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TECHNOLOGY LITERACY PROFESSIONAL DEVELOPMENT IMPACT ON THE 2018 NAEP EIGHTH GRADE INFORMATION AND COMMUNICATION TECHNOLOGY ASSESSMENT SCORES

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ABSTRACT

This study explored the impact of teacher technology literacy professional development participation on the 2018 NAEP eighth-grade information and communication technology literacy scale scores. This quantitative study analyzed data from the National Assessment of Educational Process (NAEP) Data Explorer to examine the impact of teacher technology literacy professional development participation on the 2018 NAEP eighth-grade information and communication technology literacy scale scores. The findings of this study indicate that (1) there is no impact of teacher professional development on student achievement based on the NAEP data, (2) there is no significant impact on the frequency of team teaching on student achievement scores, and (3) teacher observation has no significant impact on the average scale scores. These findings may indicate that while teacher professional development participation does not have a direct impact on student achievement, it is beneficial to teachers, teacher candidates, and students in other ways.

Keywords: Professional development; teacher effectiveness; student achievement; NAEP; technology literacy; middle level

1.0 INTRODUCTION

The classroom integration of Information and Communication Technology (ICT) has been established as an important component of student learning because it provides an opportunity for student collaboration and improved learner motivation (MacDonald, 2008). However, ICT integration has not been shown to improve student success rates, which MacDonald (2008) has attributed to teacher ineffectiveness in integrating ICT to enrich learning. Furthermore, it is argued that "these lower levels of ICT integration may be associated with a leveling off of teacher confidence in ICTs, which could be due to a need for more teacher support" (MacDonald, 2008, p. 430). Teacher professional development has been cited as extremely important for integrating ICT effectively for improved student learning and success.

Research has demonstrated that teacher professional development is an important component of student success, so much so that it is often a mandatory requirement for continued teaching practice. There are various forms and opportunities for teachers to participate in professional development, and these educational experiences are focused on improving teaching practice and improving student outcomes (Patton, et al., 2015). While professional development is highly valued, research is still conflicted in identifying the most effective types of professional

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development to improve student achievement. Patton et al. (2015) has identified important features for effective professional development, stating "it must be collaborative, involving the sharing of knowledge among educators rather than one individual teacher working in isolation" (2015, p. 5). Team teaching, or co-teaching, and peer observation are two examples of collaborative forms of professional development that are commonly utilized which have demonstrated benefits for both teachers and students (Hurd & Weilbacher, 2017; Vesikivi, et al., 2019).

Due to the identified importance of ICT classroom integration in the promotion of student collaboration and learning, it is essential that teachers can effectively integrate ICT in ways that enrich student learning to promote the greatest benefits possible. As Tondeur et al. (2016) states “merely providing ICT does not inevitably improve learning, but beyond access, it is how teachers use ICT that makes a difference” (p. 110). While teacher professional development is a heavily researched topic in education, there are many conflicting studies as to what professional development formats are most effective for improved student learning. Some studies have found that collaborative learning experiences such as team teaching and observation are beneficial learning opportunities for both seasoned teachers and teachers in training (Hurd & Weilbacher, 2017; Vesikivi, et al., 2019). Therefore, the impact of these types of professional development opportunities on student learning is worthy of further research.

Research on professional development continues to explore the most effective formats to support teachers in improving student outcomes. Research is especially limited in understanding the impact of teacher professional development, including team teaching and peer observation, on student achievement in middle level information and communication technology. This study will explore how professional development participation, team teaching, and observation impacts student information and communication technology literacy scores.

The goal of this research study is to explore the impact of professional development, including team teaching and observation, on student achievement through student information and communication technology literacy scores. This research will provide information that is valuable for teachers as they are considering the types of professional development to participate in, as well as school administrators as they determine what opportunities to seek out and facilitate for their teachers. The findings from this study may also improve learning outcomes for students, as effective ICT classroom integration has been shown to be dependent on teacher comfortability and knowledge in utilizing ICT.

The purpose of this study is to explore the impact of teacher technology literacy professional development participation on the 2018 NAEP eighth grade information and communication technology literacy scale scores.

