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Formative Assessment and Technology in the Mathematics Classroom

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Abstract

This literature review investigates the use of formative assessment and technology in the classroom. There has been research to show that mathematics proficiency has dropped recently in the United States and researchers are looking to identify new strategies for student growth. Utilizing formative assessments, as well as targeted, immediate feedback for students, can help to improve student learning. As educational technology becomes more prevalent, more studies and research are focused around its effectiveness toward student achievement. The research found that formative assessment strategies, coupled with new technologies, can positively impact student achievement.

Keywords: formative assessment, technology, student achievement

Table of Contents

Formative Assessment and Technology in the Mathematics Classroom

The United States historically underperforms compared to other industrialized countries as it pertains to mathematics achievement and proficiency. According to the National Center for Educational Statistics (NCES), in 2015, eighteen percent of fourth-grade students, twenty-nine percent of eighth-grade students, and thirty-eight percent of twelfth-grade students in the United States are performing below what is considered proficient (Mathematics Performance, 2017). While proficiency numbers have risen in recent years, there is a negative trend in students remaining proficient from year to year, as proficiency numbers decrease substantially from one grade to the next (Berrett & Carter, 2018). The United States is among a group of countries whose 15-year-old students' math performance has worsened from 2000 to 2009 on the Programme for International Student Assessment (PISA) exam (Vidgor, 2013).

The problem is that schools are focused on attempting to increase standardized assessment scores by spending more time in test preparation rather than focusing on student mastery of concepts. Many schools are devoting more time and resources toward test preparation and administration in core content areas of reading, writing, and mathematics at the expense of other important curricular areas (Fairman et. al, 2018) . Standardized assessments have become the way that students and teachers alike are evaluated. Briggs & Dominigue (2011) write, "The use of standardized test scores to evaluate teachers involves making difficult choices in which there are invariably some tradeoffs between decisions that might be optimal from the perspective of estimating an unbiased causal effect, but not optimal from the perspective of crafting an educational accountability policy with a coherent theory of action" (p.21). Instead of focusing efforts on improving summative standardized test scores, educators should be using the data and information that is available daily in front of them to drive instruction, which can be

accomplished through formative assessments. Effective teachers are continuously using formative assessment to check for student understanding and to know where to go next with instruction (DeFour et. al, 2016).

The purpose of this literature review is to identify best practices in formative assessment techniques that will improve student achievement in mathematics. As the education world continues to evolve into in-person, hybrid, and virtual classroom models, the ability for educators to assess their students has also improved. This adaptation has led to the use of technology as a method for assessment and feedback and has begun to change the way educators are assessing student learning. The hope is that, through research, this literature review will encourage educators to identify best formative assessment practices that will foster student growth.

This review is thematic in structure. As research was compiled, themes regarding the importance of feedback, strategies for formative assessment, the impact of technology use in the classroom, and the use of technology-based formative assessment. The focus of the research was peer-reviewed and scholarly articles published within the last ten years to obtain the most recent and accurate research. The articles were gathered through searches using the DeWitt Library online database at Northwestern College, as well as the Google Scholar search engine.

Review of Literature

Formative Assessment

A study by King (2016) looked to determine whether formative assessment strategies enhance the educational learning experience for lower-level learners in a mathematics classroom setting. The study divided eight fifth-grade students, who were identified as struggling students, into two groups, a control group with no intervention and an experimental group where frequent

formative assessments would be used. A pre-test was given to both groups of students, followed by a post-test to determine achievement outcomes. The findings suggest that the group of students provided with formative assessments had higher achievement than the group who were instructed as usual (King, 2016). While the sample size is small, these findings indicate that formative assessments have value.

A study by Xiaoyan, Marja, & Michiel (2016) further suggests that formative assessments are a valuable tool for teachers. This study focused on the use of formative assessments in primary mathematics classrooms in China. Two hundred sixteen students and six teachers participated in the study where teachers in six primary mathematics classrooms implemented CATs into their instruction. Throughout the implementation process, the teachers were interviewed by the authors to solicit feedback as to the progress made by utilizing the CATs. According to the authors, the teachers in this study indicated that they felt the CATs were a valuable tool for identifying student understanding of different skills. The results of the interviews suggested that teachers were more willing to use CATs in the classroom as an informative tool for student understanding, rather than to adapt future instructional plans. The teachers in this study did not utilize the CATs to inform instruction. Rather, they used the assessments to gather information and provide instant feedback to students. A majority of the teachers in the study, 5 out of 6, communicated that they would use the CATs in their classrooms in the future (Xiaoyan, Marja, & Michiel, 2016).

Dirk et. al (2012) present similar findings about the effects of formative assessment on student achievement. Their five