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Teach-To-One Blended Mathematics' Impact on Middle School Students' Mathematics Achievement

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This is to certify that the doctoral study by

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has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

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2020

Abstract

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MA, Fairfield University, 2011

MCA, Punjabi University, Patiala, India, 1995

B.Sc. Punjab University, Chandigarh, India, 1992

Project Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Education

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Abstract

Blended learning that integrates computer-assisted instruction with face-to-face instruction is gaining popularity in U.S. middle schools; therefore, the effectiveness of such blended learning models in improving middle school students' achievement in mathematics needs to be explored. Middle school students at a public Connecticut school have shown poor performance in mathematics on a state standardized test. The local district implemented a blended learning model, Teach to One: Math (TTO), in 1 of the middle schools to improve students' performance in mathematics. The theoretical framework for this study was Koehler and Mishra's theory of technology, pedagogy, and content knowledge. The key research question of this study examined if there is a statistically significant mean difference in the observed growth scores of the TTO students in School A compared to non-TTO students in School B as measured by the Measures of Academic Progress (MAP) mathematics assessment during the 2017–2018 school year. In this quantitative study, a quasi-experimental, nonequivalent, control-group design was used with a sample size of 1,341 participants. The archival data obtained from the local district were analyzed using an independent samples *t* test to determine if there was a statistically significant difference between the means of the 2 unrelated, TTO and non-TTO groups. The findings of the study indicated no significant difference between the observed growth of TTO and non-TTO students as measured by the MAP mathematics test. This study contributes to positive social change by providing data to guide the local district on whether TTO should be implemented in the other middle schools in order to improve students' achievement in mathematics.

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Dedication

I dedicate this work to my family whose love, support, and encouragement gave me strength to keep going throughout my doctoral journey. To my parents and parents-in-law, who always inspired me to work hard and taught me to believe in myself. To my husband, who encouraged me and supported me throughout the process. To my wonderful children, Arjun and Sahiba, for their love, understanding, and motivation to be my best.

Without my family's love and support, I would not have been where I am today. I thank them sincerely for supporting me in this endeavor.

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I greatly appreciate their support, expertise, and guidance that helped me in completing my doctoral journey!

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Section 1: The Problem

The Local Problem

According to the National Assessment of the Educational Progress (NAEP), in 2017, only 36% of the eighth graders in Connecticut's public schools performed at or above the proficient level (The Nation's Report Card, n.d.). Most of the K–12 public schools in Connecticut have yet to incorporate technology-assisted, personalized-teaching methodologies to improve instruction due to digital inequity and the lack of infrastructure to support digital learning (Connecticut Commission for Educational Technology, 2017). Research has indicated that blended mathematical learning that incorporates computer-assisted learning along with face-to-face (FTF) instruction by a teacher provides a more personalized learning experience for students that can often lead to improved achievement in mathematics (Iyer & Pitts, 2017). Chekour (2017) also reported that the hybrid method of mathematics instruction that paired FTF instruction with computer-assisted instruction (CAI) positively impacted student learning.

During the 2016–2017 school year, in the suburban, public school district under study, only 31% of sixth graders, 35% of seventh graders, and 29% of the eighth graders met grade-level performance standards for the state (Connecticut State Department of Education, n.d.). The district recently developed a strategic plan that outlined students' improved achievement in mathematics as one its primary goals. The strategic plan included the implementation of various interventions to improve students' mathematics achievement. One of the interventions that the district adopted from this plan was a computer-adaptive, blended, personalized math learning program called Teach to One:

Math (TTO) in 1 of its 4 middle schools (identified as School A in this study). During 2016–2017 school year, its pilot year, the TTO program was implemented for 214 sixth graders in School A. The following school year, 2017–2018, it was expanded to include 215 seventh and 225 eighth graders. The TTO program offers a blended math learning experience to the students comprising both an adaptive computer software program and face-to-face instruction. To date, a formal study of the impact of TTO had not been conducted at the local school district.

In this study, I compared two demographically similar schools in the local school district. For the 2017–2018 school year, students' observed growth, based on the Measures of Academic Progress (MAP) mathematics assessment in School A where TTO had been implemented, was compared with the observed growth of students in School B that employed a traditional mathematics program (i.e., non-TTO).

Rationale

The purpose of this project study was to compare the TTO students' growth with the growth of the district's non-TTO students as measured by the MAP mathematics assessment. With the proliferation of blended learning models, it is imperative to identify the models that are effective in improving student academic achievement. Several teachers and the guidance counselor at School A shared their concerns with the effectiveness of the TTO model in closing the achievement gap in middle school and in ensuring that the middle school students from School A are high school ready. Due to the lack of sufficient research on how the TTO model compares to the traditional, face-to-face teaching of math, it was important to conduct a study providing insight into whether

TTO is an improved method of teaching math concepts over a more traditional instructional program.

Definition of Terms

Blended learning: This method of teaching combines FTF instruction and online learning (Derbel, 2017).

Computer-assisted instruction (CAI): An educational technology platform that integrates computer science, pedagogy, and psychology to create a student-centered learning environment that promotes student learning through constructivism (Guo, 2018). It combines traditional FTF teaching with technology and presents a variety of teaching and learning tools to deepen student understanding (Chekour, 2017).

Teach to One (TTO): An adaptive, personalized learning system that uses a computer program to creates individualized lessons every day encompassing a web of mathematical skills instead of the traditional linear progression to teach mathematics (New Classrooms, n.d.).

Traditional face-to-face (FTF) instruction: The instruction delivered by a teacher to the students in a physical classroom through lectures, class discussions, and individual and collaborative group work (Lorenzo, 2017).

Significance of the Study

The review of the literature revealed limited research on the effects of self-paced blended learning on middle school students' academic achievement (Alexandre & Enslin, 2017; Balentyne & Varga, 2016). Because the integration of technology in improving learning is on the rise, it is important to determine the effectiveness of such educational technologies at each grade level (Soliman & Hilal, 2016). Currently, the district under study has implemented the blended learning model of TTO in only one middle school. There has been a lack of a formal study in the district regarding the impact of the program on students' mathematical learning and whether it is more effective than a traditional instructional program. The findings of this study may guide the district regarding the expansion of the TTO program to the other middle schools by providing meaningful data regarding the effectiveness of the program.

Research Question and Hypotheses

The local district implemented TTO, a blended learning model, to improve students' achievement in mathematics. Because educational technology is becoming an integral part of the instructional strategies, it is important to determine the effectiveness of blended learning models, such as TTO, in improving the students' mathematics performance. This study was guided by the following research question and hypotheses:

> Research Question: Is there a statistically significant mean difference in the observed growth of TTO and non-TTO as measured by the MAP mathematics assessment in School A and School B, respectively, during the 2017–2018 school year?
>
> > H_0: There is no statistically significant mean difference in the observed growth of TTO and non-TTO students as measured by the MAP mathematics assessment in School A and School B, respectively, during the 2017–2018 school year.

H_1: There is a statistically significant mean difference in the observed growth of TTO and non-TTO students as measured by the MAP mathematics assessment in School A and School B, respectively, during the 2017–2018 school year.

The independent variable in this study was the TTO program (i.e., the intervention), and the dependent variable was the students' observed growth based on the MAP mathematics assessment.

Review of the Literature

This review includes an examination of the current literature on blended learning and its effectiveness in improving students' academic achievement. The key terms used for searching the literature included *blended instruction, hybrid instruction,* and *computer-assisted learning in mathematics*. I searched the following databases: Academic Search Complete, ERIC, Education Research Starters, Primary Search, and Education Source.

Theoretical Framework

The theoretical framework for this study was an extension of Shulman's (1986) pedagogical content knowledge (PCK) framework that combined the teacher's subject matter knowledge with the most relevant and effective technology component. Built upon the PCK framework, Koehler and Mishra's (2009) theory of technology, pedagogy, and content knowledge (TPACK) addressed the interaction between these domains and how such interaction produces the flexibility needed to successfully integrate technology into teaching. With the ongoing innovations in educational technology, it is important that teachers learn to integrate technological knowledge, content knowledge, and pedagogical knowledge in order to develop an effective and efficient classroom learning environment in order to improve students' learning (Durusoy & Karamete, 2018). The PCK framework primarily outlined how to teach a specific subject matter, whereas the TPACK provided a construct of how to also teach a specific subject matter using technologies that best support individual students' academic needs (Harris & Hofer, 2011).

TPACK includes seven domains or design frames that guide teachers in the creation of effective lessons (Koehler & Mishra, 2009; see Figure 1). Teachers need to creatively integrate what they know into how they present what they know in the context of their classrooms (Koehler & Mishra, 2009). The seven domains that are a part of the TPACK framework help teachers to foster meaningful learning for students through the creation of real-world, genuine, active, and collaborative learning opportunities in an information and communication technology integrated lesson (Koh & Chai, 2016). The TPACK framework also provides teachers with an integrative knowledge set that allows them to blend their technological, content, and pedagogical knowledge for effective teaching using technology (Abdo Qasem & Viswanathappa, 2016; Jang & Chang, 2016; Landroth, 2014).

