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High School Mathematics Teachers' Use of Online Formative Assessment to Inform Instruction at a Northeast Regional High School District

Kelly Marie Slingerland
Walden University

Walden University

College of Education

This is to certify that the doctoral study by

Kelly Slingerland

has been found to be complete and satisfactory in all respects,
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Review Committee
Dr. Deborah Focarile, Committee Chairperson, Education Faculty
Dr. Tiffany Hamlett, Committee Member, Education Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
2024

Abstract

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by

Kelly Slingerland

MA, Jersey City State University, 2017

MA, Georgian Court University, 2018

BA, Georgian Court University, 2004

Project Study Submitted in Partial Fulfillment

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Doctor of Education

Curriculum, Instruction, and Assessment

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Abstract

The problem addressed through this study was the inconsistent implementation of online formative assessment to inform instruction by high school mathematics teachers in a Northeast Regional High School District (NRHSD). The purpose of this basic qualitative study was to investigate how high school mathematics teachers in a NRHSD use online formative assessment to inform instruction. Identification of successful online formative assessment can be used to inform the training, resources, and supports teachers need to promote student achievement. The technology acceptance model (TAM) was used as the conceptual framework to ground the project study. Interviews with 12 high school mathematics teachers were conducted to gather descriptive data on how teachers use online formative assessment to inform instruction. The data from the interviews were used to answer two research questions: "What are teachers' perspectives on ease of use, usefulness, and attitudes towards online formative assessment to inform high school mathematics instruction", and "What are high school mathematics teachers' recommendations regarding the training, resources, and support they need to consistently use formative assessment to inform their instruction." The results of the study indicated that using online formative assessment data to inform instruction could promote positive social change in high school mathematics classes by increasing student engagement and academic achievement. Data collected from interviews indicated that teachers need to focus on one program with professional development targeted to user level. Furthermore, putting mathematics teachers' perceptions and use of technology data into action could lead to graduating students with the skills needed to positively contribute to society.

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Dedication

I would like to dedicate this doctoral study to the memory of family members whose legacy gave me the determination to complete this degree. First, I want to thank my cousin, Jeff Maynard. Jeff never gave up on any dreams. His inspiring runs and battles with MS were always an inspiration. Second, I want to thank my aunt, Marylou From Smerecznick. She taught me that all children can learn. All children deserve patience, compassion, and love. Next, I want to thank my grandmother, Eva Smerecznick. She taught me the worth of a woman's work ethic and that unconditional love exists. And I want to thank my father, Ellis D. Lawrence. This man taught me that you can overcome anything, the past does not determine your future. The memory of these people is the legacy I leave in this work. I could not have done this without them in my head and heart.

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Section 1: The Problem

The Local Problem

The problem that was addressed through this study is the inconsistent implementation of online formative assessment to inform instruction by high school mathematics teachers in a Northeast regional high school district (NRHSD). Murphy et al. (2020) posited that the use of technology in mathematics classrooms could provide students with feedback and guide their learning. Veugen et al. (2021) noted that even though online formative assessment has increased as classroom practice, it is still not a common practice in high school education. Not consistently using online formative assessment is a problem as students who grow up with technology are comfortable with online learning platforms and these online assessments may more accurately reflect student learning (Bennet, 2012; Murphy et al., 2020; Scherer et al., 2019). The use of online formative assessment provides a venue to obtain immediate data on individual students. The ability for teachers to use this data to immediately adjust instruction and learning can increase student academic achievement (Lyon et al., 2019). Consistent implementation of online formative assessment to inform instruction may improve student achievement in mathematics (Remmi & Hashim, 2021).

In this basic qualitative study, I examined the inconsistent implementation of online formative assessment to inform instruction by high school mathematics teachers in a NRHSD. Within the NRHSD, all mathematics classrooms should be consistently using online formative assessment data to inform instruction. All mathematics teachers within the district have been given online formative assessment resources (Academic supervisor,

personal communication, September 20, 2021). The district pays for LinkIt, Edulastic, and Delta Math. LinkIt is only used as a summative assessment, yet there are many online formative assessment platforms used in the district. The degree to which usage is consistent when informing instruction varies among teachers and high schools but remains necessary in all districts.

The school district consists of three high schools, and each high school has a mathematics supervisor. During weekly reviews of lesson plans, mathematics supervisors and the district curriculum director identified that online formative assessment strategies were not consistently present in lesson plans and teachers were using online formative assessment differently or not at all (Director of curriculum, personal communication, September 15, 2021). Specifically, the high school mathematics lesson plans should include online formative assessment tools such as Edulastic, Google Forms, Desmos, and any other online tool that will give teachers and students immediate feedback about student performance with learning class content.

In addition, education technology usage increased significantly since March of 2020 when instruction at the NRHSD became remote due to the COVID-19 pandemic (Academic supervisor, personal communication, September 20, 2021). Yet, mathematics teachers in a NRHSD inconsistently use online formative assessment data to inform instruction. Mathematics teachers in the NRHSD are expected to use assessment data to adapt instruction and improve student learning and using formative assessment data to inform instruction is essential for student achievement (see Veugen et al., 2021). To accurately assess achievement, the administrators in the NRHSD determined a need for

the consistent use of online formative assessment to inform instruction (Director of curriculum, personal communication, September 15, 2021).

Teachers may use online formative assessment data to inform instruction based on an online assessment tool's perceived usefulness (PU) and perceived ease of use (PEOU). Lyon et al. (2019) found that a teacher's knowledge of using formative assessment data is often a barrier to using formative assessment to inform instruction. Mathematics teachers in the NRHSD have access to online formative assessment tools but may not know how to use the data obtained from the online resources to inform their instruction. Davis (1989) theorized that PU and PEOU use with technology will determine an educator's intention to use a new technology in the classroom, which he called the technology acceptance model (TAM).

The TAM can be used to identify barriers such as fear of using technology or trying something new that may limit people from using online tools developed and implemented by others (King & He, 2006). Using the TAM, mathematics teachers in the NRHSD view the PU and PEOU of online formative assessment. The TAM model proposed by Davis (1989) suggested that three factors can explain user motivation. The first is the PU of technology, the second is the PEOU of technology, and the third is a user's attitude toward the use of that technology. Using all three factors, the PU of technology, the PEOU of technology, and a user's attitude toward the use of that technology, was explored to understand how teachers perceive the usefulness and ease of using the data collected from online formative assessment. The TAM model was used to

study the consistency of online formative assessment used to inform instruction among mathematics teachers in a NRHSD.

Rationale

Computers, tablets, and cell phones have changed daily interaction with technology. Borba (2021) claimed that technology accessibility has changed the way students experience and learn mathematics. Teachers' use of online formative assessment can provide real-time data on student progress and is needed more now given the increase in the use of online assessment technology due to COVID-19 pandemic restrictions (Borba, 2021; Mailizar et al., 2020). Formative assessment is a practice that educators use in the classroom daily (Murphy et al., 2020), and enables educators to monitor student progress, give immediate and ongoing feedback to learners, and inform instructional practice to improve student achievement (The National Council of Mathematics Teachers, 2015). The problem I explored in this study was the inconsistent implementation of online formative assessment to inform instruction by high school mathematics teachers in the NRHSD. Consistent adaptation to this available technology and real-time information must occur in the mathematics classroom.

Online formative assessment tools to inform instruction must be implemented at the district level to improve student achievement in mathematics. The National Council of Mathematics Teachers' (2015) position on the strategic use of technology in the mathematics classroom is that the strategic use of technology for teaching takes place best through the use of digital and physical tools created by students and teachers in thoughtfully designed ways. The strategies to consistently use these tools must align with

the research related to teaching and learning to give students the greatest opportunity to advance academically.

The purpose of this basic qualitative study was to investigate how high school mathematics teachers in a NRHSD use online formative assessment to inform instruction. Identification of successful online formative assessment can be used to inform the training and resources as well as the supports teachers need to promote student achievement. The TAM, proposed by Davis (1989), stated that PU and PEOU can determine the acceptance and use of technology. Therefore, a study regarding how teachers at a NRHSD PU and PEOU of online formative assessment is essential to understanding why there is inconsistency in the use of online formative assessment to inform instruction. The success of online formative assessment to increase student engagement and academic achievement depends on how teachers perceive and implement formative assessment activities in their classrooms (Yan et al., 2021).

Definition of Terms

Digital natives: Digital natives are students who are highly technologically literate. They are students that are growing up with new technologies available in their everyday lives. Students who grow up with technology are comfortable with and fluent with technology (Bennet, 2012).

Educational technology: Educational technology is the study of facilitating learning through the use of technological resources and processes. Technology is an abstract concept or a field of practice. The role of technology in education is to provide problem space and exploration (Januszewski & Molenda, 2013).

Formative assessment (Assessment for Learning): Formative assessment is the feedback used as a classroom teaching pedagogy. Teachers make regular, immediate, and interactive assessment of students' learning (See et al., 2021). Formative assessment emphasizes continuous monitoring and collecting evidence of student progressions during the learning process (Yan et al., 2021). Assessment is formative when information is gathered about students' learning processes to enhance decision making about follow-up actions and adjust teaching and learning to meet student needs.

Informed instruction: Informed instruction is the use of data from formative assessment to enhance decision making in the classroom. Using formative assessment data leads to follow-up actions in the classroom to adjust teaching and learning to meet student needs (See et al., 2021).

Perceived ease-of-use (PEOU): PEOU is the degree to which a person believes using a particular technology would be free from effort. A person will use technology that is easy to use, but if the technology is not easy to use, a person will not use the technology (Davis, 1989).

Perceived usefulness (PU): Perceived usefulness is the degree to which a person believes using a particular technology would enhance their job performance. PU is the extent to which a particular technology is useful for what a person wants to accomplish (Davis, 1989).

Technology Acceptance Model (TAM): The TAM models how users come to accept and use a technology (Davis, 1989). The TAM states that a users' PEOU and PU of a technology will determine the acceptance and use of a technology.

Significance of the Study

In this project study, I addressed the local problem of the inconsistent implementation of online formative assessment to inform instruction by high school mathematics teachers in a NRHSD. This study is significant because it addresses an issue that has not been studied in a local setting (Director of curriculum, personal communication, September 15, 2021). The study site is invested in purchasing and using online formative assessment resources to support mathematics instruction by using some of the school's financial assistance derived from Title 1 funding (Board of directors, personal communication, August 21, 2018). Title 1 is a federally funded program where monies are provided to public K-12 schools to meet the educational needs of underserved students to obtain a fair and equal opportunity to a high-quality education (Webster, 2019). Ongoing Title 1 funding is contingent on the successful adoption of online formative assessment and other tools that promote student achievement. Exploration of mathematics teachers 'PU and PEOU of online formative assessment technology can support student achievement through Title 1 funding and inform instruction.

I used the TAM to investigate PU and PEOU of online formative assessment. This study's findings may provide insight into factors contributing to the inconsistent use of online formative assessment data to inform mathematics instruction for greater student achievement. Studying teachers' PU and PEOU of online formative assessment could affect a positive social change by providing support for teachers to use these tools to increase student engagement and academic achievement. Furthermore, exploring

mathematics teachers' perceptions and use of technology could lead to graduating students with the skills needed to positively contribute to society.

Research Questions

The following research questions were used to guide the study.

RQ1: What are teachers' perspectives on ease of use, usefulness, and attitudes towards online formative assessment to inform high school mathematics instruction?

RQ2: What are high school mathematics teachers' recommendations regarding the training, resources, and support they need to consistently use formative assessment to inform their instruction?

Review of the Literature

The literature was collected from the Walden University library databases. These included Education Research Complete, ERIC, and ProQuest Central. In addition, a comprehensive search of Google scholar was completed to review current and relevant research. The search terms used in the literature search included *formative assessment, high school mathematics, mathematics formative assessment, online formative assessment, online learning, teachers' perceptions of technology,* and the *technology acceptance model.*

The literature review findings support the idea that teachers use technology based on the PU and PEOU of that technology. Decisions in education should be made based on evidence. In the classroom, decisions about instruction should be made based on evidence from formative assessment. There are technologies available that support using formative assessment to inform instruction. Teachers will use these technologies based on their PU

and PEOU. The literature review findings support the need to study how teachers use online formative assessment to inform instruction. Based on the purpose of the study, the literature is organized into the following categories: (a) conceptual framework, (b) formative assessment, (c) mathematics and technology, and (d) online formative assessment.