Research Questions

1. In the past two years, what percentage of teachers in your school has participated in professional development in content, curriculum, or pedagogy related to technology or technological literacy?
2. How often do teachers in this school teach jointly as a team in the same class?

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3. How often do teachers in this school observe other teachers' classes and provide feedback?

2.0 LITERATURE REVIEW

2.1 Introduction

Teacher professional development is an important component of effective teaching not only for improving content knowledge and teaching strategies, but also for the impact on student achievement. While teacher professional development is common practice and an established requirement for teachers, research has yet to establish a consensus regarding the most effective types of professional development to improve student achievement, and continues to explore the overall benefits (Patton, et al., 2015). Both team teaching and peer observation are commonly utilized professional development formats that have demonstrated benefits for both teachers and students (Hurd & Weilbacher, 2017; Vesikivi, et al., 2019). However, research is especially limited in understanding the impact of teacher professional development, including team teaching and peer observation, on student achievement in middle level technology literacy. In this literature review, three themes will be discussed including (1) teacher professional development, (2) team teaching, and (3) peer observation.

2.2 Teacher Professional Development

Teacher professional development is an important component of student learning and achievement, which is evident in various state licensing requirements in which teachers must complete professional development to maintain their teaching license or certification, even with some states requiring the completion of a master's degree after initial certification and job obtainment (U.S. Bureau of Labor and Statistics, 2023). While research has demonstrated that the most important goal of professional development is to improve student outcomes, the type of professional development required varies greatly and research is further conflicting in regard to what is most effective in improving student learning outcomes (Patton et al., 2015).

Some research has established that regardless of the type of professional development teachers are participating in, it is most effective when the experience is frequent, and the learning is applied and revisited after the training experience has ended. This perspective is supported through a study by Shaha and Ellsworth (2013) that examined the impact of on-demand professional development on students, educators, and schools. The study found that the more frequent and engaging professional development is, the greater the impact on student achievement gains. However, these findings are further expounded by Patton et al. (2015) who compiled various literature resources and found that the quality of the professional development experience and how that learning continues to be reinforced and practiced is most important, rather than the frequency of teacher participation. Further contributing to the lack of consensus of previous research, Akiba and Liang (2016) conducted a study to examine the impact of formal and informal learning activities of math teachers on student achievement growth. It was found that "teacher-centered collaborative learning activities" such as teacher collaboration and information communication, were the most impactful on student achievement when compared to all other professional development programs and university courses (p. 106).

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While there are varying perspectives on the type of professional development that has the greatest impact on student outcomes, it is important to note that professional development in general has a positive effect on teacher efficacy, and that teacher's attribute an increased level of self-efficacy to gaining new knowledge through professional development. This is important in that higher levels of teacher self-efficacy are associated with higher levels of student achievement (Yoo, 2016).

2.3 Team-Teaching

Team-teaching is a form of co-teaching that is commonly used for professional development and teacher candidate learning. Team-teaching differs from other co-teaching models in that it is based on a collaborative, equal partnership in lesson planning, instruction, and evaluation (Hurd & Weilbacher, 2017; Vesikivi et al., 2019). The experience of team-teaching has been found to be beneficial for seasoned teachers, teacher candidates, and students (Smith et al., 2020; Vesikivi et al., 2019; Weilbacher & TIlford, 2015). However, research is conflicting regarding the impact team-teaching has on student achievement outcomes.

Teachers and teacher candidates have an overall positive perception of team-teaching as a form of professional development. Teachers recognize team-teaching experiences as an opportunity to develop teaching strategies and collaboration skills, as well as improving their understanding of the content taught (Vesikivi, 2019). In general, teachers experienced team-teaching very positively, especially when compared to other forms of professional development, and that it led to a significant change in their teaching practice (Hurd & Weilbacher, 2017; Smith et al., 2020). An additional study focused on teacher candidate perceptions of team-teaching at the middle school level, similar to the education level of the current study, found that team-teaching was valuable for self-reflection, strategy assessment, and observation of others' teaching strategies (Weilbacher & Tilford, 2015).