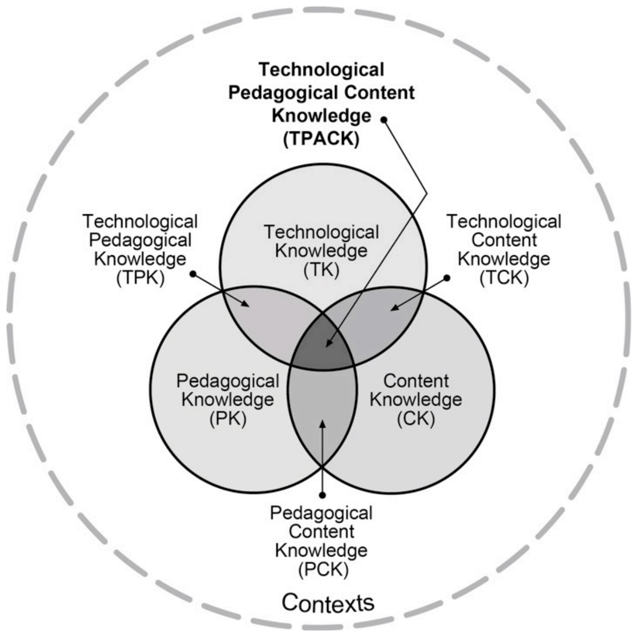

Figure 1. Seven domains in technological pedagogical content knowledge (TPACK). Reproduced from Using the TPACK Image by M. Koehler, 2011, http://tpack.org. Copyright 2012 by tpack.org. Reproduced by permission of the publisher.

Koh and Chai (2016) stated that teachers might also benefit from using a design framework along with TPACK when integrating technology into their classroom. In their study, Koh and Chai analyzed 27 primary school teachers' design plans as they formulated technology-integrated lessons using the TPACK framework and seven domains, such as idea development (i.e., evaluating lesson ideas), design management (i.e., establishing goals), perception of student abilities, enactment of actual examples of how a lesson went in class, institutional (i.e., state and school processes), design scaffold (i.e., research, theory, or design resources), and interpersonal (i.e., communication with peers), that reflect a teacher's design reasoning. Their findings suggested that even though teachers utilized various domains, the role of design knowledge in TPACK needed to be further evaluated (Koh & Chai, 2016).

Because the TTO model aims to blend FTF instruction with technology to enhance the students' mathematical learning experience, the TPACK framework can further be used to improve instruction by helping teachers to integrate technology, pedagogy, and content knowledge when utilizing the TTO model. In today's digital age, the TPACK framework allows for the development of digitally efficient teachers who are not only experts in their subject area but also have expertise in utilizing technology effectively in their classroom to promote students' learning (Huang, 2018). Technology integration in a classroom is no longer meant to be used as an expensive, passive learning tool that only allows for the transfer of mathematical ideas; rather, it is to be realized as an active learning tool that helps students internalize mathematical ideas and deepen their mathematical thinking (Huang, 2018).

Role of Educational Technology

The Connecticut Commission for Education Technology (2017), established in 2000 by Public Act 00–187, emphasized the role of innovative teaching methodologies utilizing technology in developing personalized and mastery-based pedagogies to improve student learning. Furthermore, the Connecticut Commission for Education Technology reported that K–12 schools in the state are currently lagging behind the nearby states in providing digital equity to their students and in establishing innovative instructional practices utilizing educational technologies.

Edwards, Rule, and Boody (2017) reported that the use of online mathematics learning as a viable learning method for middle school students resulted in long-term knowledge retention. In their study, they examined 38 eighth-grade students' mathematics knowledge retention who had experienced both online and FTF mathematics learning in sixth grade. During sixth grade, the participants were separated into two groups that alternated between exclusively online and FTF mathematics learning. The topics learned online by one group were learned through FTF by the other group. Their results indicated that both the online and FTF groups were equivalent in terms of knowledge retention 2 years later. In contrast to their study, in the current study, I compared non-TTO students' mathematics performance with that of TTO students who learned mathematics in a blended environment that utilized both FTF and computer-based learning.

Educational technology can support student learning by providing them effective learning tools. For example, Eyyam and Yaratan (2014) concluded that the use of educational technology helped students to think and learn better, improving their academic performance. Murphy (2016) concurred, noting that using technology engages students, improves their problem-solving skills, and results in positive academic gains. The use of technology also enhances students' participation by allowing them to be more accurate with their responses, especially in mathematics (Murphy, 2016). Furthermore, computer-based learning systems provide embedded support and electronic support tools, such as the calculator, dictionary, etc., to address students' learning needs that motivate them to become responsible learners by encouraging the use of the tools that they need (Crawford, Higgins, Huscroft-D'Angelo, & Hall, 2016). In their study, Yıldız and Aktaş (2015) analyzed the effects of computer-based teaching methods and classical teaching methods on the mathematical achievement of students in Grade 8. Their results indicated that even though the mathematical achievement improved for the students in both the groups, the academic improvement of the students in the computer-based instructional group was higher than the other group (Yıldız & Aktaş, 2015). McKnight et al. (2016) reported that teachers utilized technology to access a variety of learning resources, create larger learning communities where learners had the ability to share their work, and promote teaching roles that facilitated learning rather than delivering the content. By blending technology with FTF learning in the mathematics classroom, the TTO model provides students with a comprehensive learning environment that helps accelerate their learning by assessing their progress on a daily basis and by further using it to inform subsequent lesson planning for them.

Sherman (2014) observed the type of technology used by four teachers and the type of thinking students engaged in during the use of the technology. In the study, the use of technology was classified either as an amplifier, if it helped perform a routine task, such as a using a calculator; as a reorganizer, if it engaged students' mathematical thinking, such as identifying patterns etc.; or both. The findings emphasized that it is not the use of technology but rather how technology is used that determined its impact on students' learning (Sherman, 2014). The results indicated that integrating technology helped students' mathematical thinking by engaging them in higher-level cognitive tasks (Sherman, 2014). Akturk and Ozturk (2019) also pointed out that teachers' understanding of TPACK and their knowledge on how to effectively integrate technology, positively influenced student achievement.

Even though some researchers recommended utilizing technology to increase students' mathematical learning, teachers of mathematics often struggle with integrating technology in their classrooms (Hee-Chan & Seo-Young, 2014). Hee-Chan and Seo-Young (2014) investigated 231 secondary mathematics teachers' concerns on integrating technology when teaching mathematics and found that 73.2% of the participants were not utilizing technology when teaching mathematics. In their study, participants often expressed concerns about the unavailability of enough time to prepare technology-integrated lessons and their unwillingness to spend time to resolve nonacademic issues related to technology. Furthermore, Kirikçilar and Yildiz (2018) reported that middle school mathematics teachers struggled with integrating technology, pedagogy, and content knowledge to design computer-assisted activities to teach mathematics. However, teachers who received professional development on implementing technological interventions helped improve their students' mathematics performance (Bicer & Capraro, 2017). Beriswill, Bracey, Sherman-Morris, Huang, and Lee (2016) studied the effects of technology training on participating teachers' TPACK skills, finding that after the technology training, the participants showed the most improvement in the four technology-related dimensions of TPACK (i.e., Technological Content Knowledge, Technological Knowledge, Technological Pedagogical Knowledge, and Technological Pedagogical and Content Knowledge) that would augment their subject area content and pedagogies.

Professional development is imperative in assisting teachers to use technology effectively. Sherman (2014) recommended professional development for mathematics teachers to assist them in learning how to implement educational technology in order to maximize students' learning. The perceived usefulness of technology in teaching and learning affects the attitudes of teachers, which translates into accepting technology-integrated instruction (Lee & Chen, 2016). Furthermore, Hegedus, Dalton, and Tapper (2015) suggested improving teacher training to include how teachers think about technology and how to utilize it to improve students' achievement. Therefore, mathematics teachers utilizing blended learning models, such as TTO, need to be provided professional development on how to effectively implement technology that helps improve students' mathematical skills.

In today's digital age, a wide array of technology-based educational tools are available to promote students' learning, but simply implementing educational technology or a computer program in a classroom does not guarantee improved student learning. As schools are integrating technology to improve students' learning, school administrators and district officials need to choose the right technological tools or learning model based on the needs of their students and supported by best practices.

Blended Learning Model

According to recent studies, a blended learning model that integrated technology with traditional FTF instruction was effective in providing individualized learning experiences to students and resulted in academic improvement (Chekour, 2017; Eryilmaz, 2015; Iyer & Pitts, 2017). Similary, Wenting, Adesope, Nesbit, and Qing (2014) reported that using technology and computer programs as a primary mode of classroom instruction or as a supplementary afterclass instruction method resulted in students' higher achievement. Bottge et al. (2014) noted that the blending of explicit and anchored instructional strategies had a positive impact on students' performance in mathematics. Utilizing technology as an instructional tool engages students and promotes their learning (Devlin, Feldhaus, & Bentrem, 2013; Ferrini-Mundy & Martin, 2000; Suppes, Liang, Macken, & Flickinger, 2014) by supporting the growth of critical thinking through a personalized learning environment (Greene & Hale, 2017). Incorporating technology in education also facilitates the personalization of education for students (Alexandre & Enslin, 2017). Furthermore, the ability of CAIs to provide immediate feedback on errors helped improve students' mathematics skills (Gross & Duhon, 2013). The technology component of TTO provides immediate feedback to students on their performance and creates an individualized student learning plan based on their performance, whereas the FTF component helps explain concepts.