Conceptual Framework

Technology Acceptance Model

The TAM by Davis (1989) provided the conceptual framework for the study. The TAM is a model that uses PU and PEOU as factors determining how and when a user will utilize a technology. These two criteria are studied to determine what causes a user to accept or reject a technology. PU was defined by Davis (1989) as the degree to which a person believes that technology will increase job performance. PEOU was defined by Davis as the degree to which a person believes that using the technology will be free of effort. Examining these two factors can predict whether a technology will be used in the classroom by teachers.

Davis's originally theorized that users' attitudes toward a technology would determine the acceptance or rejection of the model. Marangunic and Granic (2015) stated that "[the] TAM has evolved to become a key model in understanding predictors of human behavior toward potential acceptance or rejection of a technology" (p. 81). PU and PEOU can be used to determine the attitude a mathematics teacher will have toward a technology. Marangunic and Granic presented a literature review of the TAM. The authors used 85 scientific publications. Marangunic and Granic concluded that "the

strength of the model is confirmed by numerous studies emphasizing its broad applicability to various technologies" (p. 92). The authors suggested that further investigation is necessary to understand how a user determines the PU and PEOU of a technology.

The framework for the study was also rooted in self-efficacy. According to Bandura (1982), self-efficacy is a person's belief in their ability to succeed in a particular situation. Using Bandura's explanation, self-efficacy can be applied to the TAM. A user will not accept a technology if they do not believe in their ability to understand and use the technology. The use of technology in the classroom will be determined by teachers' PU, PEOU, and individual teachers' self-efficacy.

In a study conducted by Xue et al. (2022), the authors stated that teachers' willingness to try and use technology in the classroom is determined by the teachers' PU, PEOU, and self-efficacy toward the technology. The authors found that the self-efficacy of teachers determined their acceptance of new teaching methods, and that teachers were more likely to accept and use technology with the inclusion of technical support and training.

Almari et al. (2019) found that deciding to adopt new technology and maintain use depends on the PU and PEOU of the technology. The authors conducted a study about students' experience with e-learning. The authors concluded a positive relationship between PU and the intention to use the technology. Also, there was a positive relationship between PEOU and the intention to use technology. The study by Almari et

al. supports the need to investigate further the PU and PEOU of technology for different user groups.

A positive attitude toward technology can affect users' PU and PEOU of a technology. Pittalis (2021) conducted a study investigating secondary mathematics teachers' intention to use geometry software. The TAM was used and extended to study the use of geometry software in mathematics classrooms. The author specifically looked at how PU and PEOU influence the intention to use the technology. The model was extended to include age, computer self-efficacy and anxiety, and personal innovation. The study concluded that PU, PEOU, and attitudes toward using the geometry program were key determinants concerning how teachers used the program (Pittalis, 2021).

Teachers determine the use of technology for formative assessment in the classroom. According to Mavroudi et al. (2021), teachers are the main factor in how and when technology is used for education. The authors also shared that online formative assessment tools can be used to enhance student learning. Scherer et al. (2019) reported that teachers are encouraged to include technology in their teaching, or as a formative assessment to inform learning. New technologies can be used to access learning and inform further instruction. The use of online formative assessment to inform instruction is further supported by Tang and Bao (2021), who investigated teachers' use of open educational resources. Tang and Bao noted that student motivation and achievement are improved with access to open educational resources compared to traditional textbooks. The authors assessed data on K-12 teachers to determine how open

educational resources were used in classrooms. They found that personal barriers, including PU and PEOU, prevented teachers from accepting and using open educational resources. It is necessary to study teachers' PU and PEOU of a technology to determine how it can be used to inform instruction.

Formative Assessment

Formative assessment is essential for education. Scherer et al. (2019) explored this topic in conjunction with the TAM, which can be used to assess the PU and PEOU of instruction with technology. Educators are encouraged, or in some cases required, to use technology to facilitate instruction or administer formative assessment (Scherer et al., 2019). The authors conducted a meta-analysis to test the fit of the TAM for explaining teachers' instructional choices and practices. The authors confirmed that the TAM, and its associated PU and PEOU, are successful predictors of teachers' acceptance of technology and technology use. The implications of the Scherer et al. study suggested that specific research on how teachers use technology for formative assessment can be grounded in the TAM.

The degree to which teachers use technology for formative assessment remains in question. How technology is integrated into the classroom and what types of formative assessment are being administered through technology are not fully understood (Scherer et al., 2019). According to Hardy (2022), there is a consensus that decisions made in education regarding instruction should be informed by evidence. The study by Hardy consisted of data from interviews with teachers focusing on the teachers' use of data and the pressure imposed on the teachers to collect and use data. The author found that using

data gave teachers an underlying pressure to perform (Hardy, 2022). The teachers felt anxiety and uneasiness rather comfortable than having the data as a tool to improve instruction. The reported anxiety and uneasiness that teachers felt in the district supports the need to investigate teachers' PU and PEOU of online formative assessment.

There is a need to study how technology is perceived to consistently administer formative assessment. According to Lyon et al. (2019), the aim of formative assessment is to collect the data needed to adjust to the next step in instruction. The authors performed a case study to observe factors that support or hinder the implementation of formative assessment. Teachers use formative assessment to collect information. This information can be used to modify teaching and learning activities to address learning gaps (Yan & Pastore, 2022). The authors discussed the need for teachers to be trained to develop formative assessment literacy. Yan and Pastore's (2022) study developed a scale to determine teachers' level of formative assessment practice. The authors also addressed the need to study how teachers currently use formative assessment data to inform instruction. By studying how teachers use formative assessment in the classroom, programs for professional training can be produced (Yan & Pastore, 2022).

Informed instruction using formative assessment data improves student learning motivation (Lyon et al., 2019). Yan et al. (2022) stated that some educators use formative assessment to gather evidence about student learning; and therefore, should be used to make decisions about future instruction. The authors found that self-efficacy was the biggest predictor of teachers' formative assessment practices. A teacher's self-efficacy about technology for formative assessment suggests that mastery would be critical for the

acceptance and informed use of formative assessment online (Yan et al., 2022). According to Lyon et al. (2019), once data from the formative assessment is obtained, the data requires interpretation before taking action can occur. Training teachers to use formative assessment to inform instruction is critical.

Mathematics and Technology

The global COVID-19 pandemic required that teachers and students shift to online education (Borba, 2021). This shift made technology in the mathematics classroom essential. To many teachers, this shift to online learning in mathematics presented a major barrier (Mailizar et al., 2020). Success is hindered if a mathematics teacher has low self-efficacy with technology and online learning. Mailizar et al. (2020) stated that a lack of confidence and understanding are major barriers for math teachers with online learning. The authors used an online questionnaire to gather information about secondary school mathematics teachers and online learning during the COVID-19 pandemic. Mathematics teachers' lack of knowledge and experience with online learning made teaching difficult. Mailizar et al. (2020) concluded that teaching experience did not necessarily affect the use of online learning tools positively. These findings suggest a need to study how to support veteran teachers with online learning tools implementation further. According to See et al. (2021), for teachers to shift their mindsets they would need to see the usefulness and the benefits of the technology being used. The authors reviewed empirical research on the use of technology in formative assessment, and the results demonstrated that online formative assessment could enhance mathematics learning. They also noted that the research on this is limited and of poor

quality. Therefore, implementing online formative assessment requires further study concerning the online self-efficacy of teachers and learners.

Using technology in mathematics class has the potential to enhance learning. According to Thurm and Barzel (2020), technology is underused by teachers because teaching with technology is a daunting task. Thurm and Barzel investigated a professional development program for teaching mathematics using technology and worked to promote teachers' specific competencies to integrate technology into their lessons. They found that teaching with technology requires that the teacher not only have mastery but also be able to guide students through the technology while helping students meet standards in mathematics. Teachers with positive beliefs about technology will use technology more (See et al., 2021). It is necessary to study teachers' beliefs about online formative assessment, and their PU and PEOU of technology, to determine how it may be used to inform instruction.

Online Formative Assessment

Teachers' perceptions will determine how formative assessment is used in the classroom. In the case of online formative assessment, teachers' PU and PEOU will determine the implementation and success of this type of formative assessment (Yan et al., 2021). According to Yan et al. (2021), the benefits of formative assessment are well documented, but there is no clear evidence that teachers consistently implement formative assessment effectively. Teachers' positive perceptions of the usefulness of formative assessment are positively related to teachers continuing to use formative assessment (Remmi & Hashim, 2021).

Teachers can use formative assessment data to promote student achievement in mathematics (Veugen et al., 2021). Formative assessment administered online with immediate feedback can increase student achievement (Murphy et al., 2020). Using online formative assessment, teachers can see where students are struggling in real-time. According to Murphy et al. (2020), real-time student performance data can be used to guide teachers in planning and adapting instruction. A key component to targeting students' misunderstandings is the immediate feedback provided by online formative assessment. This technology can assist teachers in using formative assessment data to inform instruction (Remmi & Hashim, 2021).

Teachers can use formative assessment to make consistent and immediate conclusions and decisions about student progress. According to See et al. (2021), formative assessment feedback should be immediate and specific to be effective. The authors found that real-time feedback, which adapts to student's individual needs, is the most efficient. Online formative assessment can provide this type of data and feedback. According to Thambusamy and Singh (2021), technology has the potential to transform learning for students, but only if it is a result of a change in educators' responses to that technology. The success of this type of formative assessment depends on how the data is being used to inform instruction.

Implications

Because of the increased use of remote or virtual instruction, online formative assessment has become an essential part of instruction (Murphy et al., 2020). Therefore, the problem that was addressed in this study concerned the inconsistent implementation

of online formative assessment to inform instruction by high school mathematics teachers in a NRHSD. The levels of PU, PEUO, and teachers' self-efficacy using online formative assessment were explored. The administrators in the district are concerned that the use of online formative assessment data to inform instruction is used inconsistently (Director of curriculum, personal communication, September 15, 2021). Based on anticipated findings from interviews, a project to deliver support to teachers was developed. By exploring the inconsistency related to how teachers use online formative assessment to inform mathematics instruction, I determined specific online assessment resources that teachers may need to inform instruction.

As online formative assessment can give teachers and students feedback in real time. Effective formative assessment typically includes immediate and specific feedback related to the student's needs (See et al., 2021). Immediate and specific feedback is the type of data that mathematics teachers should use to inform further instruction. Using immediate and specific data to inform instruction produces a positive change in student achievement and may contribute to the social and academic knowledge base needed for teachers and student to excel in the 21st century. This study fills a gap in practice by exploring how high school mathematics teachers in a NRHSD use online formative assessment to inform mathematics instruction.

Summary

The purpose of this basic qualitative study was to investigate how high school mathematics teachers in a NRHSD use online formative assessment to inform instruction. Identifying successful online formative assessments can be used to inform the resources,

training, and support teachers need to facilitate student achievement. In Section 1, I examined a local problem in a high school district in the northeast. The problem that was addressed through this study was the inconsistent implementation of online formative assessment to inform instruction by high school mathematics teachers in a NRHSD. The TAM provided the conceptual framework to ground the project study. Interviews with high school mathematics teachers were conducted to gather descriptive data on how teachers use online formative assessment to inform instruction.

The literature review illustrated factors such as teachers' PU, PEUO, and self-efficacy using online formative assessment. The literature review highlighted the benefits of using online formative assessment to inform instruction as online formative assessment can provide immediate and specific feedback on individual learners' needs. The literature suggested that teachers use online formative assessment to inform instruction only if there is positive PU, PEUO, and self-efficacy of teachers.

In Section 2 of this study, I examine the methodology used to collect interview data from participants. I used a basic qualitative design to address the research questions in this study. A self-designed interview protocol based on components of the conceptual framework was developed to address the problem and research questions asked in this study. Section 3 of the study is focused on developing a professional development project for mathematics teachers in the NRHSD so that teachers may use online formative assessment effectively to inform instruction. The project was developed based on the findings from the data analysis. Section 4 prvoides the strengths and limitations of the study.

Section 2: The Methodology

Research Design and Approach

A basic qualitative study design was used to investigate how mathematics teachers in an NRHSD use online formative assessment data to inform instruction. This approach was used to understand teachers' PU, PEUO, and self-efficacy with online formative assessment. A qualitative research design emphasizes collecting data on naturally occurring phenomena (Babbie, 2017). The qualitative approach is useful in educational settings when the goal is to understand, describe, and discover meaning (Burkholder et al., 2019).