Team-teaching has also been demonstrated to benefit students through opportunities to experience different teaching styles, leading to increased engagement, in addition to more opportunities for small group work and individualized instruction (Hurd & Weilbacher, 2017). However, research regarding the impact on student outcomes is conflicting. A study by Uwameiye and Ojikutu (2008) explored student achievement results between a team-teaching group and a traditional, single teacher group. The study found significantly improved scores for secondary school students who participated in the team-teaching group. In contrast, Carpenter et al. (2007) found no significant difference between team-teaching environments when compared to traditional, single teacher environments for learner achievement tests scores.

2.4 Peer Observation

Research regarding teacher peer observation and feedback as a method of professional development is limited. However, some research has demonstrated teacher benefits of observation as well as its use for teacher evaluation.

In regard to teacher observation as a professional development practice, Dos Santos (2020) found the benefits of the teacher observation experience to include the sharing of teaching strategies and practices without limitations, and the promotion of sharing and communication with teachers at all levels, rather than a ‘top down’ approach.

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Additional research exists in the exploration of teacher observation to determine effectiveness and for teacher assessment. Findings are conflicting in which some studies have found that observation is useful in measuring teacher effectiveness, and that higher levels of teacher performance are correlated with higher levels of student achievement (Garrett & Steinberg, 2015). Conflicting with these findings, additional research suggests that teacher observation for assessment is not standardized, and evidence does not support that observation and "high stakes" teacher evaluation in general is effective in improving teacher effectiveness and student outcomes (Martinez & Schaaf, 2016).

2.5 Conclusion

The literature review has demonstrated that professional development is an important component for teacher development, with the most important goal of improving student achievement. However, research has not reached consensus regarding the most effective type of professional development in terms of the impact on student achievement. Professional development in general is perceived positively by teachers and teacher candidates, and has demonstrated benefits for students outside of student achievement scores. Both team-teaching and peer observation and feedback are strategies for professional development, which are also perceived positively by teachers, however the impact on student achievement has not been demonstrated through previous research.

3.0 METHODS

This quantitative study analyzed data from the National Assessment of Educational Process (NAEP) Data Explorer to examine the impact of teacher technology literacy professional development participation on the 2018 NAEP eighth grade information and communication technology literacy scale scores. This section discusses how the NAEP Data Explorer was used to examine the relationship between teacher professional development participation and student scores on the community and technology literacy scale.

3.1 Participants and Sampling

NAEP Sampling and Data Collection

The NAEP is administered to a student sample that is representative of the national student population to allow for an accurate assessment of national student performance. Additionally, public school samples within each state are large enough for state level inferences. A probability sample design is utilized in which every school and student could potentially be selected to participate (NCES, 2022a).

Public School Selection in State Assessment Years

The NAEP sample design includes a sample of students from both public and private schools within designated grades. The National Center for Education Statistics (NCES) describes the public school selection in state assessment years as a complex sample design which includes three stages. These three stages include 1) the selection of public schools within the designated area; 2) the selection of students based on relevant grades within those designated public schools; and 3) the allocation of students to assessment subjects (NCES, 2022b).

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The sampling frame used to select public schools from each state and/or jurisdiction is based on the Common Core of Data (CCD) file, which is developed annually by the NCES. The CCD includes information about all public schools such as grades, enrollment and location (NCES, 2022b). Students within these selected schools are then randomly selected to participate regardless of demographic factors such as race, ethnicity, socioeconomic status, etc. Students are selected from fourth, eighth, or twelfth grades, and may participate in up to two assessment subjects. Public school results are reported at the state level, whereas both public and private results are reported at the national level (NCES, 2022b).

Technology and Engineering Literacy (TEL) Assessment

The current study utilizes the information and communication technology scale score results of the NAEP Technology and Engineering Literacy (TEL) assessment, which is designed to assess students' abilities in the application of technology and engineering skills to "real-life situations" (NCES, 2022c). The most recent TEL assessment was administered in 2018 in which approximately 15,400 students at the eighth grade level were assessed. NAEP defines TEL as "the capacity to use, understand, and evaluate technology as well as to understand technological principles and strategies needed to develop solutions and achieve goals in science, technology, engineering, and mathematics (STEM)" (NCES, 2022c, para 3). Within this framework definition, the TEL assessment aims to measure three components of engineering and technology experiences including (1) technology and society, 2) design and systems, and 3) information and communication technology. The TEL assessment is administered digitally to school administrators, teachers, and students to measure these experiences (NCES, 2022c).