Blended learning in mathematics was reported to have a significant correlation with academic achievement (Alexandre & Enslin, 2017). Research conducted by Alexandre and Enslin (2017) indicated that the integration of educational technology facilitated personalized instruction in the classroom because it helped create a student-centered learning environment, with the teacher acting as the facilitator during the student's learning process rather than teacher-centered learning, whereby the teacher is expected to simply deliver the content (Alexandre & Enslin, 2017). CAI was more effective in increasing students' mathematical comprehension, application skills, and attitude towards mathematics (Balentyne & Varga, 2016; Soliman & Hilal, 2016), and Sokolowski, Li, and Willson (2015) suggested that the longer and more frequent exposure to blended learning environments resulted in students' higher achievement. Schools with poor academic performance improved their test results by using CAI programs that provided differentiated instruction to students (De Witte, Haelermans, & Rogge, 2015). Computer-assisted remedial mathematics learning programs have also been found to improve students' mathematics scores on standardized tests (Lai, Luo, Zhang, Huang, & Rozelle, 2015).

Abbas (2018) studied student's interaction with content, the instructor, and other learners to determine student's satisfaction in a blended learning environment. In this study, the instructor interacted with the learner during FTF and online instruction by providing feedback, discussing, and responding via a discussion board and messages (Abbas, 2018). The results of the study indicated that blended learning helped improve students' problem-solving, critical thinking, and written communication skills by providing them a classroom environment that supported learning through peer interaction (Abbas, 2018). Though the participants reported overall satisfaction regarding the blended learning environment, it is important to note that about 30% of the participants found blended learning to be ineffective (Abbas, 2018).

In another study, Kintu, Zhu, and Kagambe (2017) surveyed 238 participants from three schools to examine the interplay of learner characteristics, blended learning design features, and learning outcomes in determining the effectiveness of blended learning. The learner characteristics included learners' self-regulation, computer fluency, gender, and age. The design features focused on the interactions among learners, FTF support, and technical tools. The learning outcomes indicated learners' engagement, performance, motivation, and knowledge gain to establish the effectiveness of blended learning. The study concluded that learners found that online tools were helpful in learning new concepts and in overall gain in knowledge (Kintu et al., 2017).

My review of the literature suggests that blended learning through the integration of technology with FTF teaching improves students' mathematical achievement. In addition to the blended learning model that utilizes technology and FTF teaching, the TTO model offers eight learning modalities such as teacher delivered modalities, student collaborative modalities, and independent modalities, to enhance student learning (New Classrooms, n.d.). During teacher delivered modalities (FTF), students would have three different learning modalities available, such as, live investigation modality where the teacher introduces students to a new skill; a project-based task where a group of students work with the teacher on solving a real-life problem; and a math advisory where the same group of students and teacher work on establishing math goals for the year. Student collaborative modalities would include small group collaboration and peer to peer interaction whereby students discuss math problems with their peers and share their solutions. Independent modalities include virtual instruction that allows the use of technology to gain knowledge, virtual reinforcement that allows use of technology to practice the skills, and independent practice to use printed resources to practice the newly learned skills (New Classrooms, n.d.).

Implications

The topic was selected as students in Grades 6-8 in the district under study performed poorly in mathematics on a standardized test (Connecticut State Department of

Education, n.d). The particular school for this study was selected as it was the only school in the district that implemented the TTO blended learning model in an effort to improve students' performance in mathematics. The use of the blended learning model to improve mathematics proficiency is supported by the literature. TTO is a personalized and computer-adaptive math instruction that utilizes various instructional modalities including face-face instruction by a teacher. The TTO program has been used in Grades 6, 7, and 8 consistently since 2017 at the local school. Based on the findings of the study, I plan to present the findings of the study to the teachers to validate the value of TTO learning model. In addition, I created a professional development program for the mathematics teachers to further assist and inform them regarding the role of a TTO program in improving students' mathematics achievement.

Summary

Most of the current literature on the effectiveness of blended learning in teaching mathematics suggested that a blended learning model had a positive impact on students' mathematics performance (Bottge et al., 2014; Wenting et al., 2014). This study aimed to determine the effectiveness of TTO as an instructional strategy to teach mathematics to middle school students.

In Section 2, I explain the research design and methodology utilized for the study. The section includes the setting and sample, the data collection, the data analysis, and the results of the study. In addition, it includes the research question and the testing of the hypotheses.

In Section 3, I describe the rationale, the professional development for teachers, and the implications of the study. It also provides scholarly review of literature related to the project genre.

In Section 4, I outline the limitations of my study, reflections on the significance of the study, as well as applications, future recommendations, and conclusions from my point of view.

Section 2: The Methodology

Introduction

I designed this study to determine the effectiveness of a TTO mathematics program by comparing the MAP mathematics scores of TTO students with that of non-TTO students. The study was carried out at the sixth, seventh, and eighth grade level in two demographically similar, local, public middle schools, one at which the TTO program had been implemented and the other with a traditional mathematics program.

This section includes a discussion of the research design, setting, sample, instruments, data collection process, procedures, and data analysis.

Research Design and Approach

The quantitative method is recommended for use when trends or relationships between variables needed to be explained (Creswell, 2012; Mokgwathi, Graham, & Fraser, 2019). Based on the measurable data collected through a pre- and posttest, the quantitative approach allowed me to conduct a group comparison to determine a potential difference in the growth of the two groups based on their MAP mathematics scores (see Ardiç & Isleyen, 2018; Fazal & Bryant, 2019). Because I used intact groups instead of randomly assigning participants to the groups in this study, I employed a quasi-experimental, nonequivalent, control-group design (see Creswell, 2012). Because the participants were assigned to the classes at the beginning of the school year, a quasi-experimental design allowed the study to happen with minimal disruption to student learning by using the intact groups (see Olelewe & Agomuo, 2016). Moreover, because I used statistics to analyze the numeric test data, a quantitative approach was an appropriate option for this study (see Creswell, 2012). An independent samples *t* test was utilized to analyze the data because it allowed me to determine if there was a statistically significant difference between the means of the two unrelated groups (see Laerd Statistics, n.d.).

Setting and Sample

The student data and the population for this study originated from a southwestern school district in Connecticut. During the beginning of the 2017–2018 school year, the district had a total population of 11,573 students in 12 elementary, four middle, and four high schools. The participants comprised students in Grades 6, 7, and 8 from two of the district's schools identified as School A and School B. The 2017–2018 school year demographics of School A and School B are listed in Table 1.

Table 1

2017–2018 School Demographics

	School A	School B
Students in Grade 6	229	210
Students in Grade 7	211	213
Students in Grade 8	240	238
Female	49.3%	49%
Male	50.7%	51%
Eligible for free & reduced-price lunch	49.3%	55.4%
African American	15.9%	18.6%
Hispanic	42.4%	59.9%
White	36.2%	26.2%
Asian	4.6%	3.5%
English language learners	10.1%	14.2%

The students at both the schools were enrolled in a mathematics class every day for a block of about 69 minutes. To avoid a Type 2 error of failing to reject the false null hypothesis, I conducted a G*power analysis to compute the adequate sample size for the study (see Hazra & Gogtay, 2016). To calculate the sample size, the input parameters included the effect size of 0.25, the power of 0.80, and the allocation as 1. The G*power analysis indicated the recommended sample size for each of the groups was 158. The potential study participants consisted of 680 students in the experimental group (i.e., TTO) and 661 students in the control group (non-TTO).

The sampling strategy used was a type of a nonprobability sampling technique, called intact sampling. Because the grade-level groups were already formed, convenient, and available for the study, a nonprobability sampling strategy was best suited (see Creswell, 2012). Because the participants were enrolled in their respective classes at the beginning of the school year, they were selected through intact sampling from an already formed grade-level group in order to minimize any disruption in their learning. I selected the sixth-, seventh-, and eighth-grade students from both the schools to participate in the study because the TTO program started in Grade 6 at School A. The eligibility criteria for participant selection in this study included the following:

1. The students attended either School A or School B in the research district for the entire 2017–2018 school year.
2. The students took the MAP mathematics assessment at the beginning and at the end of the school year.
3. The students in School A participated in the TTO program throughout the 2017–2018 school year.

Instrumentation and Materials

The instrument used to measure mathematics proficiency was the MAP mathematics assessment administered to the students at the beginning and at the end of the school year. I analyzed and compared the MAP mathematics observed growth scores based on the difference in the pre- and the posttests from the beginning and the end of the year for the experimental group (i.e., TTO students from School A) and the control group (i.e., non-TTO students from School B) to determine performance change in mathematics.

The MAP, developed by Northwest Evaluation Association (2012), is a computerized, adaptive test that dynamically adjusts to match to the student's performance level after each item has been administered. The MAP is administered to students in Grades 2 through 10 to determine their achievement in various content areas, including reading, language usage, science, and mathematics (Northwest Evaluation Association, 2013). The MAP is based on the Rasch model of item response theory, and student scores are represented by assigning the numerical Rasch UnIT scale (RIT) value (for Rasch Unit) that represents the difficulty level of the test item at which the student is capable of answering accurately approximately 50% of the time (January & Ardoin, 2015). The RIT scale is continuous across grades helping track students' performance growth within a school year and across subsequent grade levels (Northwest Evaluation Association, 2013). Each test item on the MAP assessment is linked to a vertical equal-interval scale covering all grade levels that helps measure student's academic growth longitudinally over a period of time (Northwest Evaluation Association, 2013).