A qualitative study was appropriate for examining how high school mathematics teachers use online formative assessment data to inform instruction. The basic design provided an opportunity to gain perspectives from individuals on a specific phenomenon (Burkholder et al., 2019). Using a basic design revealed participants' experiences when using online formative assessment to inform instruction, and interviews with high school mathematics teachers were conducted to gather the relevant descriptive data. A self-designed interview protocol based on components of the conceptual framework was developed to address the problem and purpose of the study. Using an interview protocol allows researchers to gain insight into the individual experience of participants (Ravitch & Carl, 2016). The goal was to solicit approximately 10 to 15 study participants to reach data saturation, and 12 were used in the final study.

For this basic qualitative study, semistructured interview questions were used to gain data to answer the two following research questions:

RQ1: What are teachers' perspectives on the ease of use, usefulness, and attitudes toward online formative assessment to inform high school mathematics instruction?

RQ2: What are high school mathematics teacher recommendations regarding the training, resources, and support they need to consistently use formative assessment to inform their instruction?

Patton (2014) asserted that the goal of an interview is to understand what cannot be directly observed. Interviews, in a qualitative study, allow the researcher to understand another person's perspective (Patton, 2014). For this study, I interviewed 12 educators who were teaching mathematics within the NRHSD at the time of the study. The interview questions were created to collect information about how high school mathematics teachers in the NRHSD use, or have used, online formative assessment to inform instruction. The semistructured interview protocol guided and allowed flexibility when interviewing the study's participants.

The interviews were recorded with Zoom and transcribed using NVIVO, a computer program. With qualitative research needing the use of codes, categories, and themes to organize and analyze data, I ensured that the interviews were appropriately coded (see Ravitch & Carl, 2021). Codes can be short and basic descriptions, and the themes found through coding may be longer phrases or sentences. Basic codes and themes are then categorized (Babbie, 2008). These codes and themes were used to explore how mathematics teachers in an NRHSD informed instruction with the use of online formative assessment.

Participants

Sampling Procedures

Before recruiting potential study participants, permission was sought from the Board of Education representing the NRHSD. Permission was also sought from the Walden University Institutional Review Board to conduct the study (approval #09-11-23-0975012). The study sample included 12 high school mathematics teachers at an NRHSD. For a basic qualitative study, the sample selected should focus on answering the research questions in a study and include at least 10 participants to obtain the appropriate level of depth needed (Burkholder et al., 2019). Purposive, or purposeful sampling is appropriate in a qualitative study (Creswell & Poth, 2018). This type of sampling in a research study allows for the selection of the participants based on information gathering that directly relates to the research questions (Ravitch & Carl, 2021). Using purposeful sampling allowed for the selection of participants with experience who can contribute to the phenomenon being studied (Ravitch & Carl, 2021).

Criteria for Participants

Participants were selected from a pool of high school mathematics teachers from grade levels 9-12 in the study site. A sample of 12 participants was selected to provide in-depth data for the study. Participants were eligible to participate in the study if they met the criteria of being (a) a high school mathematics teacher at the study site, (b) available for a 60-minute interview, and (c) had at least 3 years of teaching experience in mathematics at the study site. The criteria of 3 years of experience at the study site helped answer the second research question, “What are high school mathematics teacher

recommendations regarding the training, resources, and support they need to consistently use formative assessment to inform their instruction?" Teachers who have been in the district for 3 years will have experience with online formative assessment platforms available to teachers in the district. Teachers with experience with the platforms will be able to make recommendations for support.

Gaining Access to Participants

Before collecting data from potential participants, Walden University's IRB permitted the project study to be conducted. To gain access to participants, administrators at the study site were contacted and a I held a meeting with the director of curriculum and the district superintendent. At this meeting, I requested, with the understanding that if approval from Walden's IRB were to be obtained, to be allowed to present the research information to the school board. After Walden's IRB reviewed the proposal, they granted permission for data to be collected from high school mathematics teachers.

After permission was granted to conduct interviews at the study site, I worked directly with the director of curriculum at the study site via email through my Walden University account to gain access to participants (see Appendix B). An email solicitation was sent to all high school mathematics teachers from the study site who qualified as participants in the study. The email provided information about the study, as directed by the IRB's formal review, and included an informed consent form specifying that the study was voluntary and that participants would have full confidentiality. As recommended by Burkholder et al. (2019), the email also included information about my role as the

researcher and the purpose of the study. Email was the primary method for arranging interview times.

At the time of the interview, I explained any potential risk factors, potential benefits, the right to withdraw at any time, and an explanation of the study procedures. This information was also included in the informed consent form (see Burkholder et al., 2019). The study participants took part in a 45–60-minute semistructured interview about the use of online formative assessment in planning instruction. Participants were interviewed online via Zoom and given a digital consent form to complete before the interview was conducted. They were asked to give consent, acknowledge that they understood the study's intent, and acknowledge that they wished to continue as participants.

Procedures for Ethical Protection of Participants

This educational research study included the use of human participants. I considered legal and ethical ramifications in conducting the research. A researcher's direct contact with participants may cause ethical issues; therefore, developing relationships with participants must be framed as ethical issues (Ravitch & Carl, 2021). Participants' interview responses may bring up or expose controversial or personal issues so the basic qualitative researcher must be prepared for and anticipate ethical issues and prevent harm to human subjects (Burkholder et al., 2019).

In a district with three high schools, I am a math supervisor for one of the high schools. I supervise approximately 10 to 11 math teachers. I work closely with the other two math supervisors from the other high schools, and we plan all professional

development together. We also work together on curriculum updates and purchasing resources for math teachers. These resources include online formative assessment tools. I do not personally know any of the math teachers who were interviewed as they were not under my direct supervision. Not knowing the participants used in this study helped me support the ethics of valid research throughout the entirety of the process. Participants were informed of all aspects of the research. Informed consent was a priority to ensure that participants had a choice in participating in interviews (see Burkholder et al., 2019). Confidentiality should be established and maintained throughout a research process (Burkholder et al., 2019). Therefore, confidentiality was established and maintained throughout the research process. Confidentiality was critical to protect participants ’privacy so they were identified using alphanumeric codes such as P1, P2, P3, and so on, rather than by using any identifiers. An explanation was given on how all data and digital files would be stored on an external hard drive with password protection. Participants were asked before the interview to give written consent and to also confirm their consent. Participants were provided a copy of the consent for their records. To ensure continued confidentiality, all documents will be destroyed by shredding and complete deletion of external hard drives within 5 years of completing the study.

Data Collection

With a tight focus on acquiring tangible instances of actual processes, highly structured interview-based procedures are typically used to collect qualitative data (Liu, 2016). To ensure that the perspectives on, and experiences with the topic reach saturation,

qualitative data researchers use data collection procedures such as semi- or fully structured interviews, surveys, and questionnaires (Liu, 2016). Researchers can ask a series of standard, preset, and prestructured questions during semistructured and fully structured interviews, as well as follow up with probing inquiries (Ravitch & Carl, 2021). However, participants in surveys are presented with a question and several prepared response alternatives to express their ideas (Liu, 2016). In each of these situations, researchers create questions based on the information they have already learned about the subject they are researching (Liu, 2016).

Instead of concentrating on learning about each participant's perspective on a particular activity, researchers focus on understanding how common infrastructures, procedures, and experiences are experienced. These perspectives on qualitative data researchers seek are typically those focused on subjective, material experiences of a common external activity (Kennedy, 2016). This means that qualitative data researchers gather wide, condensed interview samples from a variety of subjects (Kennedy, 2016). This is because surveys with a large sample size frequently represent a common material experience more broadly. In some cases, researchers will conduct in-depth qualitative interviews with a small number of knowledgeable participants to obtain incredibly specialized and comprehensive viewpoints on the issue they are studying to reach data saturation (Liu, 2016). As indicated by Ravitch and Carl (2021), the iterative process will produce deeper and richer data.

According to Yin (2018), numerous data sources, such as empirical observation, interview transcripts, and documentation, were valid in a qualitative setting. Yin also

pointed out that using all valid data sources is not a requirement for a study to be legitimate. An in-person interview can help people grasp a phenomenon more thoroughly (Merriam, 2014). Notably, Ravitch and Carl (2021) suggested a dialogic engagement, a systemic procedure for iterative dialogues. To collect data and acquire findings for this study, I used open-ended, semistructured interviews with math teachers from the sample school district. I conducted one interview each with 12 participants. An interview protocol (see Appendix D) based on the study topics was used to ask questions for each participant group. The goal of conducting interviews was to gain participants' personal experiences and obtain a full range of perspectives about how mathematics teachers in an NRHSD use online formative assessment data to inform instruction (see Ravitch & Carl, 2021). This included seeking their opinion on PU, PEOU, and attitudes toward online formative assessment to inform high school mathematics instruction and their recommendations regarding the training, resources, and support they need to consistently use formative assessment to inform their instruction.

Interviews were conducted and recorded online via Zoom using my personal computer. Participants were reminded that participation in the study was completely voluntary. In addition, participants were reminded of the purpose of the study and that they could stop the interview at any time or decline to answer any question at any time. Participants were informed that the interview was recorded and were asked to confirm their consent. Throughout the interview process, the participants were asked to confirm that the responses given in the interview were accurate. This process is described as member checking (Creswell & Poth, 2018).

Description and Justification of Data Collection Methods

Semistructured interviews were conducted with the participating NRHSD. The goal of conducting interviews is to gain participants' personal experiences and obtain a full range of perspectives about a particular phenomenon (Ravitch & Carl, 2021). Semistructured interviews do not have a goal of uniformity in questioning but rather ask customized or key questions and then follow-up questions based on participants' responses (Ravitch & Carl, 2021). These interviews were used to understand high school math teachers' perspectives on ease of use, usefulness, and attitudes toward online formative assessment to inform instruction at an NRHSD. Interview data was used to gain information on recommendations regarding training, resources, and support needed for high school math teachers to consistently use formative assessment data to inform instruction at an NRHSD. An interview protocol was established to help mitigate inherent researcher bias (See Appendix C). The protocol had the same questions planned for all participants. Some follow-up questions were used to prompt clarification or elaboration from participants.

Qualitative Data Collection Process

Participants scheduled a Zoom interview through email correspondence. At the beginning of the Zoom call, participants were informed that the call would be recorded and asked if they wished to continue. A consent form that had been sent to them through email was also reviewed, and the participants were then asked if they still wished to continue. The interviews were recorded and saved with password protection using NVivo, a computer program used for creating codes in qualitative research (see Kuckartz

& Rädiker, 2022). The interviews were used to capture the participant's perspectives that helped to address the research questions. The data collection instrument was a researcher-created semistructured interview that was guided by an interview protocol that was aligned with the interview and research questions (see Creswell & Poth, 2018). Participants were reminded that participation in the study was completely voluntary. In addition, participants were reminded of the purpose of the study and that they could stop the interview or decline to answer any question at any time. Participants were informed that the interview was being recorded and were asked to confirm their consent to being recorded. Throughout the interview process, the participants were asked to confirm that the responses given in the interview were accurate in a process described as member checking (see Creswell & Poth, 2018).

Data Collection Instruments

An interview protocol (Appendix C) and a list of semistructured interview questions (Appendix C) served as the study's instruments when I conducted one-on-one interviews with participants. I explained the purpose of the study to the participants before we began the interviews, reassuring them once more that any information they decide to provide will be kept private. In line with Marshall and Rossman (2016), I checked the interview instruments in Appendix C to ensure that the content validity, number of questions, language clarity, and time needed to perform the interviews were all suitable. I also created a thorough audit trail using Taguchi's (2018) suggestions to assess reliability. Researchers can use audit trails to explain why participants are chosen for the study, the purpose of the study, the data collection process, how the data are processed

after being collected, how the methodology for establishing the reliability of the data is used, and how the study's results are reported (Yin, 2018).

I held meetings through Zoom. The one-on-one interviews took place for around an hour, and I used two digital recorders—one for recording and one as a backup—and a notebook for information arrangement. To make sure that I understood and accurately relayed the participants' feedback, I used reflective listening and then sent participants a message with early findings. The interview protocol (Appendix C) was constructed using interview materials from the university library. Semistructured interview questions (Appendix C) were also created following the same standards. I made sure the interview questions and protocol were in sync. The study's research questions were covered using interview questions (Appendix C). I developed these inquiries to learn more about the viewpoints of math instructors and how mathematics teachers in an NRHSD use online formative assessment data to inform instruction.