3.2 Data Analysis

NAEP Data Explorer

The NAEP Data Explorer (NDE) is an easy to use, statistical tool that allows users to explore NAEP data assessment results. Users can search results on various subjects, grades, and jurisdictions, and utilize statistical information to create tables, graphs, and maps (NCES, 2022d). The NAEP gathered student, teacher and school data can be further examined according to various factors such as gender, race, ethnicity, school type (public or private), and several others (NCES, 2022d).

This study utilized the NDE for data analysis. The 2018 eighth grade TEL assessment information and communication technology literacy scale scores and standard deviations were selected. The national public school jurisdiction was selected and the variable was further narrowed to include the preparation, credentials, and experiences subcategory of teacher factors, using average scale for examination. Utilizing this NDE report, the following three coded questions were selected:

1. In the past two years, what percentage of teachers in your school has participated in professional development in content, curriculum, or pedagogy related to technology or technological literacy?

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2. How often do teachers in this school teach jointly as a team in the same class?
3. How often do teachers in this school observe other teachers' classes and provide feedback?

The NDE was used to create descriptive tables and tests of statistically significant differences (alpha set a priori at 0.001 because of the large n of the sample). The table formatting was adjusted without altering the table data. Cohen's d effect sizes were calculated by using an online effect size calculator (Becker, 2000). Cohen's d is commonly used in meta-analysis to compare between two means. "Cohen suggested that d = 0.2 be considered a "small" effect size, 0.5 represents a "medium" effect size and 0.8 a "large" effect size" (Mcleod, 2023, para 3).

3.3 Results

This section discusses the statistical analysis results of the examination of three teacher factor variables and the average scale scores and standard deviations for the 2018 NAEP eighth grade information and communication technology literacy scale scores for national public school students. The results of independent t-tests with an alpha level of 0.05 are also reported.

Research Question #1: In the past two years, what percentage of teachers in your school has participated in professional development in content, curriculum, or pedagogy related to technology or technological literacy?

The 2018 NAEP eighth grade information and communication technology literacy average scale scores and standard deviations were analyzed based on the variable of the teacher percentage participating in technology or technology literacy professional development.

Table 1. Average scale scores and standard deviations for grade 8 technology and engineering literacy information and communication technology scale, by percent in professional development in technology or technological literacy [C094502] and jurisdiction: 2018

Year	Jurisdiction	Percent in professional development in technology or technological literacy	Average scale score	Standard deviation
2018	National public	Not applicable	143	37
		0%	146	38
		1-25%	152	37
		26-50%	152	37
		51-75%	150	37
		Over 75%	154	38
		I don't know.	145	38

Note: Some apparent differences between estimates may not be statistically significant.

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Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2018 Technology and Engineering Literacy Assessment.

When examining the percentage of teachers participating in professional development in technology or technology literacy and excluding the "not applicable" and "I don't know" categories, the average scale score ranges from 146, sd=38 (0% participation) to 154, sd=38 (over 75% participation).

Table 2. Difference in average scale scores between variables, for percent in professional development in technology or technological literacy [C094502] National public, 2018

	Not applicable (143)	0% (146)	1-25% (152)	26-50% (152)	51-75% (150)	Over 75% (154)
Not applicable (143)						
0% (146)	x Diff = 4 P-value = 0.6170 Family size = 21					
1-25% (152)	x Diff = 9 P-value = 0.0966 Family size = 21	x Diff = 6 P-value = 0.2465 Family size = 21				
26-50% (152)	x Diff = 10 P-value = 0.1155 Family size = 21	x Diff = 6 P-value = 0.2855 Family size = 21	x Diff = 0 P-value = 0.9607 Family size = 21			
51-75% (150)	x Diff = 8 P-value = 0.2094 Family size = 21	x Diff = 4 P-value = 0.4772 Family size = 21	x Diff = -2 P-value = 0.5686 Family size = 21	x Diff = -2 P-value = 0.6288 Family size = 21		

