growth in professional learning, research and leadership. Marilyn, thank you for believing in my abilities, encouraging me to develop my research skills and teaching me how to persevere when challenges appeared during the dissertation process. Thank you for not giving up on me.

Thank you to my parents for always asking about my work, encouraging me, and being my first teachers. I continue to learn from you daily and am eternally grateful for your commitment to being lifelong learners. I owe a great deal of thanks to my family, friends and former colleagues for their love, support and encouragement.

Finally, to my husband, Sean, a heartfelt thank you for believing in me. Thank you for the time you spent talking about research that may have meant nothing to you but everything to me. Your unending support, patience and guidance mean the world to me. You've taught me about taking risks, having courage, believing in myself and living life each and every day. I can't wait to continue on this 'life journey' with you!

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER ONE

Research Problem

An essential role for a teacher is to help students discover how to become self-directed learners. Learners use a variety of strategies for acquiring knowledge. These strategies help students develop as persons, increase their capacity to think clearly and make wise decisions, and build social skills. Schools and classrooms create communities of learners who come together to explore and learn how to navigate the world productively. Learning is a social activity; learners construct knowledge as they interact with one another (Dewey, 1916; Vygotsky, 1978). In addition to learning content knowledge, schools often provide the foundation for helping students navigate the social world and develop a personal sense of dignity, self-esteem, and efficacy to be high-quality citizens. Education can be viewed as the process of building communities of learners who use these social skills to educate themselves.

Pedagogy oftentimes focuses on teacher-to-student interactions and fails to acknowledge the learning potential of student-to-student interactions, such as working collaboratively with peers. Teachers recognize that students need to learn how to communicate with one another about meaningful tasks and that working in a collaborative group is an important part of everyday adult life. It is common to underestimate the thinking, planning, and skill development necessary for our students to work together successfully. Arne Duncan, U.S. Secretary of Education states, "In the 21st century, students must be fully engaged. This requires the use of technology tools and resources, involvement with interesting and relevant projects, and learning environments – including online environments – that are supportive and safe" (2010). Educators have the opportunity to engage students daily, with rigorous curriculum, digital resources, real-world experiences, and collaboration with others.

When considering the learning environment, learning in pairs or small groups can increase student engagement and ownership of academic assignments. Partnerships tend to increase involvement and responsibility for personal learning and provide an opportunity for students to develop social skills and empathy for others. Combining social support while increasing cognitive complexity can also produce positive effects for learning content and skills, with off-task and disruptive behavior diminishing substantially. Students feel good in cooperative settings, and positive feelings toward self and others are enhanced.

Many supporters of the instructional use of technology suggest that the integration of technology also enhances the learning environment by providing opportunities for more meaningful learning experiences and engagement to enhance student success. As an instructional strategy, the National Research Council Committee on Learning Research and Education Practice suggests that technology used in the classroom has the potential to support effective learning environments because it can provide scaffolding, or differentiation, to augment what novice learners can do and reason about as they try to understand and apply new learning (Bransford, Brown, et al, 1999).

The inclusion of technology to instructional activities where students are working in pairs or in a group increases the potential for social interaction, collaboration, problem-solving and critical thinking. From a social constructivist perspective, classrooms act as a community where learning takes place within the context of social interaction. Learning, in these classrooms, is a process of active construction of meaning, and this process works best in social settings in which two or more individuals engage in sustained discourse about a topic. Conversations and discussions help participants advance their learning in several ways. Exposure to new ideas from other students makes them aware of things that they did not know and leads to expansion of their cognitive structures. Exposure to ideas that contradict their own beliefs may cause them to examine those beliefs and perhaps reconstruct them. The need to communicate their ideas to others forces students to articulate their ideas more clearly, which sharpens their conceptions and often leads to recognition of new connections. Technology can provide the essential resources to accomplish the goals of a social constructivist classroom. Open-ended environments and productivity software allow students to experiment, engage in discourse, compare solutions and build their own learning constructs. The social aspects of learning can also be explored through online, collaborative projects and social media.

Statement of the Problem

Since 2003, the State Department of Education has provided Enhancing Education through Technology (EETT) competitive grants for Technology Rich Classrooms. These grants are funded through the Title II Part D initiative of the Elementary and Secondary Education Act. EETT defines the federal goals for educational technology. As stated in Title II Part D, “The primary goal of this part is to improve academic achievement through the use of technology in elementary schools and secondary schools” (Congress, 2001). Additional goals are to (a) ensure that students are technologically literate by the time they finish 8th grade, and (b) encourage effective integration of technology resources through training and curriculum development of research-based instructional methods. The funding awarded to each grantee ensures that each participating classroom is “technology-rich”, providing laptop computers at a 2:1 student to computer ratio, an interactive whiteboard, projector, and additional peripheral devices such as printers, scanners and student response systems.

The Technology Rich Classroom Program (TRC) implementation is based on the assumption that teachers’ access to technology alone is not sufficient to result in the successful instructional integration of the technologies in the elementary classroom (Cuban, 2001; Lawless & Pellegrino, 2007). The TRC Program links the instructional use of technology with the application of a student-centered, project based learning approach to instruction that focuses on the use of higher order thinking skills in elementary math, reading, and/or science classes. In order to support this framework in the classroom, the technology is not provided in isolation. Instead, it is offered with the assistance of a half-time facilitator who is dedicated to supporting the four classroom teachers with obtaining the technology skills, classroom management strategies, and pedagogy to teach using technology-infused lessons.

The classrooms participating as a TRC are fully equipped to tap into the potential of a social constructivist classroom, through technology, instructional practices, and learner-centered environments. The focus on student-centered, project based learning paired with instruction that focuses on the use of higher order thinking skills combined with a 2:1 student to computer ratio makes this an ideal learning environment for a variety of small group learning strategies.

In order to best meet the needs of all learners, teachers must effectively use instructional time, engage students, create opportunities for individualized learning, and match students' skill level with instructional activities. It is easy to assume that the technology rich classrooms provide more opportunities for students to work in pairs and/or groups since they are equip with a 2:1 student to computer ratio. In addition, the increased access to technology resources should provide a more constructive environment, where students are able to represent their knowledge through application, analysis and creation using 21st century tools. To this writing no attempts have been made to identify differences in student grouping strategies or higher-level activities utilized in these classrooms versus typical classrooms.

Purpose of the Study

The purpose of this study was to identify and describe grouping strategies of students observed within a technology rich classroom in comparison to a typical general education classroom. This specifically addressed the following student grouping strategies: independent, pairs, small groups, mixed groups/independent; as well as whole class with attention to teacher, to another student, or to media; and non-instructional transition activities. In addition, the study examined higher-level thinking activities assigned by the classroom teacher, based on Bloom's Taxonomy, in relation to these student grouping strategies.

There is little known about the difference in student grouping strategies among technology-rich and typical general education classrooms. Given the literature on effective learning environments and student grouping strategies, this study observed how teachers group students in these different classroom settings and if one of these environments supported aspects of social learning more than the other. The results of this study add to the research base of student grouping strategies within the context of technology rich and typical classrooms. This type of analysis of a statewide Title IID program on learning environments and grouping strategies is not available within the state, or nationally. This study provides information on the Technology Rich Classroom Program across the state and will assist in decision-making about its continuation or expansion, as well as to provide data to add to the growing body of knowledge supporting the use of technology in instruction.

While research on learning in groups has greatly increased during the past several years, few formal studies have concentrated on the grouping strategies within technology rich environments. This study focused on the various student grouping strategies and cognitive activities used within the classroom learning environments of a technology rich classroom and a typical general education classroom.

Research Questions

The major focus of this study was to explore and describe learning environments related to student grouping strategies at the elementary level and answer the following questions:

1. What differences in student grouping strategies exist between technology rich classrooms and typical general education classrooms and how frequently do these groupings appear in the two different classroom environments?
2. Is there a relationship between student grouping strategies and higher-level cognitive activities in the two different classroom environments?

The null hypothesis is that there is no significant difference between the grouping strategies utilized in a technology rich and typical classroom and that there is no relationship between the grouping strategies and higher-level cognitive activities.

Definition of Variables

This study contains one independent variable: the classroom model. There are two levels within this variable: a technology rich classroom and a typical general education classroom. The independent variable, the classroom, was measured at the nominal level.

The primary dependent variable is the student grouping strategy employed by the classroom teacher. Student groupings for classroom work included: independent, pairs, small groups, mixed groups/independent; as well as whole class with attention to teacher, to another student, or to media; and non-instructional transition activities. The observation instrument was created to provide a comprehensive picture of what happens in classrooms during content-specific lessons and activities. These grouping strategies were identified by Advanced Learning Technologies (ALTEC) and the School Program Evaluation and Research (SPEaR) teams as the most likely to be observed and the areas that the TRC Leadership Team was interested in knowing more about in relationship to their program. In general, student grouping strategies within classrooms are a constant pedagogic factor which affect participation and learning. Dynamic relationships between the classroom context and learning tasks can be developed through effective grouping strategies.

Grouping strategies often define classroom tasks, including the level of cognitive ability for classroom activities. A second dependent variable is the classroom activity, based on Bloom's Taxonomy. These activities are categorized by the level of cognitive ability required by the student for successful completion based on the observation data. The following cognitive activities are included in the data: receiving knowledge, applying, analyzing or evaluating, creating, and other. When students are receiving knowledge, they were engaged in activities that required them to either listen to knowledge imparted or answer simple questions about something they have learned. The applying category required that student applied knowledge they previously learned. This activity did not require students to think critically or construct new knowledge. When students were analyzing or evaluating, they were actively engaged in higher-level activities, analyzing a concept or synthesizing concepts. The final cognitive level categorized in the data set was creating. Creating involves all levels of the taxonomy. During the creative process, the student remembers, understands, applies knowledge, analyzes information, and evaluates outcomes and processes in order to produce a final product. Rather than simply using existing materials or ideas, the students are engaged in activities that require them to take their ideas and create something new. One additional category, "other", was identified when no academic activities were happening in the classroom. Oftentimes, this represented transition periods or when the class is getting ready for the next activity.

Both dependent variables, student grouping strategies and cognitive activity, were measured at the ratio level. Using an observation instrument developed by ALTEC and SPEaR, the various student grouping strategies and cognitive activities were recorded. A zero during the observation period indicated that the student grouping strategy was not observed, while a one indicated that the grouping strategy was present in the classroom. Likewise, the cognitive activity level in the classroom was scored during each observation interval. A zero indicated that the activity level was not present in the classroom and a one indicated that the activity level was observed. These levels of measurement provided data on how often the various student grouping strategies and higher-level activities were observed in each of the different classroom environments.

Summary

The purpose of this study was to describe the differences between two classroom models: technology rich classrooms and typical general education classrooms. Observation data collected during the 2008-09 and 2009-10 school years provided information about the individual classrooms, as well as changes in the learning environment over time.

CHAPTER TWO

Literature Review

The purpose of this literature review is to present research related to student grouping strategies, higher-order thinking activities and technology within the classroom environment. The paper includes a range of literature to describe a social pedagogic relationship between student grouping strategies and classroom learning. In all classrooms, students are grouped in one form or another. These groupings impact the quality of education received through student's interaction with teachers and peers. These interactions could be through whole class instruction, collaborative tasks in small groups or pairs, or individual assignments. These within-classroom grouping strategies provide insight into the variety of conditions that may support or hinder classroom learning. In addition, the grouping strategies impact the level of cognitive activities conducted within the classroom. Technology and strengths of the collaborative group are evident when students are active at higher levels of Bloom's Taxonomy.

The Effect of Student Grouping Strategies

Groups are smart. Under the right circumstances, groups are "remarkably intelligent, and are often smarter than the smartest people in them" (Surowiecki, 2005, p. xiii). Group work can represent "the collaborative knowledge of a group of students working together and sharing information" (Frey, 2009). By working in groups, individuals have the opportunity to consolidate knowledge with peers. This prepares students for independents tasks and learning. Learning is not considered an isolated event; it occurs as a by-product of participation in a community (Lave & Wenger, 1991).

Students not only learn through interacting with their teachers, but also by collaborating with peers in small groups and interacting with them during class discussion. Having good student-to-student relationships are important conditions if students are to be active and successful learners (Elias & Schwab, 2006; Juvonen, 2006; Johnson & Johnson, 2006). Students learning together in pairs or small groups can be helpful in addressing key curricular goals and also allow for students to actively teach one another. The social constructivist theories of teaching and learning suggest that increased emphasis on student-to-student interaction is important for achieving cognitive outcomes as well. In this perspective, students learn by collaborating with peers in pairs and small groups and by interacting with them during class discussions. Having a diverse classroom, both in students' backgrounds and viewpoints, is viewed as an asset. Small-group formats also hold potential for contributing to students' sense of belonging and community, which may enhance commitment to schooling (Juvonen, 2006; Osterman, 2000; Watson & Battistich, 2006).

Doyle (1986) reviewed the research of several leading scholars and found a clear connection between student grouping strategies and student engagement (Gump, 1967; Kounin, 1970; Rosenshine, 1980). In his report, Doyle concluded that student engagement was highest in teacher led small groups and lowest in unsupervised seatwork. The effect sizes on academic learning appear to be modest, but consistent, in contrast to the effects on social learning and personal esteem which can be considerable when comparisons are made with individualistic classroom organization. Further, there is evidence to suggest that students of all achievement levels and both genders benefit from cooperative learning (Slavin, 1995) and some evidence that these methods have especially positive values for sub-populations, such as Hispanic and African American students (Boykin, 1994; Calderon, Hertz-Lazarowitz, et al., 1998).