Ravitch and Carl (2021) noted there are things to keep in mind when conducting interviews to make sure the data gathering tools are adequate. Relational, contextual, nonevaluative, person centered, temporal, partial, subjective, and nonneutral are a few of these. Accordingly, I followed Yin's (2018) advice and implemented a flexible data collection process. Since follow up questions are essential, the semistructured interview approach will feature a customization of the protocol (Ravitch & Carl, 2021). The semistructured interviewing technique allowed for more in depth conversation and probing, possibly bringing up points that were not directly covered by the questions. I achieved data saturation by making sure that the interview replies, themes that emerged,

and the literature that was examined, were all carefully evaluated. This procedure helped me unearth valuable data that might be investigated further.

Data Organization

After completing the interviews, I categorized the data into three categories of notes, recordings, and responses, so that I could easily distinguish between the various forms of material. I listened to digital audio transcriptions of the interviews while reading the data transcribed by NVivo. The transcription was sent to the participant for corrections as part of the member checking process. Oltmann (2016) argued that the narratives should be transcribed as soon as the interview is over to ensure accuracy and prevent leaving out any important information. Yin (2018) asserts that the transcription process enables more precise data arrangement. The transcript files for the interviews in this research were encrypted, transcribed, and kept on a backup drive. This backup disk, the hard copies of transcripts, and pertinent consent documents are kept in a safe place for five years with only I, as the researcher, having access to them. I will then destroy all of the stored materials after the lapse of the five years, as suggested by Oltmann (2016) and Yin (2018).

There are numerous ways to manage and arrange data in a qualitative investigation (Oltmann, 2016). To help retain as much information as possible, researchers employ various cataloging systems, including research logs and reflective journals (Denzin & Lincoln, 2018; Levitt et al., 2018). Accordingly, I kept a reflective notebook to keep track of the range of facts. I wrote my ideas in a notebook that was only used for this purpose after classifying and coding the data collected from the participants.

I kept a journal throughout the interviews and the analysis processes. Had I waited to make my notes after the interview process, I might have missed important information since I would not have been able to remember everything that was said orally and nonverbally (Oliveira et al., 2016). Taking notes of my thoughts and understandings throughout the interview allowed me to reach a high level of understanding of what was discussed.

Role of the Researcher

While conducting research, researchers need to adhere to the necessary protocols and ethical standards (Yin, 2018). By being open and reassuring about confidentiality concerns, I adhered to the standards outlined in the Belmont Report (NRHSD, 1979). While there are many excellent types of qualitative research, I used semistructured interviews to gather the viewpoints of the participants (Levitt et al., 2018). I informed the participants of the option to opt out of the study whenever they wanted. I understand the importance of objectivity in academic work, so I looked for and took into consideration any potential sources of researcher bias when I analyzed my data.

As an extension of my first master's degree in Educational Technology, I wanted to expand my knowledge. My thesis, written in 2017, concerned the use of online assessments versus the use of traditional paper and pencil assessments. I wanted to continue that work, focusing on teachers and how to help them use readily available data online on students to advance student learning. With students today being exposed to technology at a much younger age than ever before, they are used to the immediacy of information. I believe that having that immediacy in the classroom, especially in the math

classroom, will engage and help students learn. My role as an academic supervisor is to support math teachers, and although teachers are well versed in finding and using resources in the classroom, I have noted that they do not always know how to use the data produced to inform their instruction. By studying what teachers are doing with online formative assessment data, I hope to provide professional development to help teachers use that data to increase student performance. My pool of potential interviewees was large enough to avoid interviewing anyone I know personally. In this manner, I aimed to avoid researcher bias.

The legitimacy of the findings and the researcher's reliability both depend on them acknowledging their bias (Johnson et al., 2020). By recognizing the possibility of prejudice during the data collection process, I listened to what was said without passing judgment in order to address this potential bias. Thus, I limited my bias by considering what the interviewees say and respecting different viewpoints (Dash & Verma, 2019). In addition, I practiced systematic dialogic participation, as stated by Ravitch and Carl (2021).

Limitations

The limitations of a study are the potential weaknesses that a researcher cannot control (Theofanidis & Fountouki, 2018). One limitation of this study was that the setting for the study was only one NRHSD. The district has three high schools, and the study does not encompass high schools in any other part of the country. Another limitation was that the setting was in a large suburban area and the study did not reflect the perspectives of mathematics teachers in rural areas. Another limitation was the sample size, which

consisted of 12 participants. A small sample size means that the findings may not be generalizable to the entire population or other populations. Last, the participants were high school mathematics teachers only. This study did not represent mathematics teachers in other grade levels or with other types of high school teachers.

Data Analysis Results

In qualitative research, the data analysis process is iterative and recursive, meaning the process is systematic and repeated (Ravitch & Carl, 2021). Because of this, it is important to have a data management plan to follow throughout the data collection process. Data collection and analysis should not be seen as separate stages in research development as they will be handled simultaneously throughout the process (Ravitch & Carl, 2021).

Thematic analysis is a technique that examines common replies, and points of view from several qualitative surveys to identify themes that characterize comparable subjective experiences (Kennedy, 2016). Although thematic analysis is not a comprehensive research approach, it is a valuable tool for examining many types of qualitative analysis due to its broad applicability (Kennedy, 2016). Finding and interpreting common themes in the qualitative methodological survey data that the study's researcher has gathered typically constitutes thematic analysis (Ravitch & Carl, 2021).

Thematic Data Analysis

Thematic data analysis is used to extract themes and meaning from data that was generated by the study's research questions. It is crucial to guarantee that the process of data analysis is done well. In order to produce useful data, Creswell and Báez (2020)

outlined six iterative steps: (a) evaluate the data; (b) arrange the data; (c) code the data; (d) apply emergent themes; (e) publish the findings; and (6) assure correctness through validation methods.

Step 1: Analyzing the Information

Reexamining the data is the first stage in getting ready for an efficient analysis (Lodico et al., 2010). All data should be carefully examined; it can take several evaluations to properly handle the data (Creswell & Báez, 2020). For my research, I reviewed the data multiple times to ensure that all responses are included.

Step 2: Arranging the Data

Since the amount of information from interviews was substantial, it was organized into files or computer files as suggested by Creswell and Báez (2020). Creswell and Báez (2020) offered advice on how to organize by participant, create a table or matrix, and maintain multiple copies. After the interviews, I carefully transcribed the audio by listening to what was said.

Step 3: Coding the Data

The process of coding data involves multiple steps. Creswell and Báez (2020) outlined them as follows: (a) carefully read transcripts and make notes in the margins; (b) create underlying meanings through a more thorough examination of one document; (c) start the coding process by organizing text segments by topic; (d) synthesize codes to reduce to a smaller number; (e) go back to the data to see if new codes emerge; and (f) narrow down to five to seven themes in order to provide a detailed, more descriptive portrayal. To identify and classify the information that was supplied by the participants, I

checked the transcription and manually carried out open coding. To more accurately detect and codify themes, Levitt et al. (2018) recommended that data be coded in this manner. Continuous coding has also been demonstrated to be useful for identifying emergent themes in a study and determining the moment at which such topics have reached saturation with data (Denzin & Lincoln, 2018). I studied every piece of data carefully and coded it before moving to the next one (Braun & Clarke, 2012). For a wider range and greater coding accuracy, I manually and digitally coded my data.

I used a program called NVivo 11 to analyze, recognize, and arrange the themes in my data. Disorganized data is given structure using NVivo 11 software assistance in coding and identifying themes and trends in the data (Oliveira et al., 2016). NVivo 11 software helped to highlight quotes from the interviews in words and phrases. I first looked for commonalities, then contrasts, and based on my analysis, allocated categories before switching from free coding to more narrowly focused themes (Ravitch & Carl, 2021). I started the coding process with open coding and moved on to axial coding to establish categories. To demonstrate the codes' relationships with various categories, I made a frequency table (Saldaña, 2016). To make sure that all pertinent information was included, I reviewed the transcripts one last time and triangulated the codes to determine the categories (Saldaña, 2016).

Step 4: Incorporate Emergent Concepts

After coding and determining categories, the categories were then arranged into themes that were pertinent to the study topics (Saldana, 2016). Outliers were excluded since all data sets were examined to make sure they were consistent with the research

goals (Merriam, 2014). Alternative explanations were also considered because themes from the data needed to be examined again for a thorough understanding (Ravitch & Carl, 2021). To make sure the original data was consistent with the theme findings, I checked the data by comparing the frequency table with a Venn diagram (Saldaña, 2016). I followed the advice from Creswell and Báez (2020) and took notes in each of the interviews to compare and see if the original patterns that arose from the data review survived.

The notion that themes will emerge on their own is discounted by Braun and Clarke (2012); uncovering themes requires effort. As a result, I proposed themes that best conveyed the participants' viewpoints. The themes were carefully examined to make sure they related to the research data, and I ensured that this process was repeated. Upon review of the themes, I made connections to previous works of literature and the framework I employed in this study after selecting and classifying the major themes. Although there is no acknowledged method for assessing the accuracy of qualitative coding (Hemmler et al., 2020), the iterative procedure I used accepted the research on qualitative data processing and fully described my thought and analytical process.

Step 5: Present Your Results

Based on the topics that arose from Step 4, findings were given. The study questions were used to organize the findings, followed by teacher comments. The report described how mathematics teachers in an NRHSD use online formative assessment data to inform instruction.

Step 6: Validation

In qualitative research, "trustworthiness" is used to ensure that the participants' opinions are expressed objectively, and throughout this procedure, the rules of qualitative studies will be met (Ravitch & Carl, 2021). To make sure that the qualitative data that was acquired for this study was reliable and impartial, thematic data analysis was used. Both were crucial in demonstrating the reliability of the research as well.

Trustworthiness

In qualitative research, validity and reliability can be used interchangeably. Validating a qualitative study is both a method and an objective (Ravitch & Carl, 2021). Credibility, transferability, dependability, and confirmability are a few standards for reliable and high-quality qualitative research (Korstjens & Moser, 2018). Given the nature of qualitative research, it is critical to use these components when appropriate. Internal validity, generalizability, dependability, and objectivity are qualities that quantitative research uses to offer truth. By including these qualitative items, the study's rigor is ensured, allowing for trustworthy results (Johnson et al., 2020). Another factor supporting the validity of this research is the fact that participants checked the accuracy of the data analysis results.

Credibility

To be credible in qualitative research, methods like member checking, triangulation, and sustained participation must be used (Korstjens & Moser, 2018). Aspects of truth and plausibility are provided by credibility, which might be contrasted with internal validity in quantitative research. A well designed research study is the

cornerstone of credibility (Ravitch & Carl, 2021). Thick descriptions and member checking were utilized in this study to demonstrate credibility.

Member Checking

Yin (2018) claims that member checking, a procedure for confirming the accuracy of the participant's interpretation of their comments, is a way to ensure authenticity. To ensure credibility and reliability, Ravitch and Carl (2021) referred to this as a procedure to validate participation. Reviewing the information that the participants shared during and after the interviews served as member checking for this study. The member checking process gave me the chance to study and analyze the interviewees' responses, ask clarifying questions, and review their answers to the interview questions. Each participant received an electronic copy of their responses to the interview questions after making sure they provided adequate details.

Member checking is also employed to ensure the accuracy of the data. To improve a study's correctness, trustworthiness, validity, and transferability, researchers must engage in member verification (Marshall & Rossman, 2016). Although Yin (2018) noted that member checking can occur at various phases of the data collection process, I employed this approach during and after the interviews to strengthen the validity and credibility of this study. To achieve the highest level of conversational openness possible, I attempted to make the interview process welcoming and comfortable.

Transferability

Transferability refers to the potential for applying the results to a wider context (Yin, 2018). External validity is relevant to quantitative research (Ravitch & Carl, 2021).

By examining administrators' and teachers' views, this study's transferability was meant to assist the district's wider deployment in mathematics, where PU and PEOU teachers use online formative assessment data to inform. I presented and evaluated in depth descriptions to let readers assess how much the findings were transferrable to different contexts in order to establish the possibility of transferability. This was additionally reinforced by the use of deliberate sampling.