Over 75% (154)	x Diff = 11 P-value = 0.0621 Family size = 21	x Diff = 8 P-value = 0.1558 Family size = 21	x Diff = 2 P-value = 0.4353 Family size = 21	x Diff = 1 P-value = 0.6519 Family size = 21	x Diff = 3 P-value = 0.3237 Family size = 21	
I don't know. (145)	x Diff = 2 P-value = 0.6721 Family size = 21	x Diff = -1 P-value = 0.8429 Family size = 21	x Diff = -7 P-value = 0.0180 Family size = 21	x Diff = -7 P-value = 0.0636 Family size = 21	x Diff = -5 P-value = 0.1940 Family size = 21	x Diff = -9 P-value = 0.0088 Family size = 21

LEGEND:	
<	Significantly lower.
>	Significantly higher.
x	No significant difference.
‡	A significance test could not be performed because reporting standards were not met, or appropriate standard errors could not be calculated for one or more estimates in the test.

Note: Within jurisdiction comparisons on any given year are dependent with an alpha level of 0.05.

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2018 Technology and Engineering Literacy Assessment.

As Table 2 demonstrates, an independent t-test was used to determine significance of average scale score differences based on teacher percentage of participation in professional development in technology or technology literacy. The t-test results determined there is no significant difference.

Research Question #2: How often do teachers in this school teach jointly as a team in the same class?

The 2018 NAEP eighth grade information and communication technology literacy average scale scores and standard deviations were analyzed based on the variable of the frequency of teachers teaching jointly as a team within the same class.

Table 3. Average scale scores and standard deviations for grade 8 technology and engineering literacy information and communication technology scale, by teachers teach jointly as team in same class [C102301] and jurisdiction: 2018

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Year	Jurisdiction	Teachers teach jointly as team in same class	Average scale score	Standard deviation
2018	National public	Never	148	36
		Once/twice a year	155	37
		Once/twice a month	151	36
		Once/twice a week	149	38
		Every day or almost	152	39
		Several times a day	152	38

Note: Some apparent differences between estimates may not be statistically significant.

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2018 Technology and Engineering Literacy Assessment.

The average scale scores range from 148, sd=36 for teachers that never teach jointly to 155, sd=37 for teachers that teach jointly once/twice a year. The next highest scores are 152 for both teachers that teach jointly every day or almost (sd=39), and several times a day (sd=38).

Table 4. Difference in average scale scores between variables, for teachers teach jointly as team in same class [C102301] National public, 2018

	Never (148)	Once/twice a year (155)	Once/twice a month (151)	Once/twice a week (149)	Every day or almost (152)	Several times a day (152)
Never (148)						
Once/twice a year (155)	x Diff = 7 P-value = 0.0048 Family size = 15					
Once/twice a month (151)	x Diff = 3 P-value = 0.2561 Family size = 15	x Diff = -4 P-value = 0.2170 Family size = 15				

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Once/twice a week (149)	x Diff = 1 P-value = 0.7264 Family size = 15	x Diff = -6 P-value = 0.1310 Family size = 15	x Diff = -2 P-value = 0.6207 Family size = 15			
Every day or almost (152)	x Diff = 4 P-value = 0.0857 Family size = 15	x Diff = -3 P-value = 0.1606 Family size = 15	x Diff = 0 P-value = 0.8670 Family size = 15	x Diff = 3 P-value = 0.4913 Family size = 15		
Several times a day (152)	x Diff = 4 P-value = 0.0843 Family size = 15	x Diff = -3 P-value = 0.2129 Family size = 15	x Diff = 1 P-value = 0.8098 Family size = 15	x Diff = 3 P-value = 0.4616 Family size = 15	x Diff = 0 P-value = 0.9167 Family size = 15	

LEGEND:	
<	Significantly lower.
>	Significantly higher.
x	No significant difference.

Note: Within jurisdiction comparisons on any given year are dependent with an alpha level of 0.05.

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2018 Technology and Engineering Literacy Assessment.

As Table 4 demonstrates, an independent t-test was used to determine significance of average scale score differences based on the frequency of teachers teaching jointly as a team within the same class. The t-test results determined there is no significant difference.

Research Question #3: How often do teachers in this school observe other teachers' classes and provide feedback?

The 2018 NAEP eighth grade information and communication technology literacy average scale scores and standard deviations were analyzed based on the variable of the frequency of teachers observing other teachers and providing feedback.