I obtained the data for this study from the district's research accountability officer. After receiving Walden University's Institutional Review Board's (IRB) approval to conduct this study, I e-mailed the district's research accountability officer to obtain access to the data. The IRB approval number for the study is 11-07-19-0614209. The data collected included the MAP mathematics scores from the beginning and the end of the year and the mean observed growth on MAP mathematics scores of the participants for the 2017–2018 school year. The participants' MAP mathematics mean observed growth scores from each of the schools were compared to determine the effectiveness of the instructional method utilized for mathematics instruction at each of the schools.

Data Collection and Analysis

In this study, I utilized the archival, pre- and posttest MAP mathematics assessment observed growth scores of the selected participants from the beginning and the end of the 2017–2018 school year. The data set for the study was collected with the approval of district personnel. After being granted IRB approval, I e-mailed the district research accountability officer to seek permission to access the required data set and have the data use agreement signed.

The independent variable in the study was the TTO program that is the specialized method for mathematics instruction utilized by School A. A nominal scale was appropriate for the independent variable because it allowed for the two nonordered labels, namely TTO and FTF, to be created for the study. I used the nominal scale for creating labels for variables that did not have quantitative value (see Subedi, 2016). An interval scale was utilized for the dependent variable, which was students' posttest scores on the MAP mathematics assessment. An interval scale, or continuous scale, allowed for the response choices to be equidistant from each other (see Creswell, 2012). In general, interval scales are utilized for test scores because a unit change in the test score at a given point indicated the same change in underlying skill or knowledge (Jacob & Rothstein, 2016).

I used an independent samples *t* test in this study because it allowed me to determine if there was a statistically significant difference between the means of the two unrelated groups (Laerd Statistics, n.d.). There are two types of *t* tests, an independent samples *t* test, which is utilized when the two groups being compared are independent of each other, and the paired *t* test, which is utilized when the two groups being compared are dependent of one another (Kim, 2015). Because the two groups in this study were independent of each other, I conducted an independent samples *t* test to compare the means of the observed growth scores of the two groups (see Kim, 2015; Kim & Park, 2019). In a similar study, Pablico, Diack, and Lawson (2017) utilized a *t* test as one of the statistical tests used to compare the scores of the two groups: One that received differentiated instruction and the other that did not receive differentiated instruction.

Assumptions, Limitations, Scope, and Delimitations

In this study, I utilized the MAP mathematics scores of Grade 6, 7, and 8 students in the 2 of the 3 middle schools in the study district from the 2017–2018 school year. Because the data being used were from only one school district, I assumed that the results of the study cannot be generalized to a larger population that does not match the demographics or the instructional methodologies used for the participants in this study. It was also assumed that the two instructional methods (i.e., TTO and the traditional FTF) were implemented with fidelity in the two schools under study.

The study was limited to a single year of comparative data and analysis. An additional limitation of the study was that intact sampling was utilized instead of random sampling. Intact sampling is a type of nonprobability sampling in which the sample is selected because of convenience, availability, and the fact that it exhibits a characteristic that is being researched in the study (Creswell, 2012). Because a nonprobability sampling technique was used in this study, the individuals selected as participants may not represent the population.

Protection of Participants' Rights

The permission or consent of parents or students was not required for collecting the archival data used in this study. Per the data use agreement that I signed with the local school district, the participants' scores were reviewed confidentially and their names as well as those of the schools and teachers were not identified or documented in this study. The data will be stored on my password-protected computer for 3 years after which the data will be destroyed.

Data Analysis Results

Utilizing a quasi-experimental design, my quantitative study compared the observed growth mean scores of Grade 6, 7, and 8 students in a TTO (experimental) and a non-TTO school (control) as measured by MAP mathematics test administered in the fall of 2017 and the spring of 2018 during the school year 2017-18. The TTO school, School A, had an intervention in place that provided students with a blended learning environment for teaching mathematics that integrated technology-assisted teaching with FTF mathematics teaching by the mathematics teacher in a physical classroom setting. The non-TTO school, School B, implemented the traditional mathematics teaching model where students learned FTF from their mathematics teacher in a physical classroom setting.

In my study, I answered the research question, is there a statistically significant mean difference in the observed growth of TTO and non-TTO as measured by the MAP mathematics assessment in School A and School B respectively during the school year 2017-18? The observed growth is the average difference between the RIT scores from fall 2017 to spring 2018. It was calculated by subtracting students' fall RIT scores from their spring RIT scores of the following year. Due to some changes in the number of students at School A and B throughout the school year, the sample size was n = 639 for the experimental group (School A with TTO mathematics) and n = 642 for the control group (School B with non-TTO; see Table 2).

The TTO group was associated with fall to spring observed growth mean, M = 8.60 (SD = 8.001; see Table 2). In comparison, the non-TTO group was associated with a numerically lower fall to spring observed growth mean, M = 8.59 (SD = 7.143; see Table 2). In order to test the hypothesis that the TTO and the non-TTO schools had a statistically significant mean difference in their fall to spring observed growth during the school year 2017-18, an independent samples t test was performed.

I used Statistical Package for Social Sciences (SPSS) to generate output for the independent samples t test. The results of the Levene's test is used to assess the assumption whether the variances of the two groups, TTO and non-TTO are equal. The results of Levene's test F (1279) = 4.535 (sig < .05) is statistically significant and it indicates that the assumption that the equal variances assumed is violated. The variances of the two groups are not assumed to be equal. As the assumption being assessed is violated, therefore, the data in the bottom row with equal variances not assumed will be utilized for *t* test results and data analysis (Morgan, Leech, Gloeckner, & Barrett, 2012).

Further, the analysis of the independent samples *t* test results indicated that the sig (2 tailed) > 0.05, therefore, the null hypothesis cannot be rejected (see Table 3). Thus, the independent samples *t* test result indicated that the observed growth of the TTO and the non-TTO groups as measured by MAP mathematics during the year 2017-18 is not statistically different (see Table 3).

The right two columns of the SPSS generated independent samples *t* test output display the 95% confidence interval of the difference (see Table 4). The confidence interval indicated that if the study is repeated 100 times, then 95 of the times the true difference would lie within the confidence interval (Morgan et al., 2012). The independent samples *t* test results indicated that the lower and the upper bounds of the confidence interval are -.845 and .818 respectively (see Table 4). As the lower and the upper bounds of the confidence interval have opposite signs (- and a +), it indicates that a zero lies between the lower and the upper bound, so there is no statistically significant difference (Morgan et al., 2012).

Table 2

Group Statistics Descriptive Data

	N	*Mean*	*Std. Deviation*	*Standard Error Mean*
Observed growth TTO	639	8.60	8.001	.317
Observed growth non-TTO	642	8.59	7.143	.282

Table 3

Independent Samples t Test for Equality of Means for Fall to Spring 2017-2018 Observed Growth

	t	*Df*	*Sig (2 tailed)*	Mean Difference
Equal variances assumed	-.032	1279	.974	-.014
Equal variances not assumed	-.032	1261.57	.974	-.014

Table 4

95% Confidence Interval of the Difference for Fall to Spring 2017-18 Observed Growth

	Lower	Upper
Equal variances assumed	-.845	.818
Equal variances not assumed	-.845	.818

The findings of my study indicated that there is no significant difference between the observed growth of TTO and non-TTO students as measured by the MAP mathematics test. This contradicts the findings of Yıldız and Aktaş's (2015) study that reported that the academic improvement of the students in the computer based instructional group was significantly higher than the group that was taught using the classical teaching methods. Though the two studies, Yıldız and Aktaş's study and my study, differed in several aspects including the duration for which the data were collected, the type of the computer based program utilized for instruction, and the measure utilized to assess student achievement, however they both focused on investigating the role of computer-based instruction in improving student achievement. In their study, Yildiz and Aktaş investigated the effects of computer-based teaching on academic achievement and attitudes of 46 Grade 8 students. The CAI material and the mathematical achievement test was developed by the researcher (Yildiz & Aktaş, 2015). The experimental group that received the computer based instruction and the control group that received instruction in a teacher-led classical teaching method consisted of 23 students each (Yildiz & Aktaş, 2015). Further, the duration of the instruction for both the groups in Yildiz and Aktas's study was 20 hours each (Yildiz and Aktaş, 2015). The pre- and posttest mathematical achievement scores of the experimental and control groups were compared for data analysis.

The findings of the study are aligned with the theoretical framework of the study. The theoretical framework for the study is Koehler and Mishra's (2009) TPACK, which is an extension of Shulman's (1986) PCK framework. TPACK emphasizes the integration of teacher's technological expertise with the pedagogical and content knowledge to provide an effective learning environment to the students. The teachers need to be able to utilize the technological tools to transform their teaching to create a student-centered learning environment to enhance student achievement (Sherman, 2014). Though the mean observed growth scores of the TTO and the non-TTO groups were not found to be statistically different based on the findings of my study, the students in the two groups showed growth as measured by the MAP mathematics assessment indicating that mathematics teachers' technological knowledge, content knowledge, and pedagogical knowledge can play an important role in student achievement.