Dependability

The quality of the data determines dependability (Ravitch & Carl, 2021). It is necessary to use proper data collection and processing techniques to ensure dependability. The Walden IRB's study protocol was used to ensure this. Also, interview questions were asked in the same order, and only clarification related follow up questions were asked. To ensure accuracy, notes and an audio recording were made and distributed to participants.

Confirmability

I maintained my objectivity as the researcher throughout the investigation. All conclusions were shared, not based on individual beliefs or viewpoints but rather on the data evaluated from the interviews. Sharing the audit trail from the start of the study, through the creation of the survey, to the reporting of the results increased confirmability because it allowed for an external check (Sharp & Sanders, 2019). Records were maintained throughout the investigation. This demonstrated uniformity throughout the entire research. By maintaining these documents, the reasoning and the process were clarified.

Limitations

The limitations of a study are the potential weaknesses that a researcher cannot control (Theofanidis & Fountouki, 2018). One limitation of this study was that the setting for the study was only one NRHSD. The district consists of three high schools and does not encompass high schools in any other part of the country. Another limitation was that the setting was in a large suburban area and did not reflect the perspectives of mathematics teachers in rural areas. Another limitation was the sample size, which consisted of 12 participants. A small sample size means that the findings may not be generalizable to the entire population or other populations. Last, the participants were high school mathematics teachers only. This study did not represent mathematics teachers in other grade levels or with other types of high school teachers.

How Data Were Analyzed

To extract answers, and after the interviews were complete, I converted the interview audio files into a written transcript saved as a password protected document in NVivo. The next step was to code the data. Coding is used to identify patterns and organize data (Burkholder et al., 2019). The interviews were the central source for collecting the data. Because data collection consists of a step-by-step process with a table for each participant's exact words or phrases, coding and identifying themes is easier (Ravitch & Carl, 2021). Coding is an iterative process, in the beginning stages of the research, codes should be descriptive and stay as close to the text as possible (Ravitch & Carl, 2021). I collected the interview data and conducted an analysis to determine the categories associated with the teachers' experiences of online formative assessment in

mathematics classrooms. I examined and reviewed the interview transcripts thoroughly, using inductive analysis to generate initial codes so that I could later identify the themes. The identified themes were used to support answers to the research questions, in detail, regarding the teachers' experiences of online formative assessment. I identified specific descriptive codes related to the research questions.

Following each interview, a video recording was downloaded from Zoom and stored on a password protected external drive. The video file was uploaded to NVivo, transcribed and produced a Word document of the interview transcript. The transcripts were verified for accuracy by comparing the text with the recorded interview. Copies of the transcript documents were later given to the participants for member checking purposes.

Coding is an iterative process that was adopted from Saldaña (2021). The initial phase of coding used a hybrid of descriptive and values coding. Descriptive coding summarizes data in a word or short phrase. Values coding applies codes to data that reflect a participant's values, attitudes, or beliefs. The first step to coding was to highlight phrases on the Word document. The highlighted phrases were then organized using an electronic spreadsheet. The initial codes used to organize the data were guided by the research questions. This initial coding process is used to break down data into smaller parts so that by closer examination categories can emerge (Saldaña, 2021). Holistic codes were created during the initial coding process. These initial codes made were: Curriculum and Professional Development, Student Engagement, Technology, and Informative Data.

When the initial cycle of coding data holistically was done, a second cycle of coding was needed to identify patterns in the data. The patterns identified were used to create themes. Theme development was completed by identifying the repetition of words or phrases in the coded data. A theme expands on major ideas in the codes with the use of an extended phrase or sentence (Saldaña, 2021). Themes from the second cycle of coding built on the first cycle coding.

Findings

This study was developed in response to a local problem and a gap in practice at an NRHSD. The problem that was addressed through this study is the inconsistent implementation of online formative assessment to inform instruction by high school mathematics teachers in an NRHSD. In this basic qualitative study, I examined the inconsistent implementation of online formative assessment to inform instruction by high school mathematics teachers in an NRHSD. Mathematics teachers in the NRHSD have access to online formative assessment tools but may not know how to use the data obtained from the online resources to inform their instruction. Davis (1989) theorized that the PU (perceived usefulness) and PEOU (perceived ease of use) of technology will determine an educator's intention to use new technology in the classroom, which he called the technology acceptance model (TAM).

These three factors, the PU of technology, the PEOU of technology, and a user's attitude toward the use of that technology was explored to understand how teachers perceive the usefulness and ease of using the data collected from online formative assessment. The TAM was used to study the consistency of online formative assessment

used to inform instruction among mathematics teachers in an NRHSD to answer the research questions.

RQ1: What are teachers' perspectives on ease of use, usefulness, and attitudes towards online formative assessment to inform high school mathematics instruction?

RQ2: What are high school mathematics teachers' recommendations regarding the training, resources, and support they need to consistently use formative assessment to inform their instruction?

Four categories of codes were identified in the initial cycle of coding. The identified categories were: Curriculum and Professional Development, Student Engagement, Technology, and Informative Data. From those categories, eight themes were identified. Below is a discussion of the emergence of themes from the data.

Curriculum and Professional Development

Theme 1: Math Curriculum Should Provide Real-World Applications

One theme that emerged from the data was that a high school math curriculum should provide real-world applications. When asked about the curriculum at an NRHSD, codes related to this theme were identified (see Table 1). Participants were asked the following questions regarding curriculum: What activities would you like to do, or see done, in high school math to best meet the needs of high school math students? and What teaching strategies are effective for engaging students with the content taught in high school math classes?

Table 1

Theme 1: Math Curriculum Should Provide Real-World Applications

Code	Responses
Hands on	9
Misplaced skills	4
Prior knowledge	1
Real-world	22
Time management	1
Variety	3

When asked about activities that should be done in high school mathematics, participants responded with "real-world" applications more often than any other response. Participant 3 said, "A little bit more real-world application projects. Like engineering projects that we get to do in a math classroom. Business projects or accounting projects or finance projects that we get to do in a classroom, or construction projects. Like, things in which math is utilized outside of a classroom and used in the real world a little bit more." Participant 4 shared, "…including activities that kind of show how math is present in the world around us and how they can, you know, use it to make sense of the world as well as kind of use math and see how it's used in jobs after high school." While Participant 5 said, "One area where I think throughout my career, for 20

years now, people have a hard time with is seeing mathematics as relevant. They don't necessarily envision themselves doing these procedures when they are adults." Participant 6 said, "I'd like to see more tailored to the ways that they would use math in actual fields." Participant 7 said they would like the curriculum to have, "some kind of correlation between real-world practice and mathematics, allowing them to see that some of this stuff is used in real-world." Participant 9 reflected on how this has become what they try to focus on now, saying, "…now my philosophy is making that real-world connection. When we possibly can, we take the topic that we're teaching and try to make it make that connection to what could be possibly happening out there in the world." Participant 10 and 11 shared similar thoughts on adding real-world applications to the curriculum by saying, "Any time we can relate something to the real world is always something that engages the students more" and "Anything that kind of involves real life examples of things. I feel like it just makes it more meaningful to kids and kind of helps them understand it more and kind of sees a bigger purpose to it." Participant 12 said that the most beneficial thing to add to the curriculum would be "trying to relate the material to something that kids can use." Out of the twelve participants, nine mentioned real-world applications in their answers to curricular questions.

Theme 2: Professional Development for Online Formative Assessment Should Focus on One Program at a Time and Be Designed Based and the User Level

Another theme that developed from the data was professional development needs with regard to online formative assessment data. Professional development should focus on one program at a time and the professional development should be designed based on

the user level (see Table 2). When asked about professional development needs, the codes related to this were identified as One Platform, Peer to Peer, Sample Questions, Time to Create, and User Level. Participants were asked the following question regarding professional development: What are some of the recommendations regarding the training, resources, and support you would suggest to help in the consistent use of online formative assessment to inform high school teachers' math instruction?

Table 2

Theme 2: Professional Development for Online Formative Assessment Should Focus on One Program at a Time and be Designed Based on the User Level

Code	Responses
One platform	17
Peer to peer	6
Sample questions	3
Time to create	5
User level	19

When asked about professional development and what they thought teachers needed, participants most frequently answered with codes relating to user level. Participant 1 said, "Try not to just group people together. Divide teachers that are at different levels. You don't want to take a teacher who's already very proficient and make

them sit through something that starts with the basics." Participant 3 said, "I would say training. But the caveat to that is I am particularly tech savvy, so I don't think I need training on how to utilize a specific resource. Well, I do think that there are a fair number of teachers in our district that do need that." Participant 4 talked about how professional development needs to meet the needs of specific teachers, "Work very specifically with teachers and their specific subjects." Participants 11 also made suggestions that referred to user levels, saying "Take into account what level teachers are at. I feel like a lot of times when we're given professional development as a district, as a math department, we are learning one thing and it's a one-size-fits-all situation."

The participants recommended that professional development focus on one program at a time. Participant 2 said, "I think the issue is that there is too much. We go to workshops and see five different things. We are expected to learn all these programs. It's overwhelming." Participant 9 said, "It needs to be a consistent situation, not five or six programs. Let's just focus on one." Participant 11 brought up the fact that using the platforms depends on training received on a platform. They said, "It depends on the platform and the kind of training we receive on it. Some things I think could be really great, but I don't know how to use them properly."

Student Engagement

Theme 3: Students are Engaged When There Are Active Learning Activities

Another theme that emerged from the data was that high school math students tend to be engaged in learning when there are hands-on activities embedded in lessons. When asked about the engagement of math students at an NRHSD, codes related to this

theme were identified (see Table 3). The codes related to student engagement were identified as: Active Learning, Peer to Peer, Problem Solving, Real World, Self-Efficacy, Simple Instructions, and Variety. Participants were asked the following questions regarding student engagement: What teaching strategies are effective for engaging students with the content taught in high school math classes? and What is your perception of student success in high school mathematics in the NRHSD?

Table 3

Theme 3: Students are Engaged When There Are Active Learning Activities

Code	Responses
Active learning	19
Peer to peer	2
Problem solving	1
Real world	9
Self-efficacy	4
Simple instructions	1
Variety	10

When asked about effective strategies for engaging students with mathematics content, participants most frequently answered with codes relating to active learning. Participant 2 said, “The key is to have the kids constantly moving but still have an essential question target for the whole class.” Participant 4 mentioned simple instruction

and active learning. They said, “I think students like things simple and clear, but also need some type of discovery activity.” Both Participants 5 and 6 discussed making students be active participants in the lesson. Participant 5 said, “Make them do stuff. I would say 20 years ago it was very teacher driven and students were kind of forced to do a lot of listening. Now I can have that printed and provided for them, which then in turn helps the students be more active in the thinking process rather than the note-taking kinds of tasks.” Participant 6 said, “You want them to do more activities, more applications, less lectures.” Participants 7, 8, and 9 all spoke about the importance of variety and active learning. Participant 7 said, “Multi-modality is essential. Anything that is more than just listening is engaging. Doing is always better.” Participant 8 said, “I do a lot with virtual labs. I think that and manipulatives work the best.” And Participant 9 elaborated on variety and active learning, “So I like to make sure there is an activity with Desmos or Edulastic and then get them up and moving or at the board. Next, I will have them in groups or pairs. You have to switch up the routine so it’s not the exact same thing every time, but they are still engaged and learning.”

Technology

Theme 4: Edulastic Was the Online Formative Assessment Technologies Most Frequently Mentioned by Participants as Being Used for Online Formative Assessment

Throughout the interview, participants were asked about online formative assessment. A natural outcome of that question was participants naming specific resources used for online formative assessment. The resource that was referenced the most was Edulastic. Edulastic is an online system designed for teachers to monitor

student progress by way of formative or summative assessments. The program allows an overview or a specific view, to monitor how the class and individual students are progressing.