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Table 5. Average scale scores and standard deviations for grade 8 technology and engineering literacy information and communication technology scale, by teachers observe other teachers and provide feedback [C102302] and jurisdiction: 2018

Year	Jurisdiction	Teachers observe other teachers and provide feedback	Average scale score	tandard deviatio
2018	National public	Never	151	36
		Once or twice a year	153	37
		Once/twice a month	150	37
		Once/twice a week	148	40
		Every day or almost	146	36
		Several times a day	‡	‡

‡ Reporting standards not met.

Note: Some apparent differences between estimates may not be statistically significant.

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2018 Technology and Engineering Literacy Assessment.

The Table 5 results show the average scale scores range from 146, sd=36 for teachers that observe other teachers and provide feedback every day or almost to 153, sd=37 for teachers that observe other teachers and provide feedback once or twice a year.

Table 6. Difference in average scale scores between variables, for teachers observe other teachers and provide feedback [C102302] National public, 2018

	Never (151)	Once or twice a year (153)	Once/twice a month (150)	Once/twice a week (148)	Every day or almost (146)	Several times a day
Never (151)						

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Once or twice a year (153)	x Diff = 2 P-value = 0.3953 Family size = 10					
Once/twice a month (150)	x Diff = -1 P-value = 0.7011 Family size = 10	x Diff = -3 P-value = 0.1126 Family size = 10				
Once/twice a week (148)	x Diff = -2 P-value = 0.5930 Family size = 10	x Diff = -4 P-value = 0.2527 Family size = 10	x Diff = -1 P-value = 0.7630 Family size = 10			
Every day or almost (146)	x Diff = -5 P-value = 0.5042 Family size = 10	x Diff = -7 P-value = 0.3265 Family size = 10	x Diff = -4 P-value = 0.5957 Family size = 10	x Diff = -3 P-value = 0.7398 Family size = 10		
Several times a day	‡	‡	‡	‡	‡	

LEGEND:	
<	Significantly lower.
>	Significantly higher.
x	No significant difference.
‡	A significance test could not be performed because reporting standards were not met, or appropriate standard errors could not be calculated for one or more estimates in the test.

Note: Within jurisdiction comparisons on any given year are dependent with an alpha level of 0.05.

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2018 Technology and Engineering Literacy Assessment.

As Table 6 demonstrates, an independent t-test was used to determine the significance of average scale score differences based on the frequency of teachers observing other teachers and providing feedback. The t-test results determined there is no significant difference.

4.0 DISCUSSION

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The purpose of this research study was to explore the impact of teacher technology literacy professional development participation on the 2018 NAEP eighth grade information and communication technology literacy scale scores. Specifically, this research focused on the impacts of teacher participation in technology or technological literacy professional development, the frequency of team teaching, and the frequency of teacher observation and feedback. This study did not find that these professional development variables had any significant impact on student achievement as measured by the information and communication technology student scale scores. This section further describes these results in the context of previous research.

Research Question #1: In the past two years, what percentage of teachers in your school has participated in professional development in content, curriculum, or pedagogy related to technology or technological literacy?

As demonstrated in Table 1, the eighth grade technology and engineering literacy and information and communication technology average scale scores had an overall positive trend based on the teacher percentage in professional development in technology or technological literacy, in that as the participation percentage increases, the average scale score also increases. However, the t-test results indicated there is no significant difference present in these findings, therefore the results conclude there is no impact of teacher professional development on student achievement based on the NAEP data.

While there is previous research exploring various types of professional development and direct impact on student achievement levels, research is limited in regard to teacher professional development impacts on student technology literacy achievement. However, the existing research does help to inform the results found within the current study.

Shaha and Ellsworth (2013) conducted a study focused on the impact of on demand professional development opportunities on student math and reading achievement, in which the findings demonstrated that the more frequent and engaging the professional development is, the greater the impact on student achievement in these subject areas. Although the current study focused on technology and engineering literacy student achievement, it would be expected to find similar results. However, the current study conflicts with these findings in that there is no significant impact of the percentage of teacher professional development on student achievement scores.