Whole class and independent work. The traditional approach to schooling calls for whole-class lessons followed by independent seatwork. Presenting information to the whole class is an efficient way to expose students to new content because it allows the teacher to focus the material taught, is easily combined with other methods, and is adjustable to fit the available time, physical setting and other situational constraints. During whole-class instruction, the teacher targets the lesson to the average ability of the students in the classroom, thereby assuming to meet the educational need of the greatest number of students (Ornstein, 1995). In reality, students have diverse academic needs, and whole group instruction only meets the needs of the few students whose ability is at the middle of the group average. A study from Meyers and Jones (1993) reported several unsettling discoveries related to direct instruction. While teachers are lecturing, students were not attending to what was being said 40 percent of the time. During the first ten minutes of a lecture, it was reported that students retained 70 percent of the information, while in the last 10 minutes only 20 percent. This indicates that students lose their initial interest, and attention levels continue to drop, as a lecture proceeds. Another outcome from this research suggests that four months after taking a lecture-style introductory psychology course, students knew only 8 percent more than a control group who had never taken the course (Meyers & Jones, 1993). During whole-class instruction, students rarely, if ever, interact with one another about the content. As discussed above, it is important for students to verbalize information in order to clarify what they have heard, read, observed or experienced. Oftentimes, students often do not understand the information they have received until they try to verbalize it or re-teach it to others. The social transmission of knowledge, which takes place when students interact with each other and test their ideas against those of their peers, is one of the most powerful forces for expanding students' thinking.

Pairs and small group learning. By placing students in pairs or small groups, students tap into different skills not used in whole- or large-group instruction. Small-group instruction varies in terms of tasks, group composition, and goals. Small groups can be used for drill, practice, learning facts and concepts, discussion, and problem solving. Cohen (1994) found that students who worked well together in small groups were better able to manage competition and conflict among team members, listen to and combine different points of view, construct meaning, and provide support to one another.

When students are actively involved in the learning process, they learn best. Researchers report that, regardless of the subject matter, students working in small groups, tend to learn more of what is taught and retain it longer than when the same content is presented in other instructional formats. Also, students who work in collaborative groups appear more satisfied with their classes (Beckman, 1990; Chickering & Gamson, 1991; Collier, 1980; Cooper & Associates, 1990; Goodsell, 1992; Johnson & Johnson, 1989; Johnson, Johnson, et al., 1991; Kohn, 1986; McKeachie, Pintrich, et al., 1986; Slavin, 1980, 1983; Whitman, 1988). The small group format can be viewed as an adaption to traditional whole-class instruction by having follow up activities through interactive small groups rather than individual seatwork.

In another study, Mulryan (1989, 1995) researched students' behavior during small group and whole-class instruction in mathematics. Results showed students attended better in the small-groups than in the whole-class context. Students identified as low achievers asked more questions, and high achieving students provided more information to other students in the group. Oftentimes, though, students produce fewer ideas when brainstorming in groups than when brainstorming alone (Paulus, Dzindolet, et al., 1993). In a study of eleven- to twelve-year-old students, Kutnick and Thomas (1990) found that students working in pairs did better on the cognitively based Science Reasoning Task than students working individually. Those results reflected improvement in the individual performance of both partners, not just a sharing of abilities within the group.

The importance of collaborative group learning is something that educators have acknowledged for decades. Knowledge is built and extended through the exchanging of ideas with others. Research shows that students immersed in cooperative work demonstrate higher levels of academic learning and retention than their peers working individually. Second grade students, in a comparison study that stressed cooperative learning in the classroom, were found to perform better on a measure of reading comprehension than those in traditional classroom (Law, 2008). The use of "small-group cooperative learning activities was positively associated with science achievement scores in a large-scale analysis derived from the Third International Mathematics and Science Study (TIMSS)" (House, 2005). In addition, cooperative group work has demonstrated results in increased self-esteem, improved relationships among students, and enhanced social and education skills. Students in elementary classrooms that used cooperative learning techniques were found to have a more positive perception of school and higher levels of motivation (Battistich, Solomon, et al., 1993).

In the one-to-one student relationship, it has been found that students improve academically and in attitude toward the content (Cohen, Kulik, et al., 1982). Explaining concepts and information to other group members has been positively correlated with achievement. This confirms the findings from other research (e.g., Graesser & Pearson, 1994) indicating that explaining material to others is an effective learning experience for both participants. Receiving explanations can also correlate positively with later achievement scores indicating, "students who know what to ask about and succeed in getting their questions answered are likely to master the material" (Good & Brophy, 2008, p. 196).

Most of the research regarding small groups involves students working on relatively simple content. Even when the purpose of the instruction is small group inquiry or problem solving, the teacher's intended goals are not always automatic (Blumenfeld, 1992). Without careful teacher structuring and monitoring, the same students who benefit the most from whole-class instruction are also the most likely to learn best in small groups. It is critical to prepare students for both the social and the cognitive demands of cooperation. Some cooperative learning models also require the ability to negotiate, compromise, or handle discontinuity and ambiguity, all of which need to be taught and practiced in the classroom for successful implementation.

Active Learning. An important aspect of a constructivist approach to instruction is active learning. Students learn and retain information better when they are actively involved in the lesson (Duhaney & Duhaney, 2000; Harris & Graham, 1996). Active engagement involves students continually processing and internalizing information and then making appropriate application. When learning is passive, the learner encounters information without curiosity, questions, or interest in the outcome. In an active classroom, teachers engage students in assignments and activities that provide them with opportunities to practice or apply what they are learning. Teachers often become the facilitator of learning, providing coaching, task-simplification strategies, and other forms of scaffolding that may be needed to enable students to complete the activities successfully. Through limited research available on activities and assignments (Brophy, 1992), it is reported that students often spend half or more of their time in school working independently (Fisher et al., 1980). According to process-outcome research, independent seatwork is probably overused and may not be an adequate substitute for active teacher instruction or provide adequate discussion opportunities. Time consuming, low-level tasks emphasis this inadequacy. Additional research suggests that activities and assignments should be varied and interesting enough to motivate student engagement. The assignments should represent new or challenging information to constitute meaningful learning experiences rather than busywork for the students. Yet, the assignments should also allow the student to achieve a high rate of success if they invest reasonable effort and time.

From a constructivist belief, students build knowledge through a process of active construction. This active construction involves making connections between new information and prior learning. Constructivists emphasize relating new content to knowledge that students already possess, as well as providing opportunities for students to process and apply the new learning. Many constructivist ideas are built upon the foundation that educational reformers such as John Dewey and Jean Piaget created. Learning, rather than teaching, has been the primary focus of constructivist theory and research. However, principles for how teachers can support their students' learning have also been emphasized.

Social constructivist learning. Because classrooms are considered communities, and most learning takes place within the context of social interaction, many constructivists have adopted a version of social constructivism. Social Constructivists emphasize that learning is a process through active construction of meaning. They also believe that the process works best when two or more individuals engage in sustained discourse about a topic. These discussions help learners increase their learning in several ways. Being exposed to new information from others in a social setting makes them aware of things they did not know and expands their cognitive structures. When ideas contradict their own beliefs, they may be encouraged to examine those beliefs and reconstruct them. By communicating their ideas to others, learners are forced to articulate their ideas more clearly, oftentimes creating new connections of ideas as their conceptions of information are sharpened.

In a social constructivist classroom, learners participate in sustained discussion to pursue a topic in depth, exchanging views and negotiating meanings and implications, as well as exploring the topics ramifications. This could be through whole-class discussions, or could include small group cooperative learning (King, 1994). The emphasis, from a constructivist point of view, would be for the teacher to extend beyond “information transmission” models where students memorize information, and move toward knowledge construction models. The teacher would typically begin by presenting information and essential questions, then shift to the use of discussion, allowing students to use, extend and alter the content to make their own meaning from the topic. Students use their classroom community to collaborate and construct shared understanding through sustained dialogue. Meaningful learning activities associated to real life situations are one of the key ideas within constructivist theory (Grobecker, 1999). Teachers in a constructivist classroom also focus on key ideas and the relationship of these ideas within the subject areas (Grobecker, 1999) and across subject areas (Ellis, 1997). Students' prior knowledge is seen as the foundation for instruction in a constructivist classroom (Duhaney & Duhaney, 2000).

Social constructivist teaching oftentimes seems more achievable in teacher-led small groups than in the whole class setting. Within a small group, it is more likely that students will all have similar goals, meanings, and understandings, making it easier to participate fully in group discussions. This is also easier for the teacher to monitor individual understandings and intervene to correct misconceptions.

Bloom's Taxonomy

Educators today must make tough decisions about the classroom activities consuming their instructional day. It is essential that they align educational objectives with local, state, and national standards. Bloom's Taxonomy provides a framework to help teachers match these objectives to the cognitive abilities of their students. Collaboration and the use of higher-level thinking skills benefits students through important twenty-first-century skills, such as the ability to work in teams, solve complex problems, and apply knowledge from one lesson to others, and to the real world.

Higher-order thinking skills and technology. The concept of higher order thinking skills became a major educational agenda item with the publication of Bloom's et al. taxonomy of educational objectives. This taxonomy categorized questions into six different levels within the cognitive domain of learning: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. More recently, and adapted version of Bloom's model has been adapted by Anderson and Krathwohl (2000) to fit the needs of today's classroom. This updated version, referred to as the New Blooms, employs more outcome-oriented language, workable objectives, and changing nouns to active verbs: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating.

Research supports that when practicing authentic inquiry and higher-order thinking, student achievement can achieve. Yet, when technology is present in the teaching environment, the benefits are enhanced (Edutopia, 2009). However, the act of integrating technology in isolation does not necessarily result in the acquisition of higher-order thinking skills or improved student achievement. These results are derived from how the technology is used and the role the teacher plays in the classroom. Collaboration may also be a key factor in the acquisition of higher order thinking skills (Brabec, Fisher, & Pitler, February 2004; Lemke & Coughlin, 1998; Wegerif, 2002).

Students can become engaged in content through the use of technology and higher-level activities, such as analyzing or evaluating information. The mere act of integrating technology in isolation does not necessarily result in the acquisition of higher-order thinking skills or improved student achievement. These results are derived from how the technology is used and the role the teacher plays in the classroom. Collaboration may also be a key factor in the acquisition of higher order thinking skills (Brabec, Fisher, et al., 2004; Lemke & Coughlin, 1998; Wegerif, 2002). When focused on higher-order thinking skills, research has shown that integrating technology into teaching does appear to have a particularly significant effect. Hopson (1998) evaluated the effects of placing students in a technology enriched learning environment on the development of higher order thinking skills in fifth grade students. The result of his study, which employed the CAQ

(Computer Attitude Questionnaire) and Ross Test of Higher Cognitive Processes, indicated that the technology enriched the environment positively and significantly affected the use of the higher order thinking skills and evaluation in the students (Hopson, 1998).

Student-centered environments and technology. Student-centered environments tend to benefit a greater population of learners who retain more meaningful information while actively engaged in the learning process (Becker, 1999). Technology lends itself well to these student-centered environments through the purposeful integration of electronic resources and tools that facilitate project based learning activities in K-12 classrooms (Chen, 2002). It is difficult to assess whether technology is truly making an impact on learning in these environments or perhaps it could be better viewed as a change in instruction that occurs when technology is introduced, integrated into instruction, and adopted by the teacher as a meaningful and consistent resource for student learning that results in an increasing level of student academic achievement.

Summary

The purpose of this literature review was to explore the research on and related to student grouping strategies, higher-order thinking, and technology in the classroom. The research discussed in this study points towards a need for teachers to engage students through pairs and small groups. The research shows that this type of learning environment has the potential for engaging students in meaningful learning with authentic tasks in a social setting and that small group methods can support the social construction of knowledge by students learning from and with one another. Research into how technology rich learning environments are structured and what strategies teachers have used to group students in order to be successful is extremely important for future policy decisions regarding educational technology.

CHAPTER THREE

Methodology

During the Spring of 2008, an observation form and protocol was developed to be used in TRC and non-TRC, or typical general education classrooms. This observation form was used during the 2008-09 and 2009-10 school years to collect classroom-level data. The sections of the observation form included categories for observing specific technology being used by teachers and students, how the students were grouped during classroom activities, what the teacher was doing during the observation session, how many students were considered to be off-task during the activities, and what cognitive level, based on Bloom's Taxonomy, was being implemented. The existing data set gathered during 2008-09 and 2009-10 was utilized in the analysis between a technology rich classroom environment and that of a typical general education classroom; however, the study only analyzed the data related to student grouping strategies and cognitive activities in the classroom environment.

Setting and Participants

The setting for this study includes elementary schools that were participating in the Technology Rich Classroom Program, funded through the State Department of Education's Title IID initiative. Observation data was collected at two schools: one Phase 6 school during 2008-09 and 2009-10 and one Phase 7 school during 2009-10. These sites were chosen for data collection by the TRC Leadership Team and were considered to be a sample of convenience, due to budget restrictions. Both schools were located in a mid-size town (population 51,707), but still considered a rural area (U.S. Census Bureau, 2007). Six of the classrooms observed were technology rich classrooms in grades 3, 4, 5 or 6. Six classrooms were typical general education classrooms, also in grades 3, 4, 5 or 6. Each school involved in the grant has a content focus area of mathematics, reading, or science. From the two schools selected for observations, both were focusing on student achievement in mathematics. Observations occurred during the time that the teachers were conducting classroom activities in their grant focus area of mathematics.

The technology rich classroom participants were part of a statewide grant program. As part of the grant award, the classrooms contained laptop computers with at least a 2:1 student to computer ratio, an interactive whiteboard, projector, and additional peripheral devices such as printers, scanners and student response systems. The teachers in these classrooms had the opportunity to work with a dedicated facilitator to provide onsite support, mentoring, and co-teaching. In addition, the participants were active in statewide professional learning days four times throughout the school year.

The typical general education classrooms were not participating in the statewide grant program and did not have the required technology in place in their classrooms. The classrooms contained some technology and additional student computers were available to the teachers though a checkout system, either using the computer lab or a cart of laptops. The teachers were not working with a dedicated TRC facilitator and did not participate in the statewide professional learning days.