The review of literature pointed out that merely introducing educational technology to support student learning might not result in higher student achievement, unless the teachers learn the specificity of the role of educational technology in creating a variety of mathematical tasks to enhance students' mathematical thinking (Sherman, 2014). Teachers often struggled with integrating technology for effective instruction and when they were provided adequate professional development, it helped improve student achievement (Bicer & Capraro, 2017; Hee-Chan & Seo-Young, 2014; Kirikçilar & Yildiz, 2018). In order to engage students effectively in the learning process, it is important for the teachers to understand the type of educational technology utilized and how it is implemented (Sherman, 2014). When used as an amplifier, the technology engages students in a routine classroom tasks or low-level tasks, whereas when used as a reorganizer, the teacher can utilize the technology to engage students in a higher-order thinking processes promoting deeper connections in a student-centered learning environment (Sherman, 2014). Mathematics teachers need to be able to assess, design, and develop technology based mathematical tasks to improve students' mathematical thinking. To effectively integrate technology in their classrooms, mathematics teachers need professional development (Young, Young, Hamilton, & Pratt, 2019). Based on the findings of the study and after reviewing the literature, I developed a professional development project for the TTO teachers to enhance their TPACK skills to significantly improve students' achievement in mathematics.

Section 3: The Project

Introduction

As part of this study, I developed a 3-day professional development for the TTO teachers on how to effectively utilize technology in a blended environment using the TTO model. The results of this study indicated that there is no statistically significant difference between the observed growth of TTO and non-TTO students as measured by the MAP mathematics assessment during the 2017–2018 school year. One reason for the lack of a significant increase in student achievement may be the lack of appropriate training for teachers to effectively utilize technology in their classroom (Young et al., 2019). In response, I developed a professional development project for the TTO mathematics teachers in the local district. The goals of the 3-day professional development include helping teachers understand the definition of blended learning, examine the role of technology in a blended learning model in improving student achievement in mathematics, identify the effective instructional strategies and practices utilized in a mathematics classroom, and by providing a hands-on experience on how to implement these in a mathematics classroom (see Appendix). In addition, the professional development opportunity would allow new and veteran TTO mathematics teachers to reflect on their current instructional practices and share their experiences to learn collectively from a shared knowledge base.

Rationale

Due to the shift of schools towards nontraditional interventions, such as the utilization of blended learning environments to improve student achievement in mathematics, it is important to provide professional development opportunities to mathematics teachers to help them in implementation of these interventions. Lewis and Dikkers (2016) reported that educators teaching in a blended learning environment should be provided with professional support and training through access to a variety of courses and the latest technological tools, mentorship by a veteran teacher, and opportunities to practice with materials and technology before using them for actual instruction.

The results of the current study indicated that the mathematics teachers implementing blended learning models, such as TTO, would benefit greatly from professional development focusing on teaching and learning instructional strategies for a blended learning classroom. Though the results of this study showed that the observed mean growth scores of the TTO and the non-TTO groups were $M = 8.60$ and $M = 8.59$, respectively (see Table 2) and that they were not statistically different, the results also highlighted the differences between the TTO and non-TTO mathematics teachers' instructional skills that might have impacted students' achievement. While teaching mathematics, the TTO mathematics teachers had to be able to effectively utilize the various modalities offered by the computer-assisted TTO program in addition to exercising their pedagogical and content knowledge skills. Unlike in the traditional, FTF, teacher-led teaching, the TTO model utilizes eight different modalities that encourage students to group and regroup to complete a task in which students frequently utilize educational technology independently or in a group and mathematics teachers help facilitate the completion of various tasks. The eight modalities include the live investigation for initial hands-on exploration to introduce mathematical concepts; math advisory, in which a small group of students interact with the teacher; project-based learning to apply their learning to a solve a real-world problem; students work collaboratively in small groups of up to six students; peer-to-peer interaction in which two to three students work together to solve a problem; students work individually using the computer program to gain proficiency in a mathematical procedural skill; students use the computer program to reinforce their learning; and students use printed materials or the resources to practice independently what they have learned (New Classrooms, n.d.).

My professional development project will assist the TTO mathematics teachers blend FTF teaching with the computer-assisted teaching modalities. The recommended professional development at the study site would provide the first-year TTO, mathematics teachers with an opportunity to interact with the veteran TTO, mathematics teachers in order to gain knowledge from their experiences. The veteran teachers would serve as in-service mentors for the novice TTO, mathematics teachers while also sharpening their own skills as blended learning mathematics instructors.

Review of the Literature

I conducted a review of the literature on various aspects of professional development, focusing on peer-reviewed, scholarly articles published within the last 5 years identified in Google Scholar and several educational databases, including Education Source, ERIC, Academic Search Complete, Primary Search, Research Starters-Education, and SAGE journals. To gather materials for the literature review, I used Boolean searches of the following the key terms: *professional development or* *learning*, *adult learning, effective professional learning, professional development and student outcomes or student achievement,* and *types of professional development.*

Adult Learning Theory

In order to promote intellectual growth and development among adults, Knowles (1985) recommended developing instructional activities that promote their self-directed learning by allowing active participation, utilizing their experiences to guide learning, and involving them in an evaluation. Knowles (1975) popularized the term *andragogy* as the art and science of facilitating adult learning. The andragogic model is a process model that focuses on procedures and resources that helps learners in acquiring knowledge and skills (Knowles, 1984). Because adult learning is different from a child's learning, it is important to understand the differences between andragogy and pedagogy. The four main principles that differentiates Knowles' (1984) andragogy theory from pedagogy are (a) change in self-concept from being dependent when young to a self-directed individual as an adult, (b) adults' experiences play an important during their learning process, (c) adults are more ready to learn things that they need to fulfill their professional roles, and (d) adults tend to have a problem-centered learning orientation.

Effective Professional Development

In their exploratory study, Gess-Newsome et al. (2019) reported that professional development programs that challenged teachers' current beliefs, provided them with new instructional strategies to construct new knowledge that is relevant to their classroom, and provided subsequent support to implement new learning helped improve teacher practices and student achievement. Professional development is a continuous process that includes relevant training, adequate time to practice, feedback, and ongoing support (Akiba & Liang, 2016; Schleicher, 2016). Research has also indicated that school and district leaders played an important role in improving teachers' instructional practices through high quality professional development programs that, in turn, improved student achievement (Whitworth & Chiu, 2015). Martin, Kragler, and Frazier (2017) concluded that effective teaching could be achieved through reflection, collaboration, and problem-solving. Schleicher (2016) reported that allowing teachers to share their expertise and experiences helped build a cumulative knowledge base, promoted development of teachers' learning communities, and aided transforming schools into learning organizations. Schleicher also stated that an effective professional development program included clearly stated goals to help teachers understand the value of the professional learning activities in improving their students' academic growth; provided follow-up support; and contributed in creating a sustainable, collaborative learning environment for teachers.

Knowles, Holton, and Swanson (2015) listed six, core, adult learning principles that included the learner's need to know, self-concept, prior knowledge or experiences, willingness to learn, learning orientation, and motivation to learn. As defined by Knowles et al., these six, core, adult learning principles are learner oriented and promote a collaborative learning environment in which learners and the teacher are partners rather than the teacher being the sole transmitter of the knowledge and the learner being a passive recipient of knowledge. McCauley, Hammer, and Hinojosa (2017) concurred that the learner's need to know and willingness to learn help them understand the relevance of the learning to their practice, the learner's self-concept helps establish self-directed learning, learners sharing their experiences deepens their learning, and they possessed the intrinsic motivation to learn to improve their quality of life. In addition, life experiences also play an important role in the intellectual development of adults and in their growth as learners (Nicolaescu, 2017). When adults apply their learning to real life experiences, they control their learning.

Motivation is imperative to adult learning. Sogunro (2015) reported that motivation is the key to sustained successful learning in adult learners. Furthermore, in an effort to ensure that adult learners are provided effective instruction, Sogunro's findings outlined the following eight motivational factors: a high quality curriculum that met the needs of the learners, effective instructional delivery, relevant experiential learning that they could easily implement in their practice, interactive and collaborative learning, constructive timely feedback, self-directed learning, a well-equipped and conducive learning environment, and effective academic advising to guide adult learners. Avidov-Ungar (2016) reported that teachers differ from one another in terms of their source of motivation to attend professional development. A teacher might have an intrinsic motivation that related to gaining expertise or skills or an extrinsic motivation that pertained to an increase in salary and rise in position as sources of motivation for attending professional development (Avidov-Ungar, 2016).

Giannoukos, Besas, Galiropoulos, and Hioctour (2015) suggested that effective adult learning needed to be facilitated by creating small groups or teams of adult learners in order to promote collaborative learning and provide encouragement to the learners as well as help to create a healthy learning environment that encourages the learner and promotes their interaction. With the advancement in educational technologies in the recent years, the concept of andragogy has also evolved with the creation of adult e-learning programs that provide open access to quality educational resources to people of different ages, educational backgrounds, interests, and needs (Galustyan, Borovikova, Polivaeva, Kodirov, & Zhirkova, 2019). Diep, Cocquyt, Zhu, and Vanwing (2017) also reported that the virtual learning communities of adult learners are more productive during online interactions when they are motivated and want to learn for the sake of learning rather than to merely meet course requirements.

Akiba and Liang (2016) stated that informal collaborative interactions allowed teachers to discuss specific teaching and learning issues they might be facing in their classrooms, which provided them with opportunities to seek focused input regarding these issues from their colleagues. Their study also indicated that the informal teacher-centered collaborative discourses on teaching and learning mathematics improved student achievement more than the professional development activities that did not involve informal communication between teachers (Akiba & Liang, 2016). Nagle and Pecore (2019) also stated that peer collaboration was an effective method to help create shift in teacher instructional practices. The professional development models that included practice-based collaborative inquiry learning opportunities, such as lesson study, helped teachers create long-lasting pedagogical shifts (Pella, 2015).