Patton et al. (2015) completed a thorough examination of current literature related to teacher professional development and found that while research has supported the notion that student achievement outcomes are the most important result of teacher professional development, it is often not based on this data. Instead, professional development is based on innovative teaching practices or other research. Additionally, it was found that the amount of professional development teachers participate in is not as important as the quality and process of the professional development experience, for example how the professional development learning is reinforced and practiced once the experience has ended (Patton et al., 2015). With this research in mind, when evaluating the impact of teacher professional development on student achievement, it is also important to understand the type of professional development that is being utilized as all experiences are not created or extended equally. Therefore, this research

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supports the findings of this study in that the data utilized represents various forms of professional development, which is most often not developed based on the link to student achievement outcomes.

Research Question #2: How often do teachers in this school teach jointly as a team in the same class?

When reviewing the NAEP data, Table 3 demonstrates that the eighth grade technology and engineering literacy and information and communication technology average scale score is lower for teachers that never team teach when compared to all other frequencies of team teaching, from once or twice a year through several times a day. However, the t-test determined that there is no significant impact on the frequency of team teaching on student achievement scores.

The results of these findings are similarly represented by another research study in which the achievement scores of graduate students in research and statistics courses were measured to compare a course taught in a traditional, single teacher format to a separate course taught in a team-teaching format (Carpenter et al., 2007). While there was no significant difference in achievement found between the two groups based on the specific achievement test, the overall course grades were higher for the team-teaching group when compared to the single teacher led group, which the study found indicative of an overall positive impact. These results align with the current study, which demonstrates no significant difference in student achievement based on the frequency of team-teaching, however all frequency levels of team-teaching (ranging from once or twice a year to several times a day) had higher average scale scores than the teachers that never team-teach.

Additionally, research on team-teaching experiences highlight various positive aspects of this format, even beyond that of student learning outcomes. For example, Hurd and Weilbacher (2017) demonstrated that team-teaching is beneficial for middle school students, which is a similar grade level to the current study, in that it exposed learners to different teaching styles, increased engagement, and also allowed more opportunities for small group work and individualized instruction. Therefore, while the results of this study, in addition to identified research, found that team-teaching may not have a direct influence on learner achievement scores, there are other identified benefits for learners that make this format worthwhile to incorporate as a professional development strategy. These benefits include a long term positive impact demonstrated by course grades and the additional student support of having two teachers available in the classroom.

Research Question #3: How often do teachers in this school observe other teachers' classes and provide feedback?

When reviewing the eighth grade information and communication technology literacy average scale scores based on the frequency of teachers observing other teachers and providing feedback, Table 5 demonstrates that there appears to be a negative trend, in that as the frequency of teacher observation increases, the average scale score decreases. However, an independent t-test determined that teacher observation has no significant impact on the average scale score.

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The results of the current study are supported by previous research by Martinez and Schaaf (2016) which evaluated the teacher observation process for evaluation and professional development of the three largest US schools districts. The study found that teacher observation for assessment in professional development does not improve teacher effectiveness and does not further improve student outcomes. However, research by Garrett and Stenberg (2015) found that using teacher observation as an evaluation practice, measured by the Framework for teaching instrument, is linked to student achievement in which higher levels of teacher performance in observation correlates to higher levels of student achievement.

Considering these two studies and the current research, it is apparent that the practice of teacher observation and feedback for professional development may not directly impact student achievement, however teacher observation can still be a helpful professional development opportunity through the sharing of teaching strategies and practices, and promotion of teacher communication and team engagement, allowing for opportunities for consultation which are especially helpful for new teachers (Dos Santos, 2020). Observation can also be used to determine teacher effectiveness which is also linked to student achievement (Garrett & Stenberg, 2015). Information gathered through teacher observation can further be used to identify additional teacher professional development needs and opportunities for improved teacher learning experiences.

5.0 CONCLUSIONS AND IMPLICATIONS

Professional development is an important component of continued teacher training and is attributed to effective teaching and student learning. This study explored the impact of teacher professional development on the 2018 NAEP eighth grade information and communication technology scale scores, specifically in terms of frequency of participation in professional development, team-teaching, and observation, for which prior research is limited. When compared to research findings regarding professional development in general, findings aligned with some research studies and conflicted with others. This section will provide conclusions and implications from this study and discuss limitations and recommendations for future research.