Observation Instrument and Procedures

The TRC Leadership Team, consisting of Project Leaders and Directors at ALTEC and the State Department of Education Consultant for Educational Technology, created an observation instrument with the guidance of the SPEaR team of the University's Psychology and Research in Education program to be used with the Technology Rich Classroom Program. Portions of the observation sheet were based on an observation protocol originally designed by the Intel Foundation in cooperation with Rockman, et al. (2007). The original observation instrument, the ALTEC Observation Form, is included in Appendix A and the definitions for the observation categories are included in Appendix B.

The observation instrument created by ALTEC and SPEaR was to provide a comprehensive picture of what happens in a classroom during a specific observation period. Six distinct categories were included to record: (a) technologies being used by teachers, (b) technologies being used by students, (c) student grouping and activity, (d) teacher engagement, (e) number of students on task, and (f) the classroom activity based on Bloom's Taxonomy.

Observations included momentary time sampling at 20-second intervals. Momentary time sampling has been shown to be an effective and accurate observation tool when short intervals are used and when the behavior is of substantial duration (Harrop & Daniels, 1986; Saudargas & Zanolli, 1990). In this case, the behaviors observed were not short or discrete behaviors occurring infrequently, they were general activities that would happen over a relatively long period of time during the classroom activities. In recording the observation data, the observers watched a single timer on a computer screen. Once the timer reached 20 seconds the observers recorded what was occurring at that moment. All six categories were scored each minute, with two categories being scored every 20 seconds.

Reliability for Observations

Two observers were trained on the observation form by watching videotapes of classrooms and observing in actual classroom periods until they achieved a reliability estimate of 80% or greater for all categories. After the observers reached this level of reliability, they began to observe in the classrooms that were part of the project. Reliability information was collected for a sample of the observations in the existing data set and was analyzed as part of this study.

Observation Instrument Pilot Studies

Pilot study one. During 2008-09, the ALTEC Observation Form was tested in nine classrooms. Six technology rich classroom teachers were available for involvement in this study and three teachers who were uninvolved in the TRC Program were also recruited to serve as comparison classrooms, or typical general education classrooms. All TRC teachers and two of three teachers from the typical general education classrooms were female. There were an average of 17 students in the classrooms, with a range of 13 to 21, and on average there were approximately 1 adults in the class besides the teacher, with a range from 0 to 4. The observation periods lasted an average of 55 minutes, with the shortest observation lasting 20 minutes and the longest being 60 minutes.

Table C1 (Appendix C, page 77) reports the amount of agreement using the two forms of reliability for each of the four observation periods and the average level of agreement for all four of the observation periods during 2008-09. Overall, the level of agreement between observers was similar between observations for the average frequency ratio, although the average frequency ratio did increase when looking at the correlation coefficient for each observation. Overall, these levels of agreement are acceptable in accordance with acceptable levels of agreement.

To create a composite proportion for each type of classroom environment, results from the technology rich classrooms and typical general education classrooms were collapsed together. The number of total intervals in which observations took place for each classroom type was summed, and then the total number of intervals in which each category was scored was summed. The sums of the categories were divided by the total number of observation intervals and then multiplied by 100 to obtain a percentage. The resulting number is the percentage of intervals in which each category was scored for all technology rich and typical classrooms across all four observations. A *z*-test for significant differences between proportions was conducted using the raw scores to determine which categories had significantly higher proportions. Table C2 (Appendix C, page 77) provides the proportion of total intervals in which each category was scored, and the significant differences are flagged accordingly.

As reported in Table C2, there are some differences between the technology rich and typical classrooms. The technology rich classrooms observed used technology significantly more often, with teachers and students using technology 49% and 68% of the time, respectively, while in typical general education classrooms technology was only used by teachers and students 6% and 5% of the time, respectively. This indicates that there was substantially more technology use in the technology classrooms. Since we know that the technology rich classrooms have more technology available, and the pilot study results indicate that more technology is being used in these classrooms, the observation form appears to have content validity, and measure what it was intended to measure.

Overall, the observations from the first pilot study provide some preliminary evidence that classrooms with and without a wide array of technology, that is available and used, do tend to differ. While these data provide some preliminary evidence that there are some differences between these two types of classrooms, gathering additional data from each type of classroom across time would provide a more comprehensive picture of the learning environment. Due to budget constraints, the data collectors were limited to four observation periods occurring over the course of the school year at schools that were in close proximity to the researchers. It is possible that this sample of convenience and the observation periods were not typical of classrooms, and the occasional presence of the observers may have also been a distraction. While the levels of reliability were acceptable across observations, they were generally on the low end of acceptability. It is possible that there may be some systematic differences between raters, and the numbers reported here may be biased in one way or another. Reliability figures of at least 85% across all categories would provide stronger evidence that the behaviors observed in the classrooms were the actual behaviors that occurred.

Pilot study two. During 2009-10, eight additional classrooms were recruited to be involved in a second pilot study with eight of the original classroom teachers who participated in the first pilot study. This represented 10 technology rich classrooms and 6 typical general education classrooms. Of the sixteen teachers involved in second pilot study, nine of the TRC teachers were female and 1 was male. The typical general education teacher group consisted of 2 males and 4 females. The classroom observations were conducted four times during the 2009-10 school year.

The observations completed during this period addressed teacher and student technology use, grouping strategy, teacher behavior, student engagement, and cognitive abilities. The student engagement category used during the 2008-09 school year was eliminated, as that data did not tend to be consistently reliable or accurate. The other five categories were used throughout the 2009-10 observations. The method used to collect the data was momentary time sampling, where the observers would code what was happening in the classroom every 20 seconds. An electronic observation form using Microsoft Excel was created to assist in data collection.

Table D1 (Appendix D, page 78) includes aggregated data from all classrooms and all observations for 2008-09 and 2009-10. Additionally, the effect size between the two percentages and the reliabilities for the observations are included. The effect sizes reported are interpreted as typical effect sizes, where .20, .50, and .80 mean small, medium, and large effect sizes, respectively.

In the second pilot study, the technology classrooms appeared to have several important differences over typical general education classrooms. Namely, in technology rich classrooms the students and teachers used technology much more often, the students engaged in more independent and group work, and the teachers spent less time lecturing and more time helping individuals or groups of students. In the typical general education classrooms, the students engaged in more lower-level cognitive activities.

Pilot study results. These brief studies provide some evidence that including technology in a classroom, training teachers how to use the technology, and providing support for technology use may change many aspects of learning. While these studies are small in scope, they do provide some important evidence that the use of technology in classrooms helps provide students with more opportunities to work together on projects that promote higher level thinking.

As a result of these two pilot studies, the observation instrument has been modified for better reliability, with the intent of using the observation instrument with a larger group of data collection coordinators across the state. In particular, the category choices have been collapsed to include Attention to Teacher and/or Student as one selection. As mentioned previously, the Student Engagement, or student time on task, category has been removed from the observation form. In addition, the choices in the Cognitive Abilities section have been modified to reflect Bloom's Revised Taxonomy. These modifications improved the reliability of the individual categories and observation instrument as a whole. In addition, the changes assisted in training a new group of data collection coordinators who are using the observation instrument with additional technology rich classroom grantees during 2010-11.

Through the pilot studies, the observation instrument has been developed, tested, validated and refined. The pilot studies provided a foundation for the research study identified in this manuscript. Further analysis of the data collected during the pilot studies examined the grouping strategies used throughout the school year and between school years as well as the correlation of grouping strategies to cognitive abilities, where neither was investigated in the original pilot studies. In addition, data is currently being collected in 17 sites, both middle and elementary school using the modified observation form from the pilot studies. The findings from this research study will be able to be applied to the data set being collected in this school year, 2010-11, for further analysis.

Data Analysis

Data were gathered in over 3,000 intervals during the 2008-09 and 2009-10 school years from the 12 participating classrooms. First, an independent-samples *t* test was conducted for the independent variable, the classroom, using the following groups: (a) technology rich classrooms and (b) typical general education classrooms. This independent variable was analyzed against the dependent variable, student grouping strategies, that have been observed in the classrooms. The t test identifies whether the means of two groups are statistically different from each other. The t test is one of the most commonly used statistical data analysis procedures for hypothesis testing. It simply tests whether or not two independent populations have different mean values on an identified measure. This analysis is appropriate because the proposed study is comparing the means of two classroom groups on student grouping strategies used by the classroom teacher. Using the *t* test statistic provided a *p*-value, or Alpha level, which indicates how likely we could have gotten these results by chance. The Alpha level was set at $p<.05$ for a two-tailed test to determine the critical probability for the study. If there was less than 5% chance of getting the observed differences by chance, the null hypothesis was rejected with the conclusion that there is a statistically significant difference in the grouping strategies between the two classroom groups.

To extend this analysis, I also applied a one-way ANOVA with repeated measures to each of the independent variable groups. The data were gathered in 12 classrooms during four specific observation periods during each school year. This created the situation where the same subjects were measured repeatedly on the same dependent variable and change over time could be analyzed. A strength of this type of repeated measures design is that the study can be more efficient, allowing for a smaller than usual number of subjects. The repeated-measures ANOVA accounts for a possible variance between sample members, reducing error variance. An analysis of the longitudinal data in this research study identified and described changes in grouping strategies used by classroom teachers over the course of a school year, within each treatment group, and throughout their participation in the Technology Rich Classroom Program.

A final analysis calculated the correlation coefficient to examine the relationship between the student grouping strategies and the level of cognitive activities observed in the classroom. Specifically, this analysis examined if the grouping strategies correlate to the cognitive activities of receiving knowledge, applying, analyzing/evaluating, or creating.

CHAPTER FOUR

Results And Discussion

The purpose of this study was to identify and describe grouping strategies of students observed within a technology rich classroom in comparison to a typical general education classroom. Specifically, this study reviewed the following student grouping strategies: independent, pairs, small groups, mixed groups/independent; as well as whole class with attention to teacher, to another student, or to media; and non-instructional transition activities. In addition, the study examined higher-level thinking activities assigned by the classroom teacher, based on Bloom's Taxonomy, in relation to these student grouping strategies. The following research questions were addressed:

1. What differences in student grouping strategies exist between technology rich classrooms and typical general education classrooms and how frequently do these groupings appear in the two different classroom environments?
2. Is there a relationship between student grouping strategies and higher-level cognitive activities in the two different classroom environments?

The null hypothesis is that there is no significant difference between the grouping strategies utilized in a technology rich and typical classroom and that there is no relationship between the grouping strategies and higher-level cognitive activities.

To answer these questions, the observation data for each of the seven student grouping strategy categories were gathered from both classroom environments. Seven separate *t*- tests were performed on the data with the classroom environment (technology rich or typical) as the independent variable and the grouping strategy as the dependent variable. This chapter includes a reliability analysis of the observations, findings for the groups being observed, and discussion of the methods and results.

Reliability for Observations

Three observers were trained on the use of the observation form by watching videotapes of classrooms and observing in actual classroom periods until they achieved a reliability estimate of 80% or greater for all categories. After the observers reached this level of reliability, they began to observe in the classrooms that were part of the project. Reliability information was collected for 67% of the total observation periods (42 out of 63 observations). For the actual reliability observations, two observers were present in the classroom at the same time; observing and coding the same classroom activities and using a shared timer.

Reliability was calculated using the percentage agreement between observers and the correlation between observers (Table 1). These two different methods were used to account for the strengths and weaknesses of each observer and the strengths and weaknesses of each method of calculating reliability. Using the first method, percentage agreement between observers, each observation category was totaled for each observer. Then, the lower frequency of observations was divided by the higher frequency. This produced the average ratio of agreement between all categories for each classroom. One of the problems with this method is when only a few intervals have been scored for a category; the level of agreement may appear low. For example, if one observer reports seeing a behavior two times, but the other reports a behavior occurring three times, this provides a low level of agreement (approximately 67%) even though there were many intervals in which the observers agreed the category was *not* appropriate to be scored. This can artificially decrease the overall level of agreement between observers. Additionally, there are observation periods in which a category was never recorded by either observer, and it would be reported that the observers agreed 100% of the time, which can artificially increase the overall rating.

The second way in which reliability was calculated was to correlate the numbers reported by each rater from each category using a Pearson correlation coefficient. While this provides a coefficient that shows the strength of the relationship between the raters, the correlation can also be artificially high if one rater is systematically lower or higher than the other rater (Kazdin, 1982). Additionally, when categories have not been scored during the observation period (thus, the raters scores are both zero), the level of agreement may also be inflated.

Table 1

Reliability of Observations, 2008-10

	Rater 1	Rater 2	Percentage Agreement	Pearson Correlation
Independent Work	566	468	86%	.808
Pairs	202	196	97%	.995
Small Groups	129	169	76%	.665
Mixed Groups	149	207	74%	.464
Whole Class: Attention to Teacher or Student	839	869	96%	.949
Whole Class: Attention to Media	9	11	82%	.960
Transition	120	93	81%	.896

Overall, it appears that the level of agreement between observers was similar when calculated using the percentage agreement and Pearson Correlation methods, although in some cases the method used may have inflated the reliability for some of the categories. The reliability for Small Groups and Mixed Groups appear low, however upon further analysis, the observers coded the categories opposite of one another (one coded small group, the other coded mixed groups) for one of the observation periods. When these two categories are combined, the percentage agreement is 75% and Pearson Correlation is .565. The composite reliability score for all categories is 83% using the percentage agreement method and .82 using the Pearson Correlation method. These levels of agreement are somewhat low in accordance with previous studies and with acceptable levels of agreement (80% or higher), but they are not unacceptably low (60% or lower). These lower reliability calculations will guide the study results in being interpreted somewhat cautiously.

Student Grouping Strategies

Overall results. An independent-samples *t* test was conducted to evaluate the question: what differences in student grouping strategies exist between technology rich classrooms and typical general education classrooms? When observations from the technology rich and typical general education classrooms were compared, the results did not show the mean scores consistently favoring one particular type of classroom (Table 2). Differences were statistically significant in two of the seven observation categories, whole class attention to teacher or student ($t(61) = -3.062$, $p = .003$) and transitions ($t(61) = 2.593$, $p = .012$). Positive *t* values indicate that the technology rich classroom group had a higher percentage than typical classrooms, while negative values indicate the control group (typical classrooms) had a higher value than the technology rich classrooms.