Effective professional development provides opportunities for teachers to collaborate, interact, and share their knowledge. Alexandrou (2016) reported that professional development opportunities, such as in professional learning communities, allowed teachers to come together to have meaningful conversations that enabled both reflection and helped impart knowledge to shift teacher practices to create a student-centered learning environment. Furthermore, Abu-Tineh and Sadiq (2018) suggested that students' learning improved when teachers worked collaboratively and collectively through peer observations and sharing experiences. The collaborative and interactive models of professional development, also referred to as reform models of professional development, were preferred by teachers because they promote the transfer of new knowledge into the classroom and focus on developing higher-order thinking skills (Abu-Tineh & Sadiq, 2018). Out of the several examples of the reform models of professional development, such as study groups, mentoring, teacher networks, and coaching, teachers considered the mentoring model as the most effective professional development model (Abu-Tineh & Sadiq, 2018). The professional development of mentors is also important in order to provide support to teachers in utilizing latest technology to improve student learning, create a shift in teacher practice, and help teachers improve their communication with students and their colleagues (Gjedia & Gardinier, 2018).

Even though there are several strategies to deliver content and knowledge in a professional development setting, very few focused on the transfer of learning that helps adults integrate the new learning into their classroom practice (Roumell, 2019). Roumell (2019) stated that it was important to support a continued process for a meaningful and effective transfer of learning that might result in transformed practice. For the effective transfer of learning to happen, the learning design should include ongoing opportunities for the learners to actively use and apply new skills in a real-world context (Roumell, 2019). Professional learning that led to transformation provided teachers with adequate time to reflect on what they had learned and how to apply it in the classroom (Martin, Kragler, Quatroche, & Bauserman, 2019). According to Bonghanoy, Sagpang, Alejan, and Rellon (2019), transformative professional development allowed teachers to identify the prevailing issues in their classrooms that might be obstacles in students' academic success in mathematics. Further, the study also indicated that as the teachers adopted transformative teaching and learning pedagogies, they were better able to create an engaging and productive classroom that challenges students and make learning enjoyable (Bonghanoy et al., 2019). Thus, transformative professional development empowers teachers to become creative and resourceful and maximize student participation.

Appova and Arbaugh (2018) concluded that an effective professional development engaged teachers actively in their learning through observing other teachers, reviewing student work, presenting, and planning the use of new knowledge. Besides allowing teachers to be an active learner, some other characteristics of an effective professional development included it to be content focused to allow for teachers' deeper knowledge construction and a shift in their practice, happening over a longer period to allow for shift in practice, and to further allow for teachers from same school, grade level and subject area to collaborate to promote development of a professional learning community (Appova & Arbaugh, 2018; Balta & Eryılmaz, 2019).

Balta and Eryılmaz (2019) provided the following list of nine characteristics that promote effective professional development. The characteristics included that the professional development activities needed to be content-focused; needed to engage teachers in active learning; needed to be coherent to match with teacher knowledge and needs; should last for a longer duration to make a lasting effect; should allow for collective participation where teachers teaching same content and grade learn together; sustained program that allows for a deeper learning; needed to be held at time and place that was conducive to teacher learning; facilitated immediate application of new knowledge into classroom for improved student learning; and should be integrated into teachers' every day work (Balta & Eryılmaz, 2019). Colburn, Stephenson, and Keating (2019) stated that adult learners needed to genuinely feel connected to the content covered by the professional development and needed to be able to apply to their work.

Matherson and Windle (2017) concurred that teachers desired professional development programs that were actively engaging and allowed them to practice new skills, helped them learn techniques and strategies that addressed the needs of their students and were useful in their classrooms. Further, Matherson and Windle added that the teachers preferred the professional development activities that were planned collaboratively with input from the teachers in order to ensure that their professional learning needs were met, and provided sustained support over time to allow teachers to design, plan, and implement new knowledge in their classrooms. Nichol, Chow, and Furtwengler's (2018) findings suggested that teachers needed time to implement the knowledge acquired through the professional development and to create a shift in their practice. Therefore, evaluating the new teaching strategies and the professional development program a year after teacher's participation in the program might indicate a significant increase in student outcomes as compared to evaluating it at the end of the same year as the teacher received the professional development (Nichol, Chow, & Furtwengler, 2018).

Project Description

The project will provide a 3-day professional development to the TTO mathematics teachers in the local district. The professional development would be held at the middle school that currently has a TTO program in place in order to allow the mathematics teachers to be able to practice the new knowledge and teaching strategies in an actual blended learning environment. The resources needed include a laptop for each teacher, post-its, markers, tables and chairs arranged in small group formation for the ease of collaboration, and poster paper to help participants share their learning.

As a coordinator of the professional development, I will seek permission from the local district office to conduct the professional development during a regular school day and would request for a substitute for the participant teachers to allow them to be able to attend the professional development. New Classrooms provides their partner schools, the schools that have implemented TTO, with an on-site support team of technical, operational, and instructional specialists who provide support to the partner school throughout the year on various aspects of implementing TTO. I will e-mail the on-site instructional and the technical specialist assigned to the local district to seek their support in conducting the professional development session for the TTO mathematics teachers. An email will be sent to the prospective TTO teachers before the end of the 2019-20 school year to make them aware of the 3-day professional development starting at the beginning of the 2020-21 school year on the following dates: August 25, September 1, and September 2.

The agenda for the first day of the professional development will include introductions, a presentation on the TTO model and the blended learning framework by a TTO representative, lunch, and the afternoon session regarding modelling and the implementation of the TTO model in a classroom (see Appendix). The schedule for Day 2 of the professional development will include a presentation on the research based strategies for teaching and learning in a blended learning environment by the TTO representative, lunch, and an afternoon session will include information on teaching and learning strategies for various modalities and collaborative activities for the participants to practice the strategies (see Appendix). Finally, on the third day, the participants will spend the morning and the afternoon sessions in collaboratively planning a grade level blended learning lesson for the first week of school with the help of the TTO personnel and the teachers who have already taught in the TTO classroom (see Appendix).

Project Evaluation Plan

The professional development program includes an evaluation plan to determine whether the goals of the program have been met. At the end of the professional development activity the participants will be asked to complete a survey to indicate the effectiveness and the relevance of the program (see Appendix). Antoniou, Kyriakides, and Creemers (2015) stated that the summative evaluation should serve to identify the effect of the professional development program on improving teachers’ skills that in turn would affect student learning. Therefore, the results of the summative evaluation could help measure the effectiveness of the teacher professional development programs, thus helping in decision making whether to continue the programs (Antoniou et al., 2015). Participants' feedback and responses to the questions on the summative evaluation survey (see Appendix) will help determine, if any changes or modifications are required to improve the quality of the future programs. The data collected from the survey will help to plan future professional development programs. Besides the survey, the participants will also be asked to develop a lesson plan that could be implemented in their blended learning classrooms. The lesson plan will be evaluated by the TTO personnel to ensure that the important components of the blended learning environment have been included in their lesson plan.

The key stakeholders in the project include the TTO mathematics teachers participating in the professional development who will learn strategies to implement blended learning in their classrooms. My role in this professional development will be as a program coordinator who is responsible for communicating with the district, the participants, and New Classrooms. New Classrooms will provide the instructional specialist, as part of the TTO support team to the local school, who will be conducting the professional development for the TTO mathematics teachers. The other stakeholders will include the local district leaders and the local school leaders who would be asked to approve the professional development program, and the students who would be learning in the blended learning environment.

Project Implications

One of the potential positive social changes that might result from this project include empowering teachers with the knowledge and skills to teach effectively in a blended learning environment, thus improving student learning and outcomes in mathematics. It may help strengthen the TPACK skills of the TTO mathematics teachers that in turn would help create an effective learning environment for students, thus improving their achievement in mathematics. The project would familiarize them with the meaning and the role of blended learning in improving student outcomes, help them curate useful resources on blended learning, provide collective learning opportunities, and provide collaborative planning time to plan blended learning lessons to be implemented in their classrooms. In the absence of adequate professional training on how to utilize educational technology effectively, the teachers may continue to utilize technology as a display tool rather than as a powerful instructional tool (Young et al., 2019).

The project is important to local stakeholders including the students, the mathematics teachers, and the school leaders. For example, the project is important as it would support and guide the TTO mathematics teachers in implementing the blended learning model in their classrooms to improve student learning in mathematics. Self-efficacy in mathematics is one of the factors that may help predict the future academic success (Keşan & Kaya, 2018). Research indicated that one of the factors to ascertain college and career readiness is to monitor students' academic achievement in mathematics and other subjects in middle school in order to provide them the needed interventions and support early on in order to ensure that they stay on track to college and career readiness (Gaertner & McClarty, 2015; Mattern, Allen, & Camara, 2016).

Section 4: Reflections and Conclusions

Introduction

In this quantitative study, I compared the MAP mathematics scores of students who were instructed in a blended learning environment that utilized the computer-based mathematics intervention program, TTO, in tandem with the traditional FTF teaching by a mathematics teacher, with the non-TTO group, whose students were instructed in a traditional, FTF, in-person method by their mathematics teachers. The project deliverable for the study was a professional development program for mathematics teachers on effective instructional strategies and practices to be used in a mathematics classroom and on how to utilize educational technology tools, such as TTO, to increase student achievement in mathematics.