5.1 Conclusions

The findings of this study indicate that participation in teacher professional development in general does not have an impact on student achievement as measured by the TEL and ICT scale scores presented. However, based on previous research in the context of this study's findings, professional development can have a positive impact on student achievement if it is provided both frequently and in an engaging manner (Shaha & Ellsworth, 2013). If teachers are able to participate frequently in these types of engaging professional development opportunities and are provided the time and resources to build upon that learning, then they may be able to have a positive impact on student learning outcomes as well.

Team-teaching has been found to be a beneficial professional development practice, not only for students in the classroom, but also for the experience it provides the teachers. The findings of this study, and previous research studies, indicate that team-teaching does not have an impact on student achievement as measured by the presented scale. However, students have reported other positive benefits of participating in a team-teaching format including increased

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engagement and additional student support (Hurd & Weilbacher, 2017). Therefore, team-teaching as a professional development strategy has various benefits for teachers and students alike, and should be incorporated into teacher professional development plans to establish new relationships and expand their content and teaching strategy knowledge.

Teacher observation has been found to be a helpful tool in teacher assessment to determine effectiveness and ability to impact student achievement, but observation as a professional development tool has not been shown to directly improve student achievement through previous research or the current study's findings (Garrett & Stenberg, 2015). Using observation and feedback for professional development may still be a helpful approach, especially for new teachers, as it provides an opportunity for teacher consultation, team building, and learning new strategies (Dos Santos, 2020). Additionally, teacher observation provides an opportunity to identify teacher strengths and weaknesses to better understand learning needs and further professional development opportunities that may be needed.

5.2 Implications

Professional development is a common strategy utilized to improve teacher effectiveness at all education levels and is often a requirement of licensing and certification for teaching employment. The findings from this study, within the context of previous research, has brought forward the importance of professional development beyond the frequency of teacher participation, in which frequency alone does not have an impact on student achievement for eighth grade TEL and ICT scale scores. There are various other aspects of professional development to consider when attempting to impact student achievement including the quality, framework for development, teacher time and resources, and the inclusion of varying types of professional development. Student achievement has been impacted by professional development when the experience is meaningful to the learner and engaging, and when teachers are provided the time and resources to review, plan and apply the learning between professional development learning experiences. Additionally, when professional development is based on research that is directly linked with positive impacts on student achievement. School administrators can use these findings to better inform the types of professional development opportunities provided to teachers, as well as provide support to teachers in terms of time and resources. Teachers should be provided with frequent opportunities for professional development, and the flexibility to select experiences that are most relevant to their interests and teaching content for the most meaningful and engaging experiences. Additionally, opportunities for team-teaching and observation should be provided to allow consultation and relationship building opportunities, but in addition to other professional development experiences as previously discussed. Lastly, teacher's shouldselect professional development opportunities based on research that directly connects to student learning and achievement.

5.3 Limitations

While this study provides insight into professional development impacts on student learning, there are identified limitations. The present research was based on secondary data and has inherited all potential validity problems when the data was collected. The variables were pre-decided and some of the correlation analyses may appear non-natural and should not be interpreted as a cause and effect relationship. The analysis methods were limited and are only

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based on the models in the NAEP Explorer. Due to confidentiality, the NAEP does not provide the exact sample size and it usually ranges from 10,000 to 20,000 students (NCES, 2018). This will hinder the validity of the research findings.

5.4 Recommendations for Future Research

Findings from this study both align and conflict with previous research studies which validate the need for further research to be conducted, especially focused on the impact of teacher professional development on TEL and ICT student achievement. While some research has found connections between student achievement and professional development, additional research on what type of professional development is most impactful for TEL and ICT student learning is needed. This study focused on both team-teaching and peer observation as professional development strategies, for which the findings did not show an impact on student achievement. Due to the limited amount of previous research on these forms of professional development, further research is recommended specifically to the impact on student achievement. Lastly, research has supported that frequent and engaging professional development has been connected with student achievement, however teachers may perceive engaging experiences differently based on content and education level. It would be helpful to further explore how middle level TEL and ICT teachers perceive professional development experiences in terms of engagement and relevance to their learning, and perceived impact on student learning.

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