Table 2

Student Grouping Strategies used in Technology Rich and Typical Classrooms, 2008-10

	Technology Rich Classroom		Typical Classroom			
Dependent Variables	Mean	SD	Mean	SD	*t*	*p*
Independent Work	34.5%	.300	24.6%	.214	1.501	.139
Pairs	6.2%	.206	9.5%	.209	-.630	.531
Small Groups	4.7%	.122	3.3%	.101	.473	.638
Mixed Groups	12.5%	.242	7.1%	.169	1.026	.309
Whole Class: Attention to Teacher or Student	33.3%	.242	50.4%	.198	-3.062	.003
Whole Class: Attention to Media	.5%	.018	.1%	.008	1.064	.239
Transition	8.1%	.059	4.7%	.042	2.593	.012

Independent work. An independent-samples *t* test was conducted to analyze instances where students were observed working independently in two different classroom environments. This test was not significant, $t(56) = 1.501$, $p = .139$. Students in the technology rich classroom ($M = .345$, $SD = .300$) on average were observed working independently more than students in the typical general education classroom ($M = .246$, $SD = .214$), but these differences were not statistically significant at the $p < .05$ level. The 95% confidence interval for the differences in means ranged from -.003 to .229. Statistically, classrooms were equally observed having students work independently.

Working in pairs. An independent-samples *t* test was conducted to analyze instances where students were observed working with another student (in pairs) in two different classroom environments. The test was not significant, $t(61) = -.625$, $p = .531$. Technology rich classroom ($M = .063$, $SD = .206$) on average grouped students less in pairs than typical general education classrooms (*M* = .095, *SD* = .209). The 95% confidence interval for the differences in means ranged from -.137 to .071. Statistically, classrooms were equally observed having students work in pairs.

Working in small groups. An independent-samples *t* test was conducted to analyze instances where students were observed working in small groups with 1 or 2 other students in two different classroom environments. The test was not significant, *t*(61) = -.473, *p* = .638. Technology rich classroom (*M* = .047, *SD* = .122) on average grouped students more in small groups than typical general education classrooms (*M* = .033, *SD* = .101). The 95% confidence interval for the differences in means ranged from -.043 to .070. Statistically, classrooms were equally observed having students work in small groups.

Working in mixed groups (independently, pairs or small groups). Occasionally, classroom activities require a combination of student grouping strategies. This study also explored instances when students were observed working either independently, with another student in a pair formation, or in small groups. An independent-samples *t* test was conducted and found to be not significant, *t*(61) = 1.026, *p* = .309. Technology rich classroom (*M* = .125, *SD* = .242) on average grouped students more in mixed groups than typical general education classrooms (*M* = .071, *SD* = .169). The 95% confidence interval for the differences in means ranged from -.051 to .160. Statistically, classrooms were equally observed having students work in mixed groups.

Whole class with attention to the teacher or another student. An independent-samples *t* test was conducted to analyze instances where students were observed in whole class activities with attention to the teacher or another student in two different classroom environments. The test was significant, *t*(61) = -3.062, *p* = .003. Technology rich classroom (*M* = .333, *SD* = .242) on average grouped students less in whole class activities with attention to the teacher or another student than typical general education classrooms (*M* = .504, *SD* = .198). The 95% confidence interval for the differences in means ranged from -.283 to -.059.

Whole class with attention to media. An independent-samples *t* test was conducted to analyze instances where students were observed in whole class activities with attention to media such as a computer being projected onto a large screen or a movie in two different classroom environments. The test was not significant, $t(44.67) = 1.064$, $p = .293$. Technology rich classroom (*M* = .005, *SD* = .018) on average grouped students more in whole class activities with attention to media than typical general education classrooms (*M* = .001, *SD* = .008). The 95% confidence interval for the differences in means ranged from -.003 to .011. Statistically, classrooms were equally observed in whole class activities with attention to media.

Transitions. An independent-samples *t* test was conducted to analyze classroom transitions in two different classroom environments. The test was significant, $t(56) = 2.593$, $p = .012$. Technology rich classroom (*M* = .081, *SD* = .059) on average had more observed transitions than typical general education classrooms (*M* = .047, *SD* = .042). The 95% confidence interval for the differences in means ranged from .007 to 060.

Summary. The quantitative analysis of the data showed that some differences in student grouping strategies do indeed exist between technology rich classrooms and typical general education classrooms. However, the results did not show the mean scores consistently favoring one particular type of classroom over the other type of classroom. Differences were statistically significant in two of the seven observation categories, whole class attention to teacher or student ($t(61) = -3.062$, $p = .003$) and transitions ($t(61) = 2.593$, $p = .012$).

The data set used for this analysis is relatively small, utilizing a sample of 6 technology rich classrooms and 6 typical general education classrooms. To further analyze the classroom environments, the researcher would suggest an alternative method of analysis which utilizes an average percentage of the intervals observed, similar to the data analysis from the original pilot studies. In addition, the data set included technology rich classrooms that were in their second year of implementation as well as those just beginning their first year of implementation. One could argue that during the second year of a program teachers might have a greater comfort, skill and/or knowledge level and might implement strategies in the classroom differently than a first year program. An alternative analysis using the average percentage of the intervals observed and only first year data from the classrooms will be presented in the next section.

Alternative analysis and results. Data were gathered in over 2,300 intervals during the 2008-09 and 2009-10 school years from the 12 participating classrooms. A total of 47 observation periods were conducted during the first year that the school was participating in the statewide grant program. Table 3 includes the percentage of time each category was coded during the first year of program implementation for each group. Additionally, the effect size between the two percentages and the reliabilities of the observations are included.

Table 3

Student Grouping Strategies used in Technology Rich and Typical Classrooms, 2008-10 First Year of Program Implementation

				Reliability	
Dependent Variables	Technology Rich %	Typical %	Effect Size	% Agreement	Pearson Correlation
Independent Work	37.09%	21.73%	0.340	.84	.77
Pairs	5.00%	13.07%	0.289	.99	.99
Small Groups	5.67%	4.77%	0.041	.95	.99
Mixed Groups	6.10%	6.18%	0.004	.52	.53
Whole Class: Attention to Teacher or Student	36.58%	48.94%	0.251	.97	.95
Whole Class: Attention to Media	0.59%	0.18%	0.070	.82	.96
Transition	8.98%	5.12%	0.152	.77	.92

The effect sizes reported here are based on a geometric transformation of the percentages, a recommendation provided by Rossi (1985). These effect sizes are interpreted as typical effect sizes are, where .20, .50, and .80 mean small, medium, and large effect sizes, respectively.

For grouping strategies, TRC classrooms had higher percentages of individual work, although this was a small effect size. The results show students in a typical general education classroom were observed working in pairs more than students in a technology rich classroom, again with a small effect size. There was no significant difference between the technology rich and typical general education classroom in regards to students working in small or mixed groups. Typical general education classrooms were higher in whole-class activities where the students were paying attention to the teacher, another student and/or media. Rather than working independently or with others, these classrooms spent more time engaging in instruction designed to be delivered to the entire class.

A final important reflection from these observations is that there were no differences in the transition times between TRC and typical classrooms. This is important because it indicates that the inclusion of technology in the classroom does not appear to take any time away from class in terms of transition time or time use by the teacher for other activities (e.g. set up, troubleshooting) during the first year of program implementation.

Student Grouping Strategies Throughout the Year

To examine the frequency and distribution of the student grouping strategies over time, a one-way repeated measures ANOVA was applied to each of the independent variable groups, technology rich classrooms and typical general education classrooms. The data were gathered in 12 classrooms during four specific observation periods during each school year. In this case, the dependent variable of student grouping strategies was analyzed for significant changes over time.

Technology rich classrooms. A one-way repeated measures ANOVA was conducted with the factor being observation period number and the dependent variable being the various grouping strategies within technology rich classrooms. The means and standard deviations for technology rich classrooms are presented below in Table 4.

Table 4

Means and Standard Deviations for Technology Rich Classroom Student Grouping Strategies

	Observation One		Observation Two		Observation Three		Observation Four	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Independent Work	.33	.27	.27	.18	.44	.34	.34	.40
Pairs	.00	.01	.07	.18	.12	.34	.06	.16
Small Groups	.05	.15	.04	.07	.00	.00	.10	.19
Mixed Groups	.12	.23	.10	.26	.06	.10	.22	.34
Whole Class: Attention to Teacher or Student	.38	.22	.43	.25	.31	.24	.21	.24
Whole Class: Attention to Media	.01	.03	.00	.00	.01	.03	.00	.00
Transition	.10	.06	.10	.06	.06	.07	.07	.06

Independent work. A one-way within subjects ANOVA was conducted with the factor being the observation period number and the dependent variable being independent work within a technology rich classroom. The means and standard deviations for independent work are presented in Table 4. The results for the ANOVA did not indicate a significant time effect, Wilks's $\Lambda = .67$, $F(3, 5) = .84$, $p > .05$, multivariate $\eta^2 = .33$.

Pairs. A one-way within subjects ANOVA was conducted with the factor being the observation period number and the dependent variable being pairs within a technology rich classroom. The means and standard deviations for pairs are presented in Table 4. The results for the ANOVA did not indicate a significant time effect, Wilks's $\Lambda = .63$, $F(3, 5) = 1$, $p > .05$, multivariate $\eta^2 = .38$.

Small groups. A one-way within subjects ANOVA was conducted with the factor being the observation period number and the dependent variable being small groups within a technology rich classroom. The means and standard deviations for small groups are presented in Table 4. The results for the ANOVA did not indicate a significant time effect, Wilks's Λ = .59, $F(3, 5) = 1.14$, $p > .05$, multivariate $\eta^2 = .41$.

Mixed groups. A one-way within subjects ANOVA was conducted with the factor being the observation period number and the dependent variable being students in mixed groups within a technology rich classroom. The means and standard deviations for mixed groups are presented in Table 4. The results for the ANOVA did not indicate a significant time effect, Wilks's Λ = .75, $F(3, 5) = .56$, $p > .05$, multivariate $\eta^2 = .25$.

Whole class with attention to teacher or student. A one-way within subjects ANOVA was conducted with the factor being the observation period number and the dependent variable being whole class with attention to the teacher or another student within a technology rich classroom. The means and standard deviations for whole class with attention to the teacher or another student are presented in Table 4. The results for the ANOVA did not indicate a significant time effect, Wilks's Λ = .62, $F(3, 5) = .99$, $p > .05$, multivariate $\eta^2 = .37$.

Whole class with attention to media. A one-way within subjects ANOVA was conducted with the factor being the observation period number and the dependent variable being whole class with attention to media within a technology rich classroom. The means and standard deviations for whole class with attention to media are presented in Table 4. The results for the ANOVA did not indicate a significant time effect, Wilks's Λ = .75, $F(2, 6) = 1.0$, $p > .05$, multivariate $\eta^2 = .25$.

Transitions. A one-way within subjects ANOVA was conducted with the factor being the observation period number and the dependent variable being whole class with attention to the teacher or student within a technology rich classroom. The means and standard deviations for mixed groups are presented in Table 4. The results for the ANOVA did not indicate a significant time effect, Wilks's $\Lambda = .82$, $F(3, 5) = .36$, $p > .05$, multivariate $\eta^2 = .18$.

Typical general education classrooms. A one-way within subjects ANOVA was conducted with the factor being observation period number and the dependent variable being the various grouping strategies within typical general education classrooms. The means and standard deviations for typical general education classrooms are presented in Table 5.

Table 5

Means and Standard Deviations for Typical General Education Classroom Student Grouping Strategies

	Observation One		Observation Two		Observation Three		Observation Four	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Independent Work	.13	.11	.29	.26	.32	.24	.27	.19
Pairs	.06	.12	.08	.20	.05	.12	.04	.09
Small Groups	.00	.00	.10	.17	.01	.02	.05	.12
Mixed Groups	.15	.20	.01	.03	.09	.25	.06	.17
Whole Class: Attention to Teacher or Student	.58	.22	.51	.11	.46	.28	.56	.14
Whole Class: Attention to Media	.00	.00	.01	.02	.00	.00	.00	.00
Transition	.06	.05	.04	.03	.08	.04	.02	.03

Independent work. A one-way within subjects ANOVA was conducted with the factor being the observation period number and the dependent variable being independent work within a typical general education classroom. The means and standard deviations for independent work are presented in Table 5. The results for the ANOVA did not indicate a significant time effect, Wilks's $\Lambda = .35$, $F(3, 4) = 2.48$, $p > .05$, multivariate $\eta^2 = .65$.

Pairs. A one-way within subjects ANOVA was conducted with the factor being the observation period number and the dependent variable being pairs within typical general education classroom. The means and standard deviations for pairs are presented in Table 5. The results for the ANOVA did not indicate a significant time effect, Wilks's $\Lambda = .71$, $F(2, 5) = 1$, $p > .05$, multivariate $\eta^2 = .29$.

Small groups. A one-way within subjects ANOVA was conducted with the factor being the observation period number and the dependent variable being small groups within a typical general education classroom. The means and standard deviations for small groups are presented in Table 5. The results for the ANOVA did not indicate a significant time effect, Wilks's $\Lambda = .57$, $F(3, 4) = 1.00$, $p > .05$, multivariate $\eta^2 = .43$.

Mixed groups. A one-way within subjects ANOVA was conducted with the factor being the observation period number and the dependent variable being students in mixed groups within a typical general education classroom. The means and standard deviations for mixed groups are presented in Table 5. The results for the ANOVA did not indicate a significant time effect, Wilks's $\Lambda = .57$, $F(3, 4) = 1.00$, $p > .05$, multivariate $\eta^2 = .43$.