In this section, I address the project strengths and limitations, recommendations on alternative approaches, and project development and evaluation. I also examine my reflections as a researcher and a scholar. The section concludes with a discussion of implications for positive social change, applications, and directions for future research.

Project Strengths and Limitations

I focused on the problem that the middle school students in the local school district did not perform well in mathematics on a standardized test in this study. This is important because a student's middle school achievement influences their academic choices in high school that eventually impacts their college readiness (San Pedro, Baker, & Heffernan, 2017). One of the factors that helps to improve student achievement in mathematics is by providing adequate professional development to their mathematics teachers (Bicer & Capraro, 2017). Killion (2015) reported that even though teacher professional development had a positive association with student achievement, during the years of their study, not all the students in Grades 4 and 8 in the United States had access to the teachers who had participated in professional development, especially in mathematics content, mathematics pedagogy, mathematics curriculum, and technology integration in a mathematics classroom, that are associated with a student's achievement in mathematics. Further, Young et al. (2019) pointed out that professional development helped strengthen the pedagogical content knowledge of mathematics teachers and led them to effectively integrate educational technology to support instruction that resulted in an improvement in student achievement. Therefore, the strength of the project lies in its ability to help mathematics teachers improve their teaching skills and content knowledge as well as allow them to effectively integrate their TPACK skills to improve student achievement (see Young et al., 2019).

Another strength of the project is that professional development helps reduce teachers' anxiety about learning mathematics, which improves their instructional skills. Lowering teacher's anxiety helps build their confidence and allows them to make changes to their practice that, in turn, can lead to improved student achievement (Kutaka et al., 2017).

One limitation of the project is that it focused solely on a providing professional development to mathematics teachers on implementing one of the blended learning models, namely TTO, even though teachers might also be utilizing a variety of other educational technology tools. With the continuous development and evolution of educational technology, it is important to provide adequate and relevant professional development to teachers on other technologies being utilized in the classroom to help improve their instructional skills and to potentially improve student achievement.

Another limitation of the project its short duration. The project is only a 3-day professional development project, which might not be enough time to transform mathematics teachers' current practice. Johnson, Walton, and Sondergeld (2017) stated the professional development program that provided learning to teachers over a longer duration supported them in transitioning to highly effective teaching. Therefore, an ongoing professional development that allows teachers to continually reflect on their practice, monitor the impact of their practice on student achievement, and reevaluate their needs as teachers would most likely improve their practice and subsequently improve student achievement.

Recommendations for Alternative Approaches

An alternate approach to responding to the local problem could have been to conduct a program evaluation for the TTO program in order to better understand how well it was implemented and its effect on student learning. It is important to assess whether this intervention had been implemented with fidelity in order to monitor its effect on student learning (see Doabler et al., 2018). It is also important that the intervention is implemented and adopted throughout the school as prescribed to ensure its maximum benefits. Alternatively, I could have merely presented the findings of the current study to the district officials in order to assist them with their future decision-making regarding whether to expand the TTO program to the other middle schools in the district.

Scholarship, Project Development and Evaluation, and Leadership and Change

During the process of completing my doctoral study, I grew as a scholar and a research practitioner. The process of defining the problem and completing the literature review has helped me recognize my strengths and weaknesses as an academic writer as I continued to revise my work and incorporate my chair's suggestions and feedback. Frequent interactions with my chairs, Walden methodologists, Walden librarians, and fellow researchers have helped refine my written and verbal communication skills. Through seeking and using the faculty's advice, I enhanced my scholarly writing skills. Furthermore, as a scholarly writer, I have learned to incorporate research-based and peer-reviewed studies to support my ideas. I also grew as a critical reader as I gradually developed an inquiry stance towards the literature that were a part of my study (see Kennedy, Bondy, Dana, Vescio, & Ma, 2020).

As I conducted searches of the literature, synthesized the literature review, and analyzed the results of my data, I was empowered to take action and developed a professional development program for the district's mathematics teachers. To develop the project, I used research-based strategies and tools to help mathematics teachers grow as effective professionals. To transform mathematics teachers' current instructional practices, they need professional development in personal growth, growth mindset, and beliefs in the learning potential of all students (Anderson, Boaler, & Dieckmann, 2018).

This study and project will assist mathematics teachers in transforming their current practice and, therefore, initiating a positive change in student achievement.

Developing the professional development program for the mathematics teachers as a viable solution to the local problem helped me evolve as a leader who can utilize newly acquired research skills to guide decision-making and practice (see Coffman, Putman, Adkisson, Kriner, & Monaghan, 2016). Developing the professional development program for the teachers allowed me to emerge as a teacher leader because it engaged me in an authentic task that required thinking and acting at organizational level to solve an existing problem (see King & Smith, 2020). Berestova, Gayfullina, and Tikhomirov (2020) stated that teacher leaders promote growth within educational communities by influencing and interacting with fellow educators and creating opportunities for professional growth. I also gained greater self-confidence in my ability to lead other professionals with the goal of improving student achievement.

Reflection on Importance of the Work

This study is important because it provides research-based and data-driven information to the district officials and mathematics teachers regarding a comparison of the TTO and the non-TTO students' performance on the MAP mathematics assessment. The local district officials may utilize the insights from this study for their future decision-making purposes.

The resulting project is important for the local district because it offers a potential solution to the local problem. Merely integrating technology in a classroom is not sufficient for improved student achievement unless teachers are trained on how to implement and utilize the technology effectively in a classroom to maximize student learning and achievement (Bicer & Capraro, 2017). This professional development project will help inform mathematics teachers' practice and improve their instructional skills, which may eventually improve student achievement.

While working on this study and developing the project, I have learned to develop a literature review utilizing current, peer-reviewed, and scholarly articles. Furthermore, I have learned to combine the literature review with a thoroughly prepared data analysis to develop conclusions and propose a research-based solution to the local problem. I am able to use the skills that I have learned as a researcher in my professional life, especially when presenting research-based evidence to support my ideas.

Implications, Applications, and Directions for Future Research

This study has a direct implication for positive social change in the local school district under study. The local district implemented the TTO blended learning model in one of its middle school in an effort to improve students' achievement in mathematics; however, before the current study, the district had yet to complete a formal study on the impact of TTO on student achievement. Though the findings of the study indicated that there was no significant difference between the observed growth of the TTO and non-TTO students on the MAP mathematics assessment, the literature review suggested that one probable reason for the ineffectiveness of the intervention might be that the mathematics teachers did not receive adequate professional development to implement it. Therefore, the professional development project that I developed for the mathematics teachers based on the findings of this study will assist them in using and implementing the educational technology effectively in their classrooms, which may eventually improve students' achievement in mathematics. Middle school students' improved achievement in mathematics can lead to their success through high school and beyond, which would lead to a positive social change in the local school district.

Social change refers to the change driven by people when their needs are not met by the society (Education Diplomats as Leaders of Social Change, 2020). Education is a powerful tool for social change, and depending on how it is implemented, it can either bring about a positive social change by ensuring social and economic development or a negative change by promoting social inequity (Education Diplomats as Leaders of Social Change, 2020). Therefore, it is imperative that teachers, as agents of change at different levels, including classrooms, schools, and potentially societies, have the required skills and opportunities to impact education and learning at various levels (Bourn, 2016). Providing professional development to educators in the local district helps to inform their practice and, subsequently, promotes social change through leading to improved student achievement.

The findings of this study and the resulting project open three possible pathways for future research by the district under study. First, as a future research study, the local district might want to investigate the effects of the TTO program on students' MAP mathematics scores over consecutive years. When conducted over multiple years, the study would yield better results regarding the role of the educational technology program on student achievement in mathematics. Second, it would be interesting to study students' MAP mathematics assessment data before and after the mathematics teachers have received the required professional development on using and implementing the effective instructional strategies and technology to promote students' mathematical thinking. Finally, a future research study investigating the effects of educational technology on improving student achievement in mathematics in other school districts might be helpful in gaining a deeper insight into the role of educational technology in today's classrooms.

Conclusion

In the district under study, the middle school students performed below average in mathematics as measured by the state-administered standardized assessment. In an effort to improve the mathematics achievement of the middle school students, the local district implemented TTO, a blended learning model, in one of its middle schools. In this study, I compared the mathematics achievement of TTO and the non-TTO students as measured by the MAP mathematics assessment during the 2017–2018 school year. Though the data analysis showed that there is no significant difference between the mean observed growth scores of the TTO and the non-TTO students as measured by the MAP mathematics assessment, the literature review indicated the lack of adequate professional development of mathematics teachers was one of the probable reasons for an ineffective intervention. Educators need to receive adequate professional development to be able to effectively use and implement educational technology to improve student achievement. Based on the findings of this study, I developed a professional development project for the mathematics teachers to strengthen their instructional and TPACK skills that may subsequently assist in improving their students' achievement in mathematics. Improving students' mathematics achievement can lead to a positive social change by improving their performance in high school and beyond.

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Appendix: The Project

Professional Development Agenda

Professional Development Agenda Day 1

8:30- 9:00 Sign-in, Introductions, and Welcome (I will facilitate this).

9:00 – 10:30 Presentation on TTO model and blended learning model by the instructional specialist from New Classrooms

10:30- 10:45 Break

10:45-12:00 Why blended learning? The need for the TTO model in mathematics classroom by the instructional specialist from New Classrooms.