Table 4

Theme 4: Edulastic was the Online Formative Assessment Technology Most Frequently Mentioned by Participants as Being Used for Online Formative Assessment

Code	Responses
Delta Math	4
Desmos	6
Edulastic	15
Flipped Math	1
Go Guardian	1
Google Classroom	5
IXL	3
Link It	1
Pear Deck	4

When asked about online formative assessment, participants most frequently mentioned Edulastic. Participants were asked the following questions: What is your perception of perceived usefulness (PU) with regard to the use of formative assessment to

inform high school math instruction? What is your perception of perceived ease of use (PEOU) regarding the use of online formative assessment to inform high school math instruction? What are some of the possible positive or negative effects of online formative assessments in high school math? Participant 2 said, “Online assessment is wonderful, and I've learned so much. The platform we have used the most is Edulastic. When I used to grade by paper, I would go and record all the grades and stuff, but I didn't put much deeper thought into it. But now I can see the class average. I can compare it to another class and I'm teaching the same material too. It's just, it's really made our lives as teachers a lot easier.” Participants 5,6,8,10, and 11 all mentioned that they use Edulastic daily. Participant 5 said, “I make very active use of Edulastic. I love that I can have my students do a variety of types of responses. Like drag and drop, hierarchy, or more mundane like multiple choice.” Participant 6’s thoughts were, “I mostly use Edulastic. It’s not complicated and is pretty easy.” Participant 8 said, “All my tests are online through Edulastic. I try to expose them to doing math online as much as possible because all their state tests are online” and Participant 10 added, “I use Edulastic on a day-to-day basis.” Participant 11 added how useful the information from Edulastic has been in their classes, “Edulastic has been a lifesaver in Algebra 1. I love how quickly we get feedback from that. We can have students self-assess by using, you know, a check answer feature, and that's very useful because we can see at a glance who's getting it and who's not. And we can see patterns. If everyone in the class is getting number five wrong. And you know, we probably didn't do a great job of doing that type of problem, we can go back

and reteach certain things. So, I definitely use Edulastic on a daily basis, and I think it's very valuable."

Theme 5: Teachers View the Inability to Show Work as the Most Negative Aspect of Online Formative Assessment

When asked about the negative aspects of online formative assessment, participants answered with either the inability of students to show work or cheating. Of the 12 participants, 9 responded with the inability to show work and 2 responded with cheating.

Table 5

Theme 5: Teachers View the Inability to Show Work as the Most Negative Aspect of Online Formative Assessment

Code	Responses
Cannot show work	9
Cheating	3

The most frequent answer to the question about negative aspects of online formative assessment was the inability of students to show work. Participant 3 said, "I think it stems from the fact that school kids tend to typically try to take shortcuts. And so, when we give kids online assessments, we're not giving them necessarily a canvas or easy way in which they can illustrate their ideas. Like when you give them a paper test, right? You're giving them paper and pencil. There's room on that test for them to write, work down and put answers in. So, I think the amount of work that's being shown is decreasing

significantly. And because of that, kids are doing poorly because they're not writing things out. Participant 4 said, “Not having physical things written out. If there's stuff that requires a lot of like showing and work and, you know, some kids don't like using the tools that are online.” Participant 8 said, “The disconnect is between thinking it through and doing the work, and thinking like because it's on the computer, like they can just kind of plug it in. They don't need to understand.” And Participant 10 said, “I feel like the computer is a little confusing. Even just like if you're solving a simple math problem. Like, kind of like when you see it on your computer, make sure you write it on a piece of scrap paper and then solve. So that kind of takes some extra time and it's kind of not as easy.”

Informative Data

Theme 6: Immediate Feedback Given to Students Is the Most Useful Feature of Online Formative Assessment Data

Participants gave responses about the positive and negative aspects of online formative assessment. In those responses, a theme emerged regarding the value of the data from online formative assessment. Participants view the most valuable data from online formative assessment to be the immediate feedback given to students. Participants saw value in both teachers and students being able to immediately see results of formative assessments.

Table 6

Theme 6: Immediate Feedback Given to Students is the Most Useful Feature of Online Formative Assessment Data

Code	Responses
Immediate feedback	9
Self-assess	2
Re-teaching needs	2

According to participant responses, immediate feedback to students is the best use of data from online formative assessment. Participant 2 said, “Well, one of the things I like is it gives them the feedback right then and there. So, any time in the old days when we used to give paper, pencil, and paper, I take it home and grade it. The kids had no clue till the next day when they did an online assessment. They know right then and there how they scored.” Participant 4 said that the best thing about online formative assessment is, “giving the students immediate feedback on what they're doing in the moment and being able to make little corrections for them.” Participant 5 said “It gives me feedback right away, but more importantly, it gives the students feedback right away. And it has led to my students being more tenacious in and helping themselves find the right answers or less rely on me and more reliant on themselves.” Participant 9 said, “It's a creative way that you can give feedback to a kid one-on-one, like post-assessment. But I'm able to go in there and I give comments on this problem right there. I mean, I guess I could do the

same thing with the paper that have in front of me, but they have to wait until I hand it back to them where this way, I can get it to them pretty immediately. As soon as I release the scores and send them back to them. They can see anything I have right there. And especially these kids nowadays with technology, they're on that as frequently as they possibly can."

Themes and Conceptual Framework

The TAM by Davis (1989) provided the conceptual framework for the study. Davis' TAM is a model that uses PU and PEOU as factors determining how and when a user will utilize a technology. These two criteria are studied to determine what causes a user to accept or reject a technology and can predict whether a technology application will be used in the classroom by teachers. The results of my study will be discussed in the context of TAM and how PU and PEOU can be used to combat the inconsistent use of online formative assessment data by mathematics teachers in an NRHSD to inform instruction. Six themes were identified in this study: 1: Math curriculum should contain real-world applications. 2: Professional development for online formative assessment should focus on one program at a time and be designed based on the user level. 3: Students are engaged when there are hands-on activities. 4: Edulastic was the online formative assessment technology most frequently mentioned by participants as being used for online formative assessment. 5: Teachers view the inability to show work as the most negative aspect of online formative assessment. 6: Immediate feedback given to students is the most useful feature of online formative assessment data. Examining these themes within the context of the TAM increased the understanding of

how mathematics teachers at an NRHSD use data from online formative assessments to inform instruction. The goal for analyzing this data is to provide support for teachers to use data from online formative assessment to inform instruction and to increase student engagement and academic achievement.

The TAM by Davis (1989) provides the framework that users of technology will use that technology if the PU and PEOU of that technology are favorable. Participants were specifically asked about these aspects concerning online formative assessment. Participants responses reflected these assumptions in the TAM. Participants' responses targeted using only one resource and having the training be based on the individual user level.

Summary of Data Analysis

My study was designed to address a local problem. The problem addressed through this study was the inconsistent implementation of online formative assessment to inform instruction by high school mathematics teachers in a NRHSD. All mathematics teachers within the district have been given online formative assessment resources (Academic supervisor, personal communication, September 20, 2021). The district pays for LinkIt, Edulastic, and Delta Math. LinkIt is only used as a summative assessment, yet there are many online formative assessment platforms used in the district. The degree to which usage is consistent when informing instruction varies among teachers and high schools.

Six themes were identified in this study: 1: Math curriculum should provide real-world applications. 2: Professional development for online formative assessment should

focus on one program at a time and be designed based on the user level. 3: Students are engaged when there are hands-on activities. 4: Edulastic was the online formative assessment technology most frequently mentioned by participants as being used for online formative assessment. 5: Teachers view the inability to show work as the most negative aspect of online formative assessment. 6: Immediate feedback given to students is the most useful feature of online formative assessment data. The findings of this basic qualitative study were rooted in the context of the TAM by Davis (1989). The study of participants PU and PEOU with regard to online formative assessment was a response to a local problem. An appropriate project to aid the district in addressing this problem Is the creation of professional development for mathematics teachers. The professional development will focus on one program specific to online formative assessment and be leveled according to individual user needs. It was evident that teachers are inconsistently using online formative assessment data to inform instruction.

Section 3: The Project

The study was designed to understand the complexities and deficiencies in the utilization of online formative assessments among high school mathematics educators within the NRHSD. At its base was to scrutinize the extent to which these educators integrate online formative assessment tools into their instructional practices and how they PU, PEOU, and overall attitudes toward such technological resources. Guided by the theoretical framework of the TAM, I sought to unearth varying insights into the experiences, challenges, and recommendations of mathematics teachers regarding the incorporation of online formative assessment tools. Aiming to go beyond surface-level observations, I aimed to uncover a deeper understanding of the factors that influence the adoption and consistent utilization of these tools by teachers. By addressing the local challenge of inconsistent implementation, I aspired to provide actionable recommendations for tailored training, resource allocation, and supportive measures to enhance the effective utilization of online formative assessment tools among mathematics educators within the NRHSD. Based on the findings of the study, a primary recommendation in supporting teachers is to develop targeted and differentiated professional development programs focusing on online formative assessment tools for high school mathematics teachers within the NRHSD. These programs should prioritize a singular platform at a time, allowing educators to deepen their understanding and proficiency in using specific online assessment resources. This is discussed in detail in the following sections including the rationale for a professional development project.

Rationale

One-on-one semistructured interviews with mathematics teachers from a NRHSD were conducted to understand the complexities and deficiencies in the utilization of online formative assessments among high school mathematics educators. Based on these interviews, the determination was made that mathematics teachers in this NRHSD needed support in using online formative assessment to inform their instruction. The professional development project provides targeted and differentiated support teachers to enable them to use online formative assessment data to inform instruction.

Selecting a project of professional development provides tools to mathematics teachers in a NRHSD that can be implemented immediately. The ability for teachers to use this data to immediately adjust instruction and learning can increase student academic achievement (Lyon et al., 2019). Consistent implementation of online formative assessment to inform instruction may improve student achievement in mathematics (Remmi & Hashim, 2021). The use of online formative assessment data to inform instruction will promote social change by increasing student achievement in mathematics.

Review of the Literature

The purpose of this basic qualitative study was to investigate how high school mathematics teachers in a NRHSD use online formative assessment to inform instruction. Identification of successful online formative assessment can be used to inform the training and resources as well as the supports teachers need to promote student achievement. The findings highlighted the critical need for tailored professional development focused on enhancing teachers' proficiency in using online formative

assessment tools effectively to inform mathematics instruction. Key themes emerged from the analysis, indicating a strong demand for curriculum enrichment with real-world applications, targeted professional development aligned with teachers' individual levels of expertise, and a preference for active learning strategies to promote student engagement. These results highlight the pressing need for strategic interventions to address the identified gaps in teacher training and support, ultimately improving the integration of online formative assessment into mathematics instruction within the NRHSD.

Appropriateness of Project Selection

As aforementioned, a professional development project was selected for this study. A professional development project was appropriate because it aligns with the research objectives and the nature of the research findings. Because I focused on investigating the use of online formative assessment among high school mathematics teachers and identifying professional development needs, a professional development project provided a platform to implement evidence-based recommendations for addressing the identified gaps and promoting effective instructional practices. Also, the project allowed for the synthesis of key findings from both literature and research, enabling the presentation of informed recommendations that can inform decision-making processes at the organizational level. A professional development project based on the research findings will give immediate support to teachers, thereby driving positive change in educational practices within the NRHSD.

Researching Articles Related to the Project

The Walden University Library databases were used as a source for literature review materials. The databases accessed were Education Source, ScienceDirect, SAGE Journals, Proquest One Academic, Education Base, and ERIC. The date of publication of the sources was not rigidly set at 5 years because some of the knowledge had to come from older studies and so that door was left open. Because the identified gap was regarding high school mathematics teachers' use of online formative assessment to inform mathematics instruction, the search keywords were *Implementation consistency, tailored professional development, professional development differentiated training, singular platform assessment,* and *online formative assessment utilization*.

These search keywords were based on the recommendation to develop a targeted and differentiated professional program that focuses on online formative assessment tools for high school mathematics teachers within the NRHSD. From the highlighted themes, the programs should prioritize a single platform at a time, allowing educators to deepen their understanding and proficiency in using specific online assessment resources.

Consistency in Online Mathematical Assessments

The prevalence of online formative assessment tools cannot be overstated. They offer teachers and students valuable resources for gauging learning progress and informing instruction (Lendrum & Humphrey, 2012). However, the effective use of these tools hinges on the consistency of their implementation by educators, particularly in the realm of high school mathematics instruction.

Challenges in Implementation

Consistency in the implementation of online mathematical assessments poses several challenges for high school teachers. One significant hurdle is the variability in teachers' technological proficiency and familiarity with assessment platforms (Pathiranage & Karunaratne, 2023). Teachers who lack adequate training or experience in using online assessment tools may struggle to integrate them consistently into their instructional practices, leading to disparities in their utilization across classrooms. Another challenge, according to Li et al. (2016), is logistical in nature such as access to technology and reliable internet connectivity which end up impeding the consistent use of online assessments. Disparities in resource allocation among schools or districts may exacerbate these challenges, further widening the gap in implementation consistency across educational settings.