Whole class with attention to teacher or student. A one-way within subjects ANOVA was conducted with the factor being the observation period number and the dependent variable being whole class with attention to the teacher or another student within a typical general education classroom. The means and standard deviations for whole class with attention to the teacher or another student are presented in Table 5. The results for the ANOVA did not indicate a significant time effect, Wilks's $\Lambda = .59$, $F(3, 4) = .92$, $p > .05$, multivariate $\eta^2 = .41$.

Whole class with attention to media. A one-way within subjects ANOVA was conducted with the factor being the observation period number and the dependent variable being whole class with attention to media within a typical general education classroom. The means and standard deviations for whole class with attention to media are presented in Table 5. The results for the ANOVA did not indicate a significant time effect, Wilks's $\Lambda = .86$, $F(1, 6) = 1.00$, $p > .05$, multivariate $\eta^2 = .14$.

Transitions. A one-way within subjects ANOVA was conducted with the factor being the observation period number and the dependent variable being whole class with attention to the teacher or student within a typical general education classroom. The means and standard deviations for mixed groups are presented in Table 5. The results for the ANOVA indicated a significant time effect, $F(3, 18) = 4.61$, $p < .05$. The alternative univariate tests yield the same F value, but correct the degrees of freedom of the F as a function of the degree to which the data indicate that the sphericity assumption is violated. The p value is greater for two of the alternative tests, but all three tests are significant at the traditional .05 level.

Follow-up polynomial contrasts indicated a significant linear effect with means decreasing over time, $F(1, 6) = 4.55$, $p > .05$, partial $\eta^2 =.43$. Higher-order polynomial contrasts were non-significant. It should be noted that there was little change in means between the observation periods during the school year; therefore, the significant trend was due to changes first and last observation of the school year. These results suggest that teachers in typical general education classroom spent more time with transitions early in the school year, and this transitional time decreased at the end of the school year.

Summary. The quantitative analysis of the data showed few changes in student grouping strategies occurring throughout the school year in technology rich classrooms and typical general education classrooms. Although classroom teachers vary the grouping strategies used in the classroom, none of these differences were statistically significant.

Once again, the data set included technology rich classrooms that were in their second year of implementation as well as those just beginning their first year of implementation. While each of the classrooms were observed four times throughout the year, one set of classrooms had an entire year of implementation experience, which could possibly impact the observation data collected. The first analysis explored the student grouping strategy differences within one school year but did not account for the Year 2 teachers. In addition, the observations occurred during a randomly selected date during the school year and randomly selected lessons to observe. With the nature of the classroom being very dynamic, it would be hard for one to assume that this observation gave a complete snapshot of classroom activities for the selected quarterly date within the school year. To further analyze the changes in grouping strategies between year 1 and year 2, the researcher suggests an alternative method of analysis which utilizes an independent samples *t* test to analyze the observations during Year 1 compared to the observations during Year 2.

Alternative analysis and results. Data were gathered in over 3,100 intervals during the 2008-09 and 2009-10 school years from the 12 participating classrooms. A total of 63 observation periods were conducted during two years of data collection.

Technology rich classrooms. An independent-samples *t* test was conducted to evaluate the question: how frequently do these groupings appear in the two different classroom environments? When observations from Year 1 and Year 2 were compared in the technology rich classroom environment, the results indicated a significant difference in one of the seven observation categories (Table 6). Differences were statistically significant in the mixed groups category ($t(6) = -4.014$, $p = .007$). A positive *t* value indicates that Year 1 had a higher value than Year 2, while a negative *t* value indicates that Year 2 had a higher value than Year 1.

Table 6

Means and Standard Deviations for Technology Rich Classroom Student Grouping Strategies – Year 1 v. Year 2 Comparison

	Year 1		Year 2			
Dependent Variables	Mean	SD	Mean	SD	*t*	*p*
Independent Work	36.5%	.133	28.8%	.009	.775	.468
Pairs	4.2%	.100	12.5%	.176	-.870	.418
Small Groups	5.4%	.085	2.6%	.026	.442	.674
Mixed Groups	6.7%	.067	30.0%	.088	-4.014	.007
Whole Class: Attention to Teacher or Student	38.0%	.171	19.3%	.064	1.440	.200
Whole Class: Attention to Media	.7%	.015	0%	.000	.662	.532
Transition	8.5%	.028	7.1%	.055	.520	.622

Independent work. An independent-samples *t* test was conducted to analyze instances where students were observed working independently in technology rich classrooms during two consecutive years. This test was not significant, $t(6) = .775$, $p = .468$. Students in the technology rich classroom during year 1 ($M = .365$, $SD = .133$) on average were observed working independently more than students during year 2 ($M = .288$, $SD = .009$), but these differences were not statistically significant at the $p < .05$ level. The 95% confidence interval for the differences in means ranged from -.165 to .319. Statistically, technology rich classrooms were equally observed having students work independently during year 1 and year 2.

Pairs. An independent-samples *t* test was conducted to analyze instances where students were observed working in pairs within technology rich classrooms during two consecutive years. This test was not significant, $t(6) = -.870$, $p = .418$. Students in the technology rich classroom during year 1 ($M = .042$, $SD = .100$) on average were observed working in pairs less than students during year 2 (*M* = .125, *SD* = .176), but these differences were not statistically significant at the $p < .05$ level. The 95% confidence interval for the differences in means ranged from -.316 to .150. Statistically, technology rich classrooms were equally observed having students work in pairs during year 1 and year 2.

Small groups. An independent-samples *t* test was conducted to analyze instances where students were observed working in small groups within technology rich classrooms during two consecutive years. This test was not significant, $t(6) = .442$, $p = .674$. Students in the technology rich classroom during year 1 (*M* = .054, *SD* = .085) on average were observed working in small groups more than students during year 2 (*M* = .026, *SD* = .026), but these differences were not statistically significant at the $p < .05$ level. The 95% confidence interval for the differences in means ranged from -.129 to .185. Statistically, technology rich classrooms were equally observed having students work in small groups during year 1 and year 2.

Mixed Groups. An independent-samples *t* test was conducted to analyze instances where students were observed working in mixed groups within technology rich classrooms during two consecutive years. This test was significant, $t(6) = -4.014$, $p = .007$. Students in the technology rich classroom during year 1 (*M* = .067, *SD* = .067) on average were observed working in mixed groups less than students during year 2 (*M* = .300, *SD* = .088). This difference was statistically significant at the $p < .05$ level. The 95% confidence interval for the differences in means ranged from -.375 to -.091. The results indicate that during year 2 students are more often working on activities in the classroom in a mixed setting, which might include individual students, pairs of students or small groups of students.

Whole class with attention to the teacher or student. An independent-samples *t* test was conducted to analyze instances where students were observed in a whole class setting with attention to the teacher or another student within technology rich classrooms during two consecutive years. This test was not significant, $t(6) = 1.440$, $p = .200$. Students in the technology rich classroom during year 1 ($M = .380$, $SD = .171$) on average were observed working in a whole class setting with attention to the teacher or another student more than students during year 2 ($M = .193$, $SD = .064$), but these differences were not statistically significant at the $p < .05$ level. The 95% confidence interval for the differences in means ranged from -.130 to .502. Statistically, technology rich classrooms were equally observed in whole class settings with attention to the teacher or another student during year 1 and year 2.

Whole class with attention to media. An independent-samples *t* test was conducted to analyze instances where students were observed working in a whole class setting with attention to media within technology rich classrooms during two consecutive years. This test was not significant, $t(6) = .662$, $p = .532$. Students in the technology rich classroom during year 1 ($M = .007$, $SD = .015$) on average were observed working independently more than students during year 2 ($M = .0$, $SD = .0$), but these differences were not statistically significant at the $p < .05$ level. The 95% confidence interval for the differences in means ranged from -.02 to .035. Statistically, technology rich classrooms were equally observed in instances where students were working in a whole class setting with attention to media during year 1 and year 2.

Transitions. An independent-samples *t* test was conducted to analyze instances where students were observed in transition activities within technology rich classrooms during two consecutive years. This test was not significant, $t(6) = .520$, $p = .622$. Students in the technology rich classroom during year 1 ($M = .085$, $SD = .028$) on average were observed in transition activities more than students during year 2 ($M = .071$, $SD = .055$), but these differences were not statistically significant at the $p < .05$ level. The 95% confidence interval for the differences in means ranged from -.053 to .082. Statistically, technology rich classrooms were equally observed in transition activities during year 1 and year 2.

Typical General Education Classrooms. An independent-samples *t* test was conducted to evaluate the question: how frequently do these groupings appear in the two different classroom environments? When observations from Year 1 and Year 2 were compared in the typical general education classroom environment, the results did not indicate a significant difference in any of the seven observation categories (Table 7). A positive *t* value indicates that Year 1 had a higher value than Year 2, while a negative *t* value indicates that Year 2 had a higher value than Year 1.

Table 7

Means and Standard Deviations for Typical General Education Classroom Student Grouping Strategies – Year 1 v. Year 2 Comparison

	Year 1		Year 2			
Dependent Variables	Mean	SD	Mean	SD	*t*	*p*
Independent Work	22.2%	.095	31.5%	.019	-1.303	.240
Pairs	13.8%	.218	1.6%	.022	1.357	.230
Small Groups	4.4%	.065	0.0%	.000	1.647	.161
Mixed Groups	5.6%	.112	10.8%	.153	-.534	.613
Whole Class: Attention to Teacher or Student	48.8%	.150	52.8%	.126	-.332	.751
Whole Class: Attention to Media	.2%	.005	0.0%	.000	.548	.604
Transition	5.1%	.037	3.3%	.024	.625	.555

Independent work. An independent-samples *t* test was conducted to analyze instances where students were observed working independently in typical general education classrooms during two consecutive years. This test was not significant, $t(6) = -1.303$, $p = .240$. Students in the typical general education classroom during year 1 ($M = .222$, $SD = .095$) on average were observed working independently less than students during year 2 ($M = .315$, $SD = .019$), but these differences were not statistically significant at the $p < .05$ level. The 95% confidence interval for the differences in means ranged from -.267 to .081. Statistically, typical general education classrooms were equally observed having students work independently during year 1 and year 2.

Pairs. An independent-samples *t* test was conducted to analyze instances where students were observed working in pairs within typical general education classrooms during two consecutive years. This test was not significant, $t(6) = 1.357$, $p = .230$. Students in the typical general education classroom during year 1 ($M = .138$, $SD = .218$) on average were observed working in pairs more than students during year 2 ($M = .016$, $SD = .022$), but these differences were not statistically significant at the $p < .05$ level. The 95% confidence interval for the differences in means ranged from -.106 to .351. Statistically, typical general education classrooms were equally observed having students work in pairs during year 1 and year 2.

Small groups. An independent-samples *t* test was conducted to analyze instances where students were observed working in small groups within typical general education classrooms during two consecutive years. This test was not significant, $t(6) = .1.67$, $p = .161$. Students in the typical general education classroom during year 1 ($M = .044$, $SD = .065$) on average were observed working in small groups more than students during year 2 ($M = .000$, $SD = .000$), but these differences were not statistically significant at the $p < .05$ level. The 95% confidence interval for the differences in means ranged from -.025 to .112. Statistically, typical general education classrooms were equally observed having students work in small groups during years 1 and 2.

Mixed groups. An independent-samples *t* test was conducted to analyze instances where students were observed working in mixed groups within typical general education classrooms during two consecutive years. This test was not significant, $t(6) = -.534$, $p = .613$. Students in the typical general education classroom during year 1 (*M* = ..056, *SD* = .112) on average were observed working in mixed groups less than students during year 2 (*M* = .108, *SD* = .153). This difference was statistically significant at the $p < .05$ level. The 95% confidence interval for the differences in means ranged from -.292 to .188. Statistically, typical general education classrooms were equally observed in mixed group activities during year 1 and year 2.

Whole class with attention to the teacher or student. An independent-samples *t* test was conducted to analyze instances where students were observed in a whole class setting with attention to the teacher or another student within typical general education classrooms during two consecutive years. This test was not significant, $t(6) = -.332$, $p = .751$. Students in the typical general education classroom during year 1 (*M* = .488, *SD* = .150) on average were observed working in a whole class setting with attention to the teacher or another student less than students during year 2 (*M* = .528, *SD* = .126), but these differences were not statistically significant at the $p < .05$ level. The 95% confidence interval for the differences in means ranged from -.332 to .253. Statistically, typical general education were equally observed in whole class settings with attention to the teacher or another student during year 1 and year 2.

Whole class with attention to media. An independent-samples *t* test was conducted to analyze instances where students were observed working in a whole class setting with attention to media within typical general education classrooms during two consecutive years. This test was not significant, $t(6) = .548$, $p = .604$. Students in the typical general education classroom during year 1 (*M* = .002, *SD* = .005) on average were observed working independently more than students during year 2 (*M* = .000, *SD* = .000), but these differences were not statistically significant at the $p < .05$ level. The 95% confidence interval for the differences in means ranged from -.007 to .011. Statistically, typical general education classrooms were equally observed in instances where students were working in a whole class setting with attention to media during years 1 and 2.

Transitions. An independent-samples *t* test was conducted to analyze instances where students were observed in transition activities within typical general education classrooms during two consecutive years. This test was not significant, $t(6) = .625$, $p = .555$. Students in the typical general education classroom during year 1 ($M = .051$, $SD = .037$) on average were observed in transition activities more than during year 2 ($M = .033$, $SD = .024$), but these differences were not statistically significant at the $p < .05$ level. The 95% confidence interval for the differences in means ranged from -.052 to .087. Statistically, typical general education classrooms were equally observed in transition activities during year 1 and year 2.

Summary. For grouping strategies, technology rich classrooms showed an increase between Year 1 and Year 2 in Mixed Groups, indicating that teachers were having students work more independently, in pairs and/or small groups during Year 2. There was no significant difference in the technology rich classrooms between Year 1 and Year 2 for the other six dependent variables, independent, pairs, small groups, whole class attention to teacher/student, whole class attention to media and transition.