12:00 1:00 Lunch

1:00- 2:00 Modelling and the implementation plan/techniques for the TTO model in a school by the instructional and the technical specialist by New Classrooms.

2:00- 2:10 Break

2:10- 3:00 Modelling and the implementation plan/techniques for the TTO model in a school by the instructional and the technical specialist by New Classrooms.

Professional Development Agenda Day 2

8:30- 10:30 Presentation on the research based strategies for teaching and learning in a blended learning environment by the instructional specialist from New Classrooms.

10:30 – 10:45 Break

10:45-12:00 Modelling research based teaching and learning strategies (participants put on student hats and the instructional specialist from New Classrooms acts as their coach to help them practice the teaching and learning strategies to be utilized in small-group face-to-face instruction, and during peer-to-peer interactions)

12:00 1:00 Lunch

1:00- 2:00 Teaching and learning strategies for various modalities utilized in a TTO classroom participants put on student hats and the instructional specialist from New Classrooms acts as their coach to help them practice the teaching and learning strategies to be utilized in small-group face-to-face instruction, and during peer-to-peer interactions etc.)

2:00- 2:10 Break

2:10- 3:00 Question- answer session where participants may ask questions to the instructional specialist regarding implementation of the TTO model; participants from same school collaborate and start TTO lesson planning.

Professional Development Agenda Day 3

8:30- 10:30 Participants from same school collaborate and continue their TTO lesson planning with the help from the instructional specialist.

10:30- 10:45 Break

10:45-12:00 Participants present their lesson plans and receive feedback from the instructional specialist.

12:00 1:00 Lunch

1:00- 2:00 Participants present their lesson plans and receive feedback from the instructional specialist.

2:00- 2:10 Break

2:10- 2:50 Participants complete the professional development survey for educators

2:50- 3:00 I thank the participants and the New Classrooms specialists for their participation in the professional development.

Presentation: Project- Professional Development

Project- Professional Development

Topics included-

1. Blended Learning (Day 1)

- What is it?
- Why use blended learning?
- How to implement it?

2. Various TtO Modalities (Day 2)

3. Utilizing classroom space efficiently to maximize Learning (Day 3)

Bugbee, C. (2018). [What is blended learning] [Image] *Flickr.* https://www.flickr.com/photos/chris_bugbee/43084937444/

4. Additional Blended Learning Resources for Teachers (Day 3)

Project- Professional Development

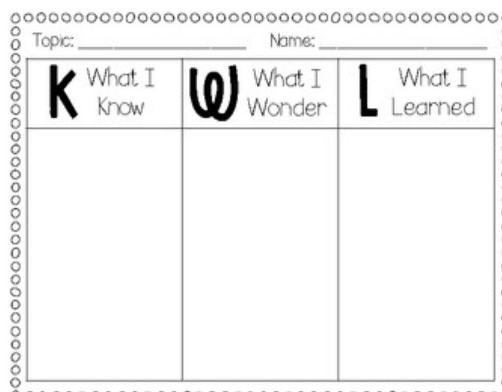
Blended Learning- KWL

- On a **BLUE** sticky note, list what do you already know about blended learning.

- On a **PINK** sticky note, list some questions that you would like to ask about blended learning

- Participants share their responses.

- Place your sticky notes in the appropriate sections on the KWL poster displayed on the side wall.



Project- Professional Development

Blended Learning: What is it?

- **Blended learning combines face-to-face (FtF) instruction and online learning (Derbel, 2017).**

- **It may also be referred to as Computer-assisted instruction (CAI). CAI is an educational technology platform that integrates computer science, pedagogy, and psychology to create a student-centered learning environment that promotes student learning through constructivism (Guo, 2018).**

- **It combines traditional FtF teaching with technology and presents a variety of teaching and learning tools to deepen student understanding (Chekour, 2017).**

Bugbee, C. (2018). [What is blended learning] [Image] *Flickr.* https://www.flickr.com/photos/chris_bugbee/43084937444/

Project- Professional Development

Blended Learning: Why use blended learning?

- Integration of educational technology facilitated personalized instruction and helped create a student-centered learning environment in the classroom (Alexandre & Enslin, 2017).

- Computer-assisted instruction was more effective in increasing students' mathematical comprehension, application skills, and attitude towards mathematics (Soliman & Hilal, 2016; Balentyne & Varga, 2016)

- longer and frequent exposure to blended learning environments resulted in student's higher achievement (Sokolowski & Willson, 2015).

- **Schools with poor academic performance improved their test results by using computer-assisted instructional programs that provided differentiated instruction to students (De Witte, Haelermans, & Rogge, 2015).**

- **computer-assisted remedial mathematics learning programs have been found to improve students' mathematics scores on standardized tests (Lai, Luo, Zhang, Huang, & Rozelle, 2015).**

Project- Professional Development

Blended Learning: How to implement it?

Blended instruction must integrate three components—contextual, instructional, and technological—each of which is closely aligned with common instructional design processes familiar to most teachers (Oliver & Stallings, 2014).

- Contextual considerations-

- includes topic and subject suitability for blending,
- learner challenges and available scaffolds, and
- models of blending that may or may not work across different instructional settings

- **Instructional strategy and teaching considerations-**
  - Includes utilizing the right mix of student-centered and collaborative activities that are well-supported by blended learning model
  - educating teachers about their new roles as educators when utilizing blending models

- **Technology considerations-**
  - includes appropriate blended modes and resources that best support a chosen instructional strategy, and to educating teachers to make such matches on the basis of pedagogy, not technology (Oliver & Stallings, 2014).

Project- Professional Development

TtO as a blended learning model provides-

- Adaptive, personalized, and individualized instructional experience
- customized student schedule based on their skill map
- integrates computer-based and in-person learning through different instructional approaches
- Different Instructional Approaches - **TtO Modalities**

Project - Professional Development

Introduction to TtO Modalities -

As a blended learning model, the TtO program utilizes the following modalities-

- **Teacher Delivered Modalities (Live investigation, Tasks, Math Advisory)**
- **Student Collaboration Modalities (Small group collaboration, peer-to-peer)**
- **Independent modalities (Virtual instruction, virtual reinforcement, independent practice)**

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TtO Modalities -

- Types of **Teacher Delivered Modalities** –

1. Live investigation

- Initial exposure to a new mathematical concept through hands-on exploration
- may be conducted in a small group to a whole class setting

2. Tasks

- utilizes project based learning tasks
- promotes problem solving using real world scenarios

3. Math Advisory

- Mathematics teacher meets with the same group of students throughout the year to help them meet their learning goals and provide opportunities reflect on their learning.

Project - Professional Development

TtO Modalities -

- Types of **Student Collaboration Modalities** -

1. Small group collaboration

- Students collaborate, communicate, reason , and discuss mathematical problems in groups of up to six students

2. Peer to peer

- A group of two to three students work on same mathematical skill and share their reasoning with their peers.

Project - Professional Development

TtO Modalities -

- Types of **Independent Modalities** -

1. Virtual Instruction

- Students utilize educational technology to learn mathematical procedures and skills.

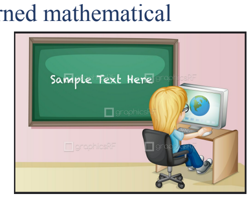
2. Virtual reinforcement

- opportunity to practice newly learned mathematical procedures and skills

3. Independent Practice

- provides opportunities to students to reinforce the newly learned mathematical skills.

- utilizes printed material and a variety of other resources



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Project - Professional Development

Utilizing Classroom Space Efficiently To Maximize Learning-

- Strategies to create open and flexible learning spaces that allow implementation of multiple learning modalities

- Open space design (large open space learning environment with different learning stations that implement different instructional modalities)

- Closed space design (To create a Math Center in a more traditional mathematics classroom setting)

Project- Professional Development

Blended Learning- KWL

- On a **GREEN** sticky note , list what did you learn about blended learning
- Participants share their responses.
- Place your sticky notes in the appropriate section on the KWL poster.
- Revisit the **questions** in the **W section** of KWL and discuss the questions.

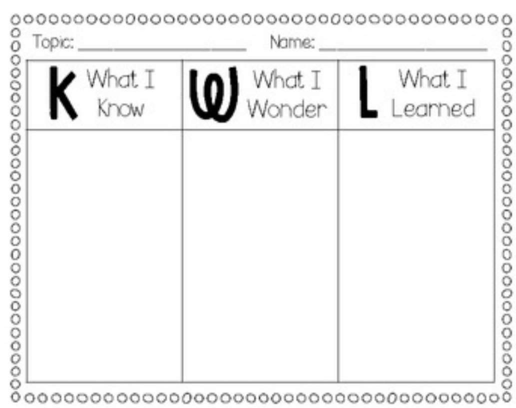

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Image Sources

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Project - Professional Development

Questions?

Comments

Summative Evaluation Survey for Educators

Please respond to each item below by circling the number that best describes your experience on the scale of 1= poor and 5= excellent.

Evaluation	**Excellent**		**Average**		**Poor**
1. The program was well organized.	5	4	3	2	1
2. The program objectives were clearly stated.	5	4	3	2	1
3. The program met your professional needs.	5	4	3	2	1
4. The program instructor's overall performance.	5	4	3	2	1
5. The program included research based activities.	5	4	3	2	1
6. The program helped improve your teaching skills.	5	4	3	2	1
7. The program helped improve your professional growth.	5	4	3	2	1
8. You would recommend the program for other teachers.	5	4	3	2	1