Factors Influencing Implementation Consistency

As theorized by Davis (1989), one critical factor influencing implementation consistency is teachers' perceived usefulness and ease of use of assessment platforms, as outlined in the TAM. What Davis meant was that teachers who perceive online assessment tools as valuable for enhancing student learning and convenient to use are more likely to integrate them consistently into their instructional practices. Organizational support and professional development opportunities to play a crucial role in promoting implementation consistency (Zaslow et al., 2010). It has been noted that teachers who receive adequate training, ongoing support, and access to resources tailored

to their needs are better equipped to utilize online assessment tools effectively and consistently.

Strategies for Ensuring Implementation Consistency

To address the challenges and promote consistency in online mathematical assessments, educators and educational leaders can employ various strategies. One of the strategies that I found was the provision of comprehensive and differentiated professional development opportunities tailored to teachers' technological proficiency levels and instructional needs (see Lendrum & Humphrey, 2012). These opportunities should offer hands-on training, ongoing support, and opportunities for collaboration and peer learning. There is also a need to establish clear guidelines, standards, and protocols for the use of online assessment tools because that can help standardize their implementation across classrooms and schools (Lendrum & Humphrey, 2012). Consistent communication and collaboration among teachers, administrators, and technology support staff are essential for ensuring alignment and coherence in assessment practices.

Singular Platform Assessment in Mathematics Education

In the realm of mathematics education, the use of singular platform assessment has been shown to be a promising approach and can enhance consistency, efficiency, and effectiveness when assessing student learning outcomes. As one of the themes that came up in the study, I explore the benefits of the concept in mathematics education, evaluate the challenges as well as the implications for teaching and learning.

Benefits of Singular Platform Assessment

Topuz and colleagues (2022) defined the concept as the use of a single integrated platform administering, scoring, and analyzing assessments in mathematics education. This approach has many benefits including the promotion of consistency and standardization in assessment practices across classrooms and schools (Topuz et al., 2022). Suffice it to say that providing a uniform framework for assessment administration and scoring, singular platforms reduce variability and ensure that all students are evaluated using the same criteria and standards.

Basantes-Andrade et al. (2022) went as far as to posit that singular platform assessments offer educators valuable insights into student performance and progress through real-time data analytics and reporting features. These platforms often include built-in algorithms that automatically score and analyze student responses, providing immediate feedback to both students and teachers (Giabbanelli et al., 2019). The advantage here is the timely feedback accorded educators making them more responsive to student needs. Additionally, it enables teachers to identify areas of strength and weakness and tailor their teaching strategies accordingly.

Challenges and Considerations

While there are benefits associated with singular platform assessments, there are challenges that need to be addressed. One important challenge is ensuring equitable access and opportunity for all students to engage with the assessment platform (Pittalis, 2021). It is difficult to talk about implementation without considering technological disparities in terms of internet connectivity and access particularly among marginalized

student populations (Li et al., 2016). Policy makers must address these disparities proactively so that all students have the opportunity to benefit from singular platform assessments.

Additionally, educators must consider the validity and reliability of assessments administered through singular platforms (Relkin et al., 2020). While these platforms offer automated scoring and analysis features, there is a risk of algorithmic bias or inaccuracies in scoring, particularly for open-ended or complex mathematical tasks (Kordzadeh & Ghasemaghaei, 2022). Educators are expected to critically evaluate the alignment between assessment tasks and learning objectives to ensure that singular platform assessments provide valid and reliable measures of student proficiency without disadvantaging some people with technological bias.

Implications for Teaching and Learning

The adoption of singular platform assessments has profound implications for teaching and learning in mathematics education (Relkin et al., 2020). By streamlining assessment administration and scoring processes, these platforms free up valuable instructional time for teachers to focus on meaningful learning activities and interventions (Pittalis, 2021). Teachers can use the data generated by singular platform assessments to inform their instructional decisions, identify individual student needs, and differentiate instruction effectively. Importantly, singular platform assessments promote student engagement and motivation by providing immediate feedback and opportunities for self-assessment and reflection (Kordzadeh & Ghasemaghaei, 2022). Students can

track their progress over time, set learning goals, and monitor their achievement, fostering a sense of ownership and agency in their learning journey (Relkin et al., 2020).

To this end, this study represents a promising approach to enhancing consistency, efficiency, and effectiveness in mathematics education. By providing a uniform framework for assessment administration and scoring, a singular platform offers educators valuable insights into student performance and progress. Notably, educators must address challenges related to equitable access, validity, and reliability to maximize the potential of singular platform assessments for promoting student learning and achievement in mathematics. The professional development project can support implementation and ongoing support of singular platform assessments that can have the power to transform teaching and learning experiences, ultimately fostering deeper understanding and mastery of mathematical concepts and skills.

Hands-On Learning and Student Engagement in Assessment

As one of the themes identified, hands on learning and active engagement strategies are important in education, especially in mathematics assessment (Brinson, 2015). This review would be incomplete without exploring the role of hands on learning and active engagement in promoting student engagement during assessments in educational settings. This section takes the form of the examination of the theoretical underpinnings, empirical evidence, and practical implications of these strategies, with the aim of elucidating the strategies potential to enhance student learning outcomes and assessment experiences.

Theoretical Framework

Hands on learning and active engagement strategies are rooted in constructivist and socio cultural theories of learning, which emphasize the importance of learners' active participation in the construction of knowledge (King & He, 2006). According to these theories, meaningful learning occurs when students are actively engaged in authentic tasks, problem-solving activities, and collaborative interactions with their peers and teachers (Zheng et al., 2014). King and He (2006) explain that hands on learning and active engagement provide students with opportunities to apply their knowledge in real-world contexts, make connections between abstract concepts and concrete experiences, and develop deeper understanding and conceptual mastery.

Numerous studies have documented the fact that hands on learning has a positive impact on student engagement during assessments. For example, Arthurs and Kreager (2017) found that active learning strategies, such as peer instruction and group discussions, significantly increased student engagement and participation in classrooms. Similarly, Hattie and Timperley (2007) identified active engagement as a key factor influencing student achievement, highlighting the importance of hands-on learning experiences in promoting deeper understanding and retention of content. Additionally, Bandura found that empirical evidence suggests that hands on learning and active engagement strategies can enhance students' motivation, self-efficacy, and sense of ownership over their learning (Bandura, 1982). This is made possible by the fact that active learning and hands on experiences provide learners with opportunities to explore, manipulate, and interact with materials and resources, which fosters a sense of agency

and autonomy, which are essential for fostering intrinsic motivation and lifelong learning habits.

Practical Implications

Incorporating hands on learning and active engagement strategies into assessment practices requires careful planning, scaffolding, and alignment with learning objectives and outcomes (Tang & Bao, 2021). To incorporate this strategy, educators can design assessments that integrate hands-on activities, simulations, experiments, and project-based tasks to provide students with authentic and meaningful learning experiences. Pathiranage and Karunaratne (2023) explained that formative assessment techniques, such as peer feedback, self-assessment, and reflection, can promote active engagement and metacognitive awareness among students. This strategy ties to the others because technology enhanced assessment tools and platforms can facilitate hands on learning and active engagement in virtual or blended learning environments. Virtual labs, simulations, and interactive multimedia resources can provide students with immersive and interactive learning experiences, enabling them to explore complex concepts and phenomena in a dynamic and engaging manner.

Hands on learning and active engagement are important aspects in promoting student engagement and achievement during assessments in educational settings. Grounded in constructivist and sociocultural theories of learning, these strategies provide students with opportunities to actively participate in the construction of knowledge, develop deeper understanding and conceptual mastery, and foster intrinsic motivation and self-efficacy. By integrating hands on learning and active engagement into assessment

practices, educators help create learning experiences that are both meaningful and authentic, ultimately empowering students to become lifelong learners and critical thinkers.

Professional Development Matching Teachers' Expertise Level

Professional development (PD) tailored to teachers' individual levels of expertise is increasingly recognized as essential for enhancing assessment practices in mathematics education (Postholm, 2018). Traditional PD models have adopted a one-size-fits-all approach whose consequence is that it neglects the diverse needs and skill levels of educators (Hauge, 2019; McChesney & Aldridge, 2019). However, research indicates that targeted PD initiatives, which align with teachers' existing knowledge and instructional contexts, hold significant promise in addressing these shortcomings (Kalinowski et al., 2019; Lay et al., 2020). By acknowledging teachers' varying levels of expertise, from novice to experienced practitioners, targeted PD programs can provide personalized learning experiences that are more effective in fostering growth and improvement (Hauge, 2019).

The success of targeted PD is brought about by the understanding of the proficiency levels of the teacher (Romijn et al., 2021). PD initiatives must include comprehensive needs assessments to identify teachers' strengths, challenges, and areas requiring development in mathematical assessment practices (Gesel et al., 2021). With this information, it is bestowed upon PD providers to design differentiated content that caters to specific mathematical assessment topics, ensuring that the learning experiences are relevant and impactful for teachers at different expertise levels (Santos & Miguel,

2019). That is not all because collaborative learning opportunities too can be incorporated into targeted PD initiatives, enabling teachers to engage in shared inquiry and peer learning, as these have been shown to deepen understanding and foster collaboration (Gesel et al., 2021).

The impact of targeted PD on teacher practice and student learning in mathematics has been well documented (Ventista & Brown, 2023). Studies have demonstrated that teachers who participate in targeted PD initiatives exhibit improvements in assessment literacy, confidence, and pedagogical strategies (Mohamad Hasim et al., 2022). On top of that, enhanced assessment practices resulting from targeted PD have been associated with improvements in student achievement and mathematical understanding (Yang & Kaiser, 2022). This points to the importance of ongoing, differentiated support for educators to continually refine their assessment practices and ultimately enhance student learning outcomes in mathematics.

Project Description

I used my findings in this study to serve as the basis for the development of a professional development project. My goal for the professional development project was to provide support to mathematics teachers in a NRHSD to consistently use online formative assessment data to inform instruction. I created a self-assessment to provided targeted supports for teachers. A Google Site is the platform for all materials for the professional development project (see Appendix A). After teachers use the self-assessment to determines a level of support, teachers will have differentiated supports. The supports will be in the form of video tutorials, peer-to-peer collaboration, and one-

on-one support. Google Slide presentations will also be created for targeted mini-lessons. The facilitator of the professional development will use data from the workshop to inform the workshop in real-time, modeling the intended implementation in the classroom.

Potential Resources

The facilitator of the professional development will require an appropriate space with internet access. The space must have a place for whole group instruction and breakout sessions. The facilitator will need a projector, projector screen, and adequate internet connection. The professional development is meant to be delivered as an in-person workshop. The facilitator of the professional development will need to require the participants to complete a self-assessment to group participants based on level of support needed with technology.

Potential Barriers and Solutions

There are potential barriers to implementing this professional development. The first potential barrier is the time that will be needed to complete the workshop. The proposed solution to this barrier is to work with the district by providing an appropriate time frame to schedule the workshop. The second barrier is to limit the number of participants in each session. The goal will be to have all math teachers in a NRHSD participate in the workshop. For the number of participants to be limited will require multiple days of the workshop. A proposed solution to this could be to give the self-assessment before the workshop to group the participants based on results of the self-assessment before scheduling the workshops. A second proposed solution to this is to

have a large group where participants take the self-assessment. The self-assessment results will then create break out groups.

Implementation Proposal and Timeline

The professional development workshop would take place before classes started in August for three days. The workshop will start at 8:00 am and end at 2:30 pm. A light breakfast, snacks, and lunch will be provided. The beginning of the first day will be an overview of using online data to inform instruction. Participants will take a self-assessment to determine targeted supports needed. Participants will be divided into groups based on the results of the self-assessment. The workshop will be tailored based on participants level of experience with online formative assessment platforms. Participants will complete different exercises based on expertise level. The next two days of the workshop will have participants divided into groups based on the results of the self-assessment from the first day. Participants will be working on one platform. The last day of the workshop will focus on using data from online formative assessment to inform instruction.

Roles and Responsibilities

My role is to develop, implement, and facilitate the workshop. The facilitation of the workshop should model how instruction can be informed and differentiated in the classroom. I will develop an agenda, a self-assessment, a Google Site, Google Slides, guided activities, and all other materials for the professional development. An exit ticket at the conclusion of the activities will serve as evaluations in professional development. I will find and confirm the venue for the professional development. I will coordinate with

the director curriculum in the NRHSD to schedule appropriate time for the workshop. I will coordinate and facilitate each session of the professional development. The participants in the professional development program are responsible for attending the program, having an open mind, being engaged, and being willing to acknowledge possible shortcomings to grow.