Results indicated no significant differences in the grouping strategies practiced in typical general education classrooms between Year 1 and Year 2. From this, it can be assumed that students in typical general education classrooms are grouped in similar styles each year.

Relationship between Student Grouping Strategies and Level of Cognitive Activities

Overall results. A final research question was to examine if there was a relationship between student grouping strategies and higher-level cognitive activities in the two different classroom environments. Correlation coefficients were computed among the Student Grouping Strategies and Levels of Cognitive Activities. Using the Bonferroni approach to control for Type

I error across the 12 correlations, a p value of less than .004 (.05 / 12 = .004) was required for significance. The results of the correlational analysis for technology rich classrooms presented in Table 8 show that 5 out of 12 correlations were statistically significant.

Table 8

Correlations among the Student Grouping Strategies and Levels of Cognitive Activities in Technology Rich Classrooms

	Receiving Knowledge	Applying	Analyzing or Evaluating	Creating	Other
Independent Work	-.30	.46*	.20	-.37	-.08
Pairs	-.11	-.26	-.06	.42	-.19
Small Groups	-.12	-.17	.10	.31	-.02
Mixed Groups	-.25	-.14	-.11	.45*	-.29
Whole Class: Attention to Teacher/Student	.76*	-.15	-.05	-.42	.40
Whole Class: Attention to Media	.12	-.26	.66*	-.10	-.12
Transition	.04	.16	-.18	-.32	.68*

* $p < .004$

The correlations within pairs and small groups tended to be lower and not significant. In general, the results suggest that if students are working independently in technology rich classrooms, they tend to be applying knowledge. Mixed groups of individuals, pairs and small groups within technology rich classrooms tend to be creating new knowledge, although this was seldom observed. In addition, when students are in whole class settings with attention to the teacher or another student, they were observed to be receiving knowledge. Results indicate that students who are arranged in a whole class setting with attention to the media tend to be analyzing or evaluating information, although this was seldom observed during the classroom observations. Finally, students observed in transition periods within technology rich classrooms tend to be not engaged in a particular category of cognitive activity.

The results of the correlational analysis for typical general education classrooms presented in Table 9 show that 3 out of 12 correlations were statistically significant.

Table 9

Correlations among the Student Grouping Strategies and Levels of Cognitive Activities in Typical General Education Classrooms

	Receiving Knowledge	Applying	Analyzing or Evaluating	Creating	Other
Independent Work	-.07	.30	.01	-.19	-.11
Pairs	-.19	.27	.03	-.08	-.16
Small Groups	-.30	.01	.43	.46	.08
Mixed Groups	-.22	.24	-.26	-.08	.02
Whole Class: Attention to Teacher/Student	.63*	-.72*	.08	.09	.10
Whole Class: Attention to Media	.26	-.33	-.12	-.03	.19
Transition	-.18	-.19	-.09	.16	.62*

* $p < .004$

The correlations within independent work, pairs, small groups and mixed groups within typical classrooms tended to be lower and not significant. In general, the results suggest that if students are engaged in whole class activities with their attention to the teacher or another student, they tend to be receiving knowledge and are less likely to be applying skills or knowledge to complete an activity. Results were not significant for students in a typical classroom who were arranged in a whole class setting with attention to the media. As observed in technology rich classrooms, students observed in transition periods within typical general education classrooms tend to be not engaged in a particular category of cognitive activity.

Conclusions

This study was designed to measure differences in grouping strategies in two different classroom environments, technology rich classrooms and typical general education classrooms. The study explored the various grouping strategies that are used by teachers in each of these environments. The study also explored if individual areas within these grouping strategies increased or decreased throughout the course of the school year. A final exploration analyzed if the grouping strategies correlated with cognitive activities in which the students were engaged. The results indicate that there is a difference in grouping strategies between technology rich and typical classrooms, particularly in two of the seven observation categories, whole class attention to teacher or student and transitions. In addition, student grouping strategies appear to be similar in both the technology rich and typical classrooms across the other five evaluated variables.

One possible explanation for the results indicating similar grouping styles can be attributed to the professional development and goals of the technology rich classroom program. Within the technology rich classroom program, teachers are provided professional learning opportunities from a local facilitator as well as the state program coordinator. While this professional development primarily focuses on the integration of technology into standards-based instruction, it also addresses issues such as classroom management with technology, student centered learning and higher order thinking activities within the curriculum. The professional development does not address student grouping strategies, therefore the technology rich classroom teachers would not have received any additional training on the various strategies for grouping students within the classroom.

A second possible explanation for similar grouping strategy results might be the general nature of the classroom. Many factors weigh into the decision for teachers to choose a particular grouping strategy in the classroom. These could include the experience of the teacher, the students and how they interact with one another, or even the content and level of instruction for the content being taught. For example, if the content is new to students, the teacher may employ a different grouping strategy for the students than if they are practicing or applying knowledge from the new content. The mean scores of observations for Independent work, small groups, mixed groups, and whole class attention to media were higher for technology rich classrooms, though none were statistically significant. This difference adds to the possible explanation that the structure of the classroom environment itself might explain the differences in grouping strategies utilized in the two types of classrooms.

Significantly, typical classrooms utilized a whole class attention to teacher or student strategy more often than technology rich classrooms for grouping students. This lack of teacher-directed instruction within the technology rich classroom might also be attributed to the previously mentioned professional development that the teachers received. Teachers participating in the technology rich classroom program received instruction, practice sessions and instructional coaching on how to make their classroom more student-centered. Based on the observation results, it appears that the technology rich classrooms were indeed more student-centered with less whole class activities where all students are paying attention to the teacher or a student.

When analyzing grouping strategies used throughout the year or over the course of two years, there were a few significant differences. Using a one-way within subjects ANOVA, data suggest that teachers in typical general education classrooms spent more time with classroom transitions early in the school year, and that this transitional time decreased at the end of the school year. A further analysis of grouping strategies used during year 1 and year 2 indicate that technology rich classrooms group students in mixed groups (with students working individually, with a pair, and/or a group of students) more frequently during the second year of program implementation than during the first year. There were no significant difference in grouping strategies for the typical general education classrooms between Year 1 and Year 2. Evaluation at this level indicates that the typical general education classrooms truly serve as a control group for better understanding grouping strategies used within technology rich classrooms.

This research study focused on classroom components related to grouping strategies used within technology rich and typical general education classrooms. In addition, observation data were collected to identify the level of cognitive activity students were engaged with, as identified by Bloom's Taxonomy. Analysis of this data showed a significant correlation in the technology rich classrooms in all five of the cognitive levels observed. Students who were passively receiving knowledge were typically grouped in whole class arrangements with attention to the teacher or another student. When students were engaged in application activities, they were working independently. Analyzing or evaluating information was observed when the whole class was paying attention to media, although this grouping strategy was seldom observed. Creating new products or knowledge correlated with students working in mixed groups. Finally, when students were not engaged in a specific cognitive activity they were typically in transition and weren't grouped in any particular strategy.

Within a typical general education classroom, two cognitive levels were significant in the whole class attention to teacher or student category. Students receiving knowledge was correlated to students working in a whole class setting with attention to teacher or student. When students in typical general education classrooms were applying information, they typically were not working in a whole class setting with attention to teacher or student. As observed in the technology rich classrooms, when students weren't engaged in a specific cognitive activity they were typically in transition and were not grouped in any particular strategy.

While the primary focus of the research study did not relate to higher-level thinking activities, it is not surprising that these activities were significant in the technology rich classroom correlations. Higher-level thinking activities are related to success within technology rich environments; however these practices are not necessarily associated with technology program design components. One possible explanation for these results is that professional development provided to technology rich classroom teachers promoted the use of higher-level thinking activities using technology. Teachers in the technology rich classroom environment were encouraged by their job-embedded facilitator to use higher-level cognitive activities in their classrooms.

During the course of this chapter, the results of the data analysis have been reported and explained. The results were described in both text and table form. These results provide the necessary data with which to formulate, through the discussion section, concluding commentary related to the differences observed in grouping strategies in each of these classroom environments. Further, the results from this study can be utilized at the policy level regarding educational technology programs and their implementation. Although the implications of this research have been discussed, several questions still remain. What can be concluded from these findings? Given these findings, what recommendations are appropriate for implementation of technology rich classrooms and further research of technology rich learning environments? The results presented in this chapter form the basis for the answers to these questions and the conclusions presented in the final chapter.

CHAPTER FIVE

Conclusions And Recommendations

This study examined student grouping strategies within technology rich and typical general education classrooms. The research discussed in this study points towards a need for teachers to engage students through pairs and small groups. The presence of computers adds to the potential for engaging students in meaningful learning with authentic tasks in a social setting. In addition, small group methods can support the social construction of knowledge by students learning from and with one another. Research into how technology rich learning environments are structured and what strategies teachers have used to group students in order to be successful is extremely important for future policy decisions regarding educational technology. The results of this study indicate that based on the sample, grouping strategies in a technology rich classroom vary from that of a typical general education classroom. Equally powerful is the finding that grouping strategies differ between year 1 and year 2 of the technology rich classroom implementation.

The purpose of this study was to identify and describe grouping strategies of students observed within a technology rich classroom environment in comparison to a typical general education classroom. Specifically, this study reviewed the following student grouping strategies: independent, pairs, small groups, mixed groups/independent; as well as whole class with attention to teacher, to another student, or to media; and non-instructional transition activities. A review of current literature suggested that engaging students in pairs and small groups has the potential to create meaningful, authentic learning tasks. In addition, the study examined higher-level thinking activities assigned by the classroom teacher, based on Bloom's Taxonomy, in relation to these student grouping strategies. Two research questions framed this study:

1. What differences in student grouping strategies exist between technology rich classrooms and typical general education classrooms and how frequently do these groupings appear in the two different classroom environments?
2. Is there a relationship between student grouping strategies and higher-level cognitive activities in the two different classroom environments?

The analysis of data outlined in Chapter Four contradicts the assumption that a 2:1 student to laptop initiative as identified in the technology rich classrooms would produce students working more in pairs and small groups and less independent activities. In this chapter, final overall study conclusions and their implications are provided. Recognition of the limitations of the study and a discussion of future research are also presented.

This study contributes to the greater body of research on learning in groups, particularly within technology rich environments, and can be applied at the policy level to inform educational technology programs and the implementation of these programs.

Major Findings and Implications

The review of literature described in Chapter 2 incorporated research surrounding student grouping strategies, higher-order thinking activities and technology within the classroom environment. Grouping strategies utilized within the classroom, as well as pedagogy and resources, impact the quality of education received and provide insight into the variety of conditions that may support or hinder classroom learning.

The study focused on identifying and describing grouping strategies of students observed within a technology rich classroom environment in comparison to a typical general education classroom. Specifically, this study reviewed the following student grouping strategies: independent, pairs, small groups, mixed groups/independent; as well as whole class with attention to teacher, to another student, or to media; and non-instructional transition activities. The results of this study contribute information to the view that there are only slight differences in grouping strategies observed between technology rich and typical classrooms. The difference in these strategies might be attributed to the professional development received by the technology rich classroom teacher, encouraging a more student-center environment using higher-level cognitive activities.

This study provided data about the research question: What differences in student grouping strategies exist between technology rich classrooms and typical general education classrooms and how frequently do these groupings appear in the two different classroom environments? The results indicate that few differences in student grouping strategies do indeed exist between technology rich classrooms and typical general education classrooms. Differences were statistically significant in two of the seven observation categories, whole class attention to teacher or student and transitions. Whole class attention to teacher or student was observed more in a typical general education classroom and transitions were observed more in a technology rich classroom. If one would look at the average percentage of classroom time that that was observed, technology rich classrooms had higher percentages of individual work, although this was a small effect size. In addition, the results show students in a typical general education classroom were observed, on the average, working in pairs more than students in a technology rich classroom, again with a small effect size. There was no significant difference between the technology rich and typical general education classroom in regards to students working in small or mixed groups. Again, typical general education classrooms were higher in whole-class activities where the students were paying attention to the teacher, another student and/or media. Transition time between the two classroom environments indicated no significant difference.

The second part of the research question, how frequently do these groupings appear in the two different classroom environments, was answered through an analysis of variance and *t* tests.

The results indicate no significant difference throughout the school year for grouping strategies within the technology rich classroom. Within a typical general education classroom, results indicate that classroom transitions occur less frequently at the end of the school year than they did at the beginning of the school year. To further identify changes in grouping strategies, the researcher analyzed the average percentage of time the grouping strategies were observed during Year 1 compared to Year 2. Results of data in a technology rich classroom environment indicate that students are working in mixed groups more during year 2 than during year 1. This could possibly be attributed to the teachers' comfort level with the technology, technology-based resources, and student-centered learning that occurs during the second year of project implementation. The typical general education classroom showed no significant results between year 1 and year 2.

In addressing the second question, is there a relationship between student grouping strategies and higher-level cognitive activities in the two different classroom environments, the results indicated a correlation between the grouping strategies and levels of cognitive activities within the technology rich classroom environment. One grouping strategy, whole class with attention to teacher or student, correlated with receiving knowledge and applying information within the typical general education classroom.

Based on the observed trends found in Chapter 4, a technology rich classroom environment does not appear to influence the variation of grouping strategies teachers make use of in the classroom.

Implications for Practice

Significant investments have been made across the country to equip classrooms with technology tools and resources. While research indicates that these tools and resources found in technology rich classrooms may engage students, results of this study do not indicate a change in student grouping strategies used in these classrooms. Teachers tend to vary the strategies they use for grouping students whether technology is present or not present in the classroom. This study contributes to the greater body of knowledge on technology rich classrooms with respect to student grouping strategies and cognitive activities, and can be applied at the district and building level to inform the development of successful programs.

Limitations of the Study

Internal validity. This study had several limitations concerning internal and external validity. Low statistical power was identified as an internal threat to the study. Although the data set includes momentary time samples for each classroom teacher (n>3,100), the classroom sample size is small (n=12). Because the researcher eliminated some of the classrooms from the original data set in order to equalize the demographic variables, less data was available for analysis. In addition, the data used for this analysis included only a rural setting; impacting the opportunity to generalize the results to urban populations. There was also the potential for "bleeding" data since the typical general education classrooms (control) were located within the same school as the technology rich classrooms (experimental). Maturation was also considered to be a threat, as the teachers in either classroom model become more experienced and comfortable with technology they have available. In addition, compensatory rivalry could have affected the observations if the control group had a natural motivation to reduce or reverse the expected difference.

A second limitation relates to the inability to obtain baseline data with respect to the classroom environment prior to the 2008-09 school year. Data collection began in September 2008. Results of this study could potentially be strengthened with data from the previous school year before the school was participating in the statewide grant program.

Finally, since the observation instrument was developed in-house, there is a possibility for low reliability scores and lack of validity. To combat this, observers produced an inter-rater reliability score of 80% or greater before collecting data that will be used in this study and constantly monitored their data collection immediately following each observation period.

External validity. This study sought out to discover differences in the classroom environment related to technology rich classrooms and typical general education classrooms. The data collected and used for this study has only come from two schools within one participating school district. The implementation of the technology rich classroom model at these two sites may vary some and may not be generalizable to other technology rich classroom sites for the purpose of this analysis. An attempt was made to strategically select the sample with the most similar demographics. However, we were not able to account for how the Facilitator interacted with the technology rich classroom teachers or the support they were able to provide to other teachers in the school.

External validity could be compromised by the interaction of Selection and Treatment within the groups. The schools independently selected the teachers that would be participating in the Technology Rich Classroom project using self-defined criteria. In some cases, the teachers may have been willing participants. Or, the teachers may have been chosen for other reasons than a willingness to use new technologies in the classroom. In addition, this is not a random sample, which will increase threats to external validity. Participating schools were chosen as a sample of convenience for the observations.

There is also a concern that everyday classroom and school activities may have had an impact on the observation data. It is hard to predict the interruptions, special assemblies, and student history that may impact the classroom setting. External events within the school or local community could have impacted the classroom observation data.

Directions for Further Research

Further research on technology rich learning environments would be a valuable asset to the education community as technology continues to play a larger role in today's classrooms. This study specifically addressed student grouping strategies within classrooms. There are many other constructs within technology rich classrooms and technology integration programs that have potential for future research efforts. Based on these findings, future research could focus on deeper analysis of technologies being used for related grouping strategies and level of cognitive activities. Future studies need to identify and examine technologies that are related to specific school work; how they are working on the assignment (independently or collaboratively) and what they are being asked to do. In order to identify these core components, future research should closely observe teacher and student technology use in the classroom in order to correlate these results back to grouping strategies and higher-level activities. Future research could include a more detailed analysis about the technology available in each classroom for student use. Since the Technology Rich Classroom Program requires a 2:1 student to computer ratio, it is interesting that the observations indicated students working independently in the TRC group. Analyzing the data differently may indicate if the independent work was with or without technology. Additionally, anecdotal data indicates that some of the Technology Rich Classrooms actually have a 1:1 student to computer ratio (either full time or with borrowed equipment) and may have impacted these results.

Another construct observed in the data set but not analyzed by the researcher for this study includes teacher engagement, more specifically, observing what the teacher is doing in the classroom throughout the observation period. These results can be helpful for teacher educators by educating future teachers about the power of technology for individualizing instruction. Because students are able to work independently or with others on technology activities, teachers are more available for students needing individual help.

Additional analysis could be conducted on exemplary technology rich classrooms. By identify critical components for successful implementation, further analysis, both quantitative and qualitative, could help identify specific aspects of the program such as 1) why is this program implementation successful, 2) who is it successful for, and 3) under what conditions is it successful. The wide array of variables includes the facilitator, district and/or building leadership, teacher buy-in, reliability of equipment, and so on. Ideally, this analysis would warrant a close examination of all of the variables involved.

Finally, a longitudinal study could be conducted by observing in the technology rich classrooms after the grant funding has ended for the schools. An interesting analysis would be to identify if teachers continue teaching in ways supported by the technology rich classroom program or if their use of technology, pedagogy and instructional styles changed when they were no longer part of the technology rich classroom program and receiving support from a dedicated facilitator.

Post Script

The results from this research do not answer all questions related to student grouping strategies within technology rich and typical general education classrooms. Many questions remain, however this study adds to the body of literature that preceded it. Undoubtedly, more research is needed to further answer the questions raised in this study. By continuing research in this area, we can further inform the educational community related to technology rich learning environments.

The effectiveness of technology depends largely upon the appropriate selection and implementation of the technology to meet desired teaching and learning goals. As stated by Schneiderman, "Education technology is neither inherently effective nor inherently ineffective;

instead, its degree of effectiveness depends upon the congruence among the goals of instruction, characteristics of the learners, design of the software, and educator training and decision-making, among other factors" (2004). Effective implementation can be attributed to proper planning, teacher training, school leadership, technical support, hardware, network infrastructure and Internet access, pedagogy and instructional use, intensity of software use (SIIA, 2009).

References

Barbec, K., K. Fisher, et al. (2004). "Building Better Instruction: How Technology Supports Nine Research-Proven Instructional Strategies." Learning and Leading with Technology 31(5): 6-11.

Battistich, V., D. Solomon, et al. (1993). "Interactive Processes and Student Outcomes in Cooperative Learning Groups." The Elementary School Journal 94(1): 19-32.

Beckman, M. (1990). "Collaborative Learning: Preparing for the Workplace and Democracy." College Teaching 38(4): 128-133.

Becker, H. J. (1999). Internet use by teachers: Conditions of professional use and teacher-directed student use. Teaching, learning, and computing: 1998 National survey report 1, University of California, Irvine: Center for Research on Information Technology and Organizations.

Blumenfeld, P., Ed. (1992). The Task and the Teacher: Enhancing Student Thoughtfulness in Science. Advances in Research on Teaching. Greenwich, CT, JAI Press.

Blumenfeld, P., R. W. Marx, et al. (2006). Learning Environments. Handbook of Child Psychology (6th Edition). W. Damon, R. Lerner, A. Renninger and I. E. Sigel. Hoboken, NJ, Wiley. 4: 297-342.

Boykin, A. W., Ed. (1994). Harvesting Culture and Talent: African American Children and Educational Reform. Schools and Students at Risk. New York, Teachers College Press.

Bransford, J. D., A. L. Brown, et al., Eds. (1999). How People Learn: Brain, Mind, Experience, and School Washington, DC, National Academy Press.

Brophy, J., Ed. (1992). Advances in Research on Teaching. Planning and Managing Learning Tasks and Activities. Greenwich, CT, JAI Press.

Calderon, J., R. Hertz-Lararowitz, et al. (1998). "Effects of bilingual cooperative integrated reading composition on students making the transition from Spanish to English reading." Elementary School Journal 99(2): 153-165.

Chen, M. (2001). Project-based learning transforms curriculum and assessment. Edutopia. San Rafael, CA, George Lucas Educational Foundation.

Chickering, A. W. and Z. F. Gamson, Eds. (1991). Applying the Seven Principles for Good Practice in Undergraduate Education. New Directions for Teaching and Learning. San Francisco, Jossey-Bass.

Cohen, E. G. (1994). "Restructuring the Classroom: Conditions for Productive Small Groups." Review of Educational Research 64: 1-35.

Cohen, P. A., J. A. Kulik, et al. (1982). "Educational Outcomes of Tutoring: A Mea-Analysis of Findings." American Educational Research Journal 19: 237-248.

Collier, K. G. (1980). "Peer-Group Learning in Higher Education: The Development of Higher-Order Skills." Studies in Higher Education 5(1): 55-62.

Congress (2001). No Child Left Behind Act of 2001. Washington, DC.

Cooper, J. and Associates (1990). Cooperative Learning and College Instruction. Long Beach, Institute for Teaching and Learning, California State University.

Cuban, L. (2003). Oversold and Underused: Computers in the Classroom Harvard University Press.

Dewey, J. (1916). Democracy and Education, Free Press.

Doyle, W. (1986). Classroom organization and management. Handbook of Research on Teaching (3rd Edition). M. C. Wittrock. New York, MacMillan Publishing Company: 392-431.

Duhaney, D. C. and L. M. G. Duhaney (2000). "Assistive Technology: Meeting the Needs of Learners with Disabilities." International Journal of Instructional Media 27: 393-401.

Duncan, A. (March 2010). Using Technology to Transform Schools. Speech presented at the Association of American Publishers Annual Meeting, Washington, D. C. .

Elias, M. and Y. Schwab (2006). From compliance to responsibility: Social and emotional learning and classroom management. Handbook of classroom management: Research, practice, and contemporary issues. C. Evertson and C. Weinstein. Mahwah, NJ, Erlbaum: 309-342.

Ellis, E. S. (1997). "Watering up the curriculum for adolescents with learning disabilities: Goals of the knowledge dimension." Remedial and Special Education 18: 326-346.

Fisher, C., D. Berliner, et al. (1980). Teaching behaviors, academic learning time, student achievement: An Overview. Time to Learn. C. Denham and A. Lieberman. Washington, DC, National Institute of Education: 7-32.

Frey, N., D. Fisher, et al. (2009). Productive Group Work: How to Engage Students, Build Teamwork, and Promote Understanding. Alexandria, VA, ASCD.

Good, T. L. and J. E. Brophy (2008). Looking in Classrooms, Pearson Education, Inc.

Goodsell, A. S. (1992). Collaborative Learning: A Sourcebook for Higher Education. National Centre for Postsecondary Teaching, Learning and Assessment.

Graesser, A. and N. Pearson (1994). "Question Asking During Tutoring " American Educational Research Journal 31: 104-137.

Grobecker, B. (1999). "Mathematics Reform and Learning Disabilities." Learning Disability Quarterly 22: 43-58.

Gump, P. V. (1967). The classroom behavior setting: Its nature and relation to student behavior (Final Report). Washington, DC, U. S. Office of Education, Bureau of Research.

Harris, K. R. and S. Graham (1996). "Constructivism and students with special needs: Issues in the classroom." Learning Disabilities Research and Practice 11: 134-137.

Harrop, A. and M. Daniels (1986). "Methods of time sampling: A reappraisal of momentary time sampling and partial interval recording." Journal of Applied Behavior Analysis 19: 73-77.

Hopson, M. H. (1998). Effects of a technology enriched learning environment on student development of higher order thinking skills. Denton, TX, University of North Texas.

House, J. D. (2005). "Classroom instruction and science achievement in Japan, Hong Kong, and Chinese Taipei: Results from the TIMSS 1999 assessment." International Journal of Instructional Media 32(3): 295-311.

Johnson, D. W. and F. P. Johnson (2006). Joining together: Group theory and group skills (9th Ed.). Englewood Cliffs: NJ, Prentice-Hall.

Johnson, D. W. and R. T. Johnson (1989). Cooperation and Competition: Theory and Research. Edina, MN, Interaction Books.

Johnson, D. W., R. T. Johnson, et al. (1991). Cooperative Learning: Increasing College Faculty Instructional Productivity. ASHE-ERIC Higher Education Report No. 4. Washington, DC, George Washington University.

Junoven, J. (2006). Sense of belonging, social bonds, and school functioning. Handbook of Educational Psychology (2nd Edition). P. A. Alexander and P. H. Winne. Mahwah, NJ, Erlbaum: 655-674.

Kazdin, A. E. (1982). Interobserver Agreement. Single-case Research Designs: Methods for Clinical and Applied Settings. A. E. Kazdin. New York, Oxford: 48-75.

King, A. (1994). "Guiding knowledge construction in the classroom: Effects of teaching children how to question and how to explain." American Education al Research Journal 31: 338-368.

Kohn, A. (1986). No Contest: The Case Against Competition. Boston, Houghton Mifflin.

Kounin, J. S. (1970). Discipline and group management in classrooms. New York, Hold, Rinehart & Winston.

Kutnick, P. and M. Thomas (1990). "Dyadic pairings for the enhancement of cognitive development in the school curriculum; some preliminary results on science tasks." British Educational Research Journal 16: 399-406.

Lave, J. and E. Wenger (1991). Situated learning: Legitimate peripheral participation. New York, Cambridge University Press.

Law, Y. (2008). "Effects of Cooperative Learning on Second Graders' Learning from Text." Educational Psychology 28(5): 567-582.

Lawless, K. A. and J. W. Pellegrino (2007). "Professional Development in Integrating Technology into Teaching and Learning: Knowns, Unknowns, and Ways to Pursue Better Questions and Answers." Review of Educational Research 77(4): 575-614.

Lemke, C. and E. Coughlin (1998). Technology in American Schools: Seven Dimensions for Gauging Progress. Santa Monica, Milken Family Foundation.

McCaslin, M. M. and T. L. Good (1996). Listening in Classrooms. New York, HarperCollins.

McKeachie, W. J., P. R. Pintrich, et al. (1986). Teaching and Learning in the College Classroom: A Review of the Research Literature. Ann Arbor, National Center for Research to Improve Postsecondary Teaching and Learning, University of Michigan.

Meyers, C. and T. B. Jones (1993). Promoting Active Learning: Strategies for the College Classroom. San Francisco:, Jossey-Bass.

Mulryan, C. (1989). A study of intermediate-grade students’ involvement and participation in cooperative small groups in mathematics., University of Missouri-Columbia.

Mulryan, C. (1995). "Fifth and six graders’ involvement and participation in cooperative small groups in mathematics." The Elementary School Journal 95: 297-310.

O'Donnell, A. (2006). The Role of Peers and Group Learning. Handbook of Educational

Psychology (2nd Edition). P. A. Alexander and P. H. Winne. Mahwah, NJ, Erlbaum: 781-802.

Ornstein, A. C. (1995). "Synthesis of Research: Teaching whole-group classrooms." Peabody Journal of Education 70: 104-116.