Project Evaluation Plan

The evaluation planned for the professional development project are based on the work of Guskey (2006) and further work from Guskey (2024). Guskey's model for evaluation professional learning is composed of five levels: participants' reactions, participant learning, organization support and change, participant use of new knowledge and skills, and impact on student learning outcomes. The first two levels can be evaluated using the self-assessment, exit tickets, and reflections. Levels three through five will need to be evaluated further into the school year. Participants will be asked to reflect on implementation and progress at the conclusion of each trimester in the school district. These reflections can be used to assess further needs for professional development and support.

Project Implications

The project will have positive social change implications by providing mathematics teachers from NRHSD professional development that will increase student achievement in mathematics. The professional development will have teachers' self-assessment to determine their user level with one online formative assessment platform. Participants will then receive targeted instruction based on their user level. Participants

will also receive strategies for using online formative assessment data to inform instruction. The consistent use of online formative assessment data to inform instruction will help to increase student achievement in mathematics.

Section 4: Reflections and Conclusions

Project Strengths and Limitations

The project may help increase student achievement in mathematics in a NRHSD. I focused on executing a 3-day professional development project. The goal of the project is to provide mathematics teachers from a NRHSD the supports necessary to consistently use online formative assessment data to inform instruction. This project supports teachers by providing targeted and differentiated support for one online formative assessment platform. In the project study, I addressed the strengths and limitations in addressing the problem with the inconsistent use of online formative assessment data by mathematics teachers to inform instruction in a NRHSD.

The strength of this project study is that mathematics teachers in a NRHSD will be given the opportunity to increase student achievement in mathematics by consistently using online formative assessment data to inform instruction. The professional development experience will provide targeted and differentiated support to participants. A potential limitation of this study could be the small number of participants. The study was specific to a NRHSD; participation on the study was completely voluntary. Another limitation is in scheduling of interviews. Teachers' schedules are very busy and arranging interview times could be difficult. In the future, researchers should consider further investigation into professional development for using online formative assessment data to inform instruction.

Recommendations for Alternative Approaches

The problem that was addressed through this study is the inconsistent implementation of online formative assessment to inform instruction by high school mathematics teachers in a NRHSD. In this basic qualitative study, I examined the inconsistent implementation of online formative assessment to inform instruction by high school mathematics teachers in a NRHSD. To address the problem, mathematics teachers from a NRHSD were interviewed and a professional development project was created. The problem could have been addressed in various ways such as online surveys, case studies, observational studies, or focus groups.

An alternative definition of the problem could have been that there were not enough supports for teachers to consistently use online formative assessment data to inform instruction. An alternative solution would be to provide targeted professional development when online formative assessment is implemented. A second alternative definition to the problem could have been that teachers are not equipped to use online formative assessment data to inform instruction. An alternative solution to that local problem could have been to provide ongoing professional development opportunities to develop teachers' skills regarding the use of online formative assessment data to inform instruction.

Scholarship, Project Development and Evaluation, and Leadership and Change

In this qualitative study, I learned how to implement the research process. I was able to grow and develop as a researcher. I was able to provide potential solutions to problems identified in my findings. By conducting research, I learned how to explore the

human experience from a qualitative perspective. By developing a project, I learned to create solutions to a problem based on my research findings. As a scholar, I faced rigorous challenges that I was able to overcome through perseverance.

Reflective Analysis of Myself as a Scholar

As I reflect on my scholarship experience, I found the process to be demanding and frustrating at times. The process was completely out of my comfort zone as a mathematician. Qualitative research was not intuitive for me, as a mathematician I am used to more black and white processes. The Walden University staff provided support and encouragement. Support was provided to me by my advisor, instructors, and committee members. The university provided multiple resources to support success in coursework and the project study process. As a novice researcher, I learned how to disseminate the findings of this study to readers. I most appreciated the process of coding interviews to discover themes. As a scholar, I struggled with the writing process. The support from the university enabled me to complete the process.

The process at Walden University for completing the doctoral study developed my skills as a researcher. The research project added to my ability to become an agent for social change. The research project interview process was an avenue that allowed me to develop an appreciation for studying the human experience. I was able to develop listening skills used to dive further into a topic with participants. I have grown as a practitioner who can now conduct research to promote social change.

Reflection on Importance of the Work

Based on the findings from this study, it was evident that mathematics teachers in a NRHSD need professional development to consistently use online formative assessment data to inform instruction. I learned that teachers will use data differently or not at all. I was able to determine that teachers would prefer to learn about one online platform and that the professional development should target the individual user level. By coding interview data, I was able to develop themes that could be applied to the development of the project. I learned that professional development is necessary for the consistent implementation of using online formative assessment data to inform instruction.

Implications, Applications, and Directions for Future Research

The study has the potential to foster social change. The consistent use of online formative assessment data by math teachers in a NRHSD could promote social change by improving student achievement in mathematics. Implementing the 3-day professional development project can help mathematics teachers grow professionally to improve high school mathematics achievement. The study was based on the TAM proposed by Davis (1989). The TAM can be used to identify barriers such as fear of using technology or trying something new that may limit people from using online tools developed and implemented by others (King & He, 2006). Using the TAM, mathematics teachers in the NRHSD view the PU and PEOU of online formative assessment. This model supports the selection of professional development as the study project. Targeted and differentiated professional development will impact a users' PU and PEOU of online formative assessment platforms.

Further research is necessary to support this topic. Mathematics was the only subject explored in this study. Online formative assessment data can be used to inform instruction is all disciplines. This study was also limited to high school. Future studies should investigate multiple grade levels.

Conclusion

I investigated the inconsistent use of online formative assessment data to inform instruction by mathematics teachers in a NRHSD. The basic qualitative study conducted allowed for the creation of professional development. The professional development opportunities for mathematics teachers in a NRHSD may provide the teachers with supports to consistently use online formative assessment data to inform instruction. The feedback from the professional development could better equip the school district to provide supports to teachers. Through literature review, data collection, and data analysis, it became evident that mathematics teachers in a NRHSD need support to consistently use online formative assessment data to inform instruction. The professional development focused on one platform, and it targeted and differentiated based on user level. Research supported the need for professional development that caters to individual user needs based on level of competency.

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Appendix A: The Project

Link to Project Website: https://sites.google.com/view/kslingpdonlinefomrative/home

Workshop Title: Maximize Online Formative Assessment Data to Inform Instruction
Learning Outcomes: 1. Define informed instruction 2. Determine individual Edulastic user level 3. Create online formative assessment content 4. Analyze data from online formative assessments 5. Use data from online formative assessments to inform instruction
Delivery Mode: Face-to-Face
Focus Area: Using Online Formative Assessment Data to Inform Instruction

Description:
Day 1:

Time	Activity
8:00 AM - 8:45 AM	Sign-In Breakfast Introductions
8:45 AM - 9:45 AM	The facilitator will lead a whole group presentation/discussion: Informative Data What is informative data? What is formative assessment? JamBoard Activity Who is that data for?
9:45 AM - 10:30 AM	Self-Assessment
10:30 AM - 11:45 AM	Break
10:45 AM - 11:30 AM	Review the different levels of users Novice Proficient Advanced Expert
11:30 AM - 12:30 PM	Lunch
12:30 PM - 1:15 PM	Determine which participants belong to which groups Create break-out groups
1:15 PM - 2:00 PM	Leveled activity using Edulastic in Break Out Groups - Edulastic Scavenger Hunt
2:00 PM - 2:30 PM	Whole group debrief & exit ticket

Day 2:

Time	Activity
8:00 AM - 8:45 AM	Sign-In Breakfast
8:45 AM - 9:45 AM	Re-Cap - the presentation will be based on data from the exit slip and other formative assessment throughout the previous days' activities (modeling how to use data to inform instruction) Review morning/afternoon goals for each group level Reform Break out groups
9:45 AM - 11:00 AM	Break out group leveled activities: building Edulastic formative assessments based on user-level Novice - set up Google classroom integration, create assessment with pre-made question bank Proficient - create a multiple choice assessment Advanced - create questions where students create graphs Expert - create questions where students create equations
11:00 AM - 11:30 AM	Whole group discussion Pros/Cons

11:30 AM - 12:30 PM Lunch
12:30 PM - 1:30 PM Break out group leveled activities: building Edulastic formative assessments based on user-level

Novice - create an assessment with pre-made questions
Proficient - author multiple choice questions
Advanced - complete data analysis activity, multiple choice
Expert - complete data analysis, graphs

2:00 PM - 2:30 PM Whole group debrief & exit ticket

Day 3:

Time Activity

8:00 AM - 8:45 AM Sign-In
Breakfast
8:45 AM - 9:15 AM Re-Cap
Review morning/afternoon goals for each group level
Reform Break out groups
9:15 AM - 10:45 AM Break out group leveled activities: building Edulastic formative assessments based on user-level

Novice - author multiple choice questions
Proficient - create questions where students create graphs
Advanced - create questions where students create equations
Expert - create questions where students create equations

10:45 AM - 11:30 AM Whole Group - present created items, with explanations of how

11:30 AM - 12:30 PM Lunch
12:30 PM - 1:30 PM Whole group - what do we do with the data?

2:00 PM - 2:30 PM Whole group debrief & exit ticket

Materials:
Online Formative Assessment Data Workshop
Day 1
Day 2
Day 3
Self-Assessment

Appendix B: Email Invitation

Dear Prospective Participant,

My name is _____, a doctoral student at Walden University. I am conducting interviews as part of a research study exploring how mathematics teachers in a NRHSD use online formative assessment data to inform math instruction in high school. I will be guided and supervised by _____, my Chair, in completing this study. As a Walden student, having completed the required training and been approved, I am eligible to conduct this study. You are being invited to take part in a study because you have experience with formative assessment. In addition, your invitation requires that you are (a) over the age of 18, (b) not in a subordinate position to the researcher. If you agree to be interviewed, the interviews will take approximately 60 minutes. Following your interview, you will be provided a transcribed copy of the interview in digital format that will be emailed to you within 30 days of your interview. This will provide you with the opportunity to review the transcript and check for accuracy. It should take about minutes to review this transcript. If you note any mistakes, errors, or omissions, you will have 7 days from your receipt of the transcript to provide the researcher with any corrections via email. Following 7 days, it will be assumed that the data provided to you reflects the true and accurate content of your interview with the researcher.

For the interviews, we can conduct an online meeting via Google Meet, Zoom, or by using another online platform. Your responses to the questions will be kept confidential. There is no compensation for participating in this study, and you can withdraw at any time. Your participation will be a valuable addition to this research. If you are interested in participating, please contact me via phone at or by email at. If you have any questions, please do not hesitate to ask. Thank you for your time.

Sincerely,

. Appendix C: Interview Protocol

I will use the following interview protocol:

1. I will introduce myself to the participant as a Walden University doctoral student and inform him or her of the time and the reason for the interview.
2. I will make available to the participant a copy of the consent form to read and sign. I will ask the participant to retain a copy after signing.
3. I will inform the participant of my audio recording of the interview.
4. I will use the following research questions to guide the study: What are teachers' perspectives on ease of use, usefulness, and attitudes towards online formative assessment to inform high school mathematics instruction?

   What are high school mathematics teachers 'recommendations regarding the training, resources, and support they need to consistently use formative assessment to inform their instruction?

   a. Interview Questions:
5. What are some of your beliefs of high school mathematics in the NRHSD?
6. What is your perception of student success of high school mathematics in the NRHSD?
7. What activities would you like to do, or see done, in high school math to best meet the needs of high school math students?
8. What teaching strategies are effective for engaging students with the content taught in high school math classes?

9. What is your perception of perceived usefulness (PU) with regard to the use of online formative assessment to inform high school math instruction?
10. What is your perception of perceived ease of use (PEOU) regarding the use of online formative assessment to inform high school math instruction?
11. What are some of the possible positive effects of online formative assessments in high school math?
12. What are some of the negative effects of online formative assessments in high school math? And, why might this be so?
13. What are some of the recommendations regarding the training, resources, and support would you suggest to help in consistent use of online formative assessment to inform high school teachers 'math instruction?
14. What more would you like to add about the interview topic that I have not yet addressed?
15. I will thank the interviewee for participating, stop the audio recording, and conclude the interview.