Osterman, K. F. (2000). "Students' need for belonging in the school community." Review of Educational Research 70(3): 323-368.

Paulus, P., M. Dzindolet, et al. (1993). "Perception of performance in group brainstorming: The illusion of group productivity." Personality and Social Psychology Bulletin 9: 78-79.

Rosenshine, B. V. (1980). How Time is Spent in Elementary Classrooms. Time to Learn. C. Denham and A. Lieberman. Washington, DC, National Institute of Education.

Rossi, J. S. (1985). "Tables of effect size for z score tests of differences between proportions and between correlation coefficients." Educational and Psychological Measurement 45: 737-743.

Saudargas, R. A. and K. Zanolli (1990). "Momentary time sampling as an estimate of percentage time: A field validation." Journal of Applied Behavior Analysis 23: 533-537.

Schneiderman, M. (2004). What does SBR mean for educational technology. T.H.E. Journal, 31(11), 30-36.

Slavin, R. E. (1980). "Cooperative Learning." Review of Educational Research 50(2): 315-342.

Slavin, R. E. (1983). "When Does Cooperative Learning Increase Student Achievement?" Psychological Bulletin 94(3): 429-445.

Slavin, R. E. (1995). Cooperative learning: Theory, research, and practice (2nd Edition). Boston, Allyn and Bacon.

Software & Information Industry Association (2009, March 9). *Software implementation checklist for educators*. Washington, DC: SIIA. Retrieved from http://www.siia.net.

Surowiecki, J. (2005). The wisdom of crowds: Why the many are smarter than the few and how collective wisdom shapes business, economics, societies, and nations. New York, Anchor Books.

United States Census Bureau (2007). 2007 Population Estimates. Washington, DC.

Vygotsky, L. (1978). Mind in society: The development of higher psychological processes Cambridge, Harvard University Press.

Watson, M. and V. Battistich (2006). Building and sustaining caring communities. Handbook of classroom management: Research, practice, and contemporary issues. C. Evertson and C. Weinstein. Mahwah, NJ, Erlbaum: 253-279.

Webb, N. and A. Palincsar (1996). Group Processes in the Classroom. Handbook of Educational Psychology. D. Berliner and R. Calfee. New York, Macmillan: 841-876.

Wegerif, R. (2002). Literature Review in Thinking Skills, Technology and Learning: Report 2. UK, National Endowment for Science, Technology and the Arts.

Whitman, N. A. (1988). Peer Teaching: To Teach Is to Learn Twice. ASHE-ERIC Higher Education Report No. 4. Washington, DC, Association for the Study of Higher Education.

Appendix A

TRC Research pre-observation assessment

Date_____________________

School____

Teacher ____

Observation start _______ stop _______

Number of Students in Class_______

Number of adults in addition to teacher _______

Subject (s) ____

Configuration of desks/table
_______ tables and chairs
_______ desks in rows
_______ clusters of 3 to 5 desks per group
_______ other ____

Equipment in the Classroom
_______ Computers 1:1 or 1:2
_______ Interactive white board
_______ one or two classroom computers
_______ Electronic Projector
_______ Response system
_______ Camera
_______ GPS
_______ Handheld computer(s)
_______ Science probe
_______ Printer
_______ Scanner
_______ Wii
_______ Overhead projector
_______ TV
_______ Audio player
_______ Telephone

Notes:

Time Interval											TTIME
Teacher Technology											
1. Computer	○	○	○	○	○	○	○	○	○	○	
2. Power point/present.	○	○	○	○	○	○	○	○	○	○	
3. Web site	○	○	○	○	○	○	○	○	○	○	**:20**
4. Projector	○	○	○	○	○	○	○	○	○	○	
5. Interactive whiteboard	○	○	○	○	○	○	○	○	○	○	
Other (number)											
Student Technology											
1. Computer	○	○	○	○	○	○	○	○	○	○	
2. Web site	○	○	○	○	○	○	○	○	○	○	
3. Power point/present.	○	○	○	○	○	○	○	○	○	○	**:20**
Other (number)											
Grouping Strategy											
1. Independent work	○	○	○	○	○	○	○	○	○	○	
2. Pairs of students	○	○	○	○	○	○	○	○	○	○	
3. Small groups	○	○	○	○	○	○	○	○	○	○	
4. Mixed group/indep	○	○	○	○	○	○	○	○	○	○	
5. Whole class											**:40**
a. Attn. to teacher	○	○	○	○	○	○	○	○	○	○	
b. Attn. to student(s)	○	○	○	○	○	○	○	○	○	○	
c. Attn. to media	○	○	○	○	○	○	○	○	○	○	
6. Transition	○	○	○	○	○	○	○	○	○	○	
Teacher Engagement											
1. Active with students											
a. Lecturing	○	○	○	○	○	○	○	○	○	○	
b. Discussion	○	○	○	○	○	○	○	○	○	○	
c. Indiv./Group help	○	○	○	○	○	○	○	○	○	○	**:40**
2. Observing students	○	○	○	○	○	○	○	○	○	○	
3. Transition	○	○	○	○	○	○	○	○	○	○	
4. Other	○	○	○	○	○	○	○	○	○	○	
Student Engagement											
1. 0 students off task	○	○	○	○	○	○	○	○	○	○	
2. 1-3 students off task	○	○	○	○	○	○	○	○	○	○	
3. 4-6 students off task	○	○	○	○	○	○	○	○	○	○	**:60**
4. 7-10 students off task	○	○	○	○	○	○	○	○	○	○	
5. >10 students off task	○	○	○	○	○	○	○	○	○	○	
Cognitive Abilities											
1. Receipt of Know.	○	○	○	○	○	○	○	○	○	○	
2. Applied Procedural	○	○	○	○	○	○	○	○	○	○	
3. Know. Representation	○	○	○	○	○	○	○	○	○	○	**:60**
4. Know. Construction	○	○	○	○	○	○	○	○	○	○	
5. Other (describe)	○	○	○	○	○	○	○	○	○	○	

Appendix B

ALTEC Classroom Observation: Procedures and Definitions

Procedures for scoring – This procedure uses momentary time sampling in order to gain a general picture of the classroom during the target lesson. When observing a classroom, the observer must look up every 20 seconds and fill in what they were to observe during the interval. Two observations are to be made during each interval, and these are indicated on the sheet.

Definitions:

Teacher/Student Technology Used – Indicate any technologies that were used at the time of the observation. For students, even if only one student is using the technology, it should be included to gain an understanding of all technologies that are in use during a class period. For teachers, any time the teacher is actively using a technology or if they are presenting material using the technology (even if they were not actively manipulating it) technology should be scored. For example, if the teacher is presenting information on an "Elmo", this should be scored the entire time it is on and material is presented on it, even if the teacher is walking around helping students. The material that is presented should be relevant to the activity currently occurring in the class.

Grouping Strategy – Indicate how students are working at the time of the observations. If there are more than one type of group occurring, mark all categories that apply to each interval (if some students are working individually and others are working in groups, indicate both categories).

1. Independent work – when students are working on an assignment or project that is to be completed independently by the student. NOT if the student is working independently on part of a group project.
2. Pairs of students – when students are working together in pairs on an assignment that is to be completed jointly. NOT if the students are working in pairs as part of a group project.
3. Small groups – when students are working in groups larger than two to complete an assignment or project. Small groups can be indicated even when members of the group are working independently on aspects of a project, the purpose of the work is to contribute to the group project.
4. Mixed groups – This category should be scored when the students are in a mixture of different groupings. For example, if some students are working in small groups while others are working individually, this category should be scored.
5. Whole class – when the entire class is focused on one person or media.

a. Attn. to teacher – when the class is listening to the teacher giving instructions, lecturing, or engaging in some activity that requires the attention of the class.
b. Attn to student(s) – when students are presenting work to the class or taking part in a discussion with the teacher. This should only be scored when the students are actually talking. For example, if the students are presenting information and the teacher begins talking during the scoring interval, the attention to teacher should be scored.
c. Attn. to media – when the students are watching a video or engaging in any activity that requires them to focus on a media object as the primary activity. If a teacher is using the technology as part of a lesson and they are talking or leading the class discussion, "Attention to Teacher" should be indicated even if the students appear to be paying attention to the media or technology. "Attention to media" should be indicated if the students are primarily paying attention to media to receive information about the lesson and the teacher has minimal involvement.

Student Engagement – At the beginning of the interval, count the number of students who appear to be off-task, or are not engaged in the activity. This can be done by quickly glancing over the room and seeing if students are obviously not involved in the activity. Off-task behavior is defined as: a) not oriented toward teacher or task while listening to instructions, b) not following instructions appropriately,

c) not oriented toward the task. This can be a difficult behavior to estimate reliably, which is why the number of students has been grouped into categories.

Teacher Engagement – Indicate what activity in which the teacher is engaged in each interval

1. Active with students - they are actively engaged with students in some manner
   a. Lecturing – the teacher is talking to the class and is either presenting material to be learned or giving instructions about a task
   b. Discussion – the teacher is actively engaged in a discussion where students are contributing substantially to the task or lesson
   c. Individual/group help – the teacher is actively engaged in assisting a group or individual on a task they are completing. For this category they must either be actively listening to a question from a student or talking to the student/group
2. Observing students – when the teacher is walking around the class and observing the class as a whole while they are engaged in an activity.
3. Transition – the teacher organizing or helping students organize for the next task.
4. Unrelated activity – the teacher is doing something that is not related to the task at hand, such as at their desk, reading something unrelated, or out of the room. This category should be checked when a teacher is not visible during video observations.

Cognitive Activity (from INTEL Classroom observation, Rockman *ET AL*)

1. ***Receipt of Knowledge*** – (includes Bloom's knowledge and comprehension) May include listening, repetition, answering simple/closed-ended questions, or reading. Knowledge gained can be found in external sources; no original or creative thinking involved
   a. Students listen to a lecture from the teacher
   b. Students watch an audio-visual presentation
   c. Students sitting and listening to instructions
2. ***Applied Procedural Knowledge*** – (includes Bloom's Application) Involves following step-by-step procedures for completing a task or activity or arriving at a solution. The procedural steps can be provided by the teacher or found in the student guide.
   a. Students enter data into a spreadsheet
   b. Students use a worksheet to conduct Web Quest
   c. Students completing a task after instructions are given
3. ***Knowledge Representation*** – (Includes Bloom's Analysis) Students may present and explain their original work. May also include students explaining their understanding of concepts in a way that helps others understand.
   a. Students make a graph from data they have entered on a spreadsheet.
   b. Students summarize an article they have read online.
4. ***Knowledge Construction*** – (Includes Bloom's Synthesis and Evaluation) Students are involved in activities or tasks that call for original or creative thinking to produce a product, arrive at a solution, or develop an understanding that they would not find elsewhere.
   a. Students interpret a graph they have made from data collected or taken from another source.
   b. Students explain why there may be differences in information they have read online (i.e. different sources of bias).

Appendix C

Table C1: Average agreement for all observations, 2008-09.

Method	*Observation 1*	*Observation 2*	*Observation 3*	*Observation 4*	**Total Average**
Average Frequency Ratio	80.41%	80.79%	82.81%	78.63%	80.68%
Correlation	.849	.964	.984	.938	.934

Table C2: Total proportions of intervals scored over all observations, 2008-09.

Category	*Total TRC Proportion*	*Total Non-TRC Proportion*
Teacher using Technology	*48.50***	6.26
Students using Technology	*68.28***	4.93
Independent Work	*44.96***	33.73
Pairs	*5.85***	0.00
Small Groups	5.15	5.37
Mixed Groups	*16.32***	10.30
Attention to Teacher	19.09	*38.81***
Attention to Students	1.15	*6.42***
Student Transition	6.70	5.22
Teacher Lecture	12.93	*18.36**
Discussion	9.08	*24.03***
Individual or Group Help	*46.96***	30.00
Observing Students	8.70	7.16
Teacher Transition	7.70	5.37
Unrelated Activity	15.32	14.63
0 Off Task	*75.06***	60.00
1-3 Off Task	24.02	*34.93***
4-6 Off Task	0.85	*3.43***
Receipt of Knowledge	12.63	*22.99***
Applied Procedural	60.51	60.75
Knowledge Representation	*7.24***	3.88
Knowledge Construction	*9.85***	0.60
Other	9.93	11.64

*Indicates proportion is significantly higher, $p < .01$
**Indicates proportion is significantly higher, $p < .001$

Appendix D

Table D1. Classroom observations, 2008-10.

	TRC Percentage	Control Percentage	Effect Size	Reliability
Technology Use				
Teacher Technology Used	**41.15%**	11.99%	0.69	.86
Student Technology Used	**65.79%**	4.18%	1.48	.99
Grouping Strategy				
Independent Work	**41.65%**	27.28%	0.30	.81
Pairs	6.70%	9.55%	0.11	.99
Small Groups	2.40%	3.37%	0.06	.66*
Mixed Group/Independent	**16.29%**	8.11%	0.25	.47*
Attention to Teacher	26.11%	**48.00%**	0.46	.98
Attention to Media	0.37%	0.00%	0.12	.96
Transition	6.20%	3.62%	0.12	.90
Teacher Engagement				
Lecture/Discussion	25.98%	**46.00%**	0.42	.98
Helping Students	**46.36%**	29.09%	0.36	.98
Observing Students	10.90%	12.11%	0.04	.85
Transition/Other	16.95%	12.61%	0.12	.93
Cognitive Abilities				
Receipt of Knowledge	15.08%	**28.53%**	0.33	.88
Applied Procedural	62.68%	58.61%	0.08	.96
Knowledge Representation	5.76%	3.93%	0.09	.90
Knowledge Construction	**8.16%**	0.25%	0.48	.99
Other	8.38%	8.55%	0.01	.86

*These two reliabilities are low because the observers coded them opposite of one another (one coded small group, the other coded mixed groups) for one observation. When combined, the reliability was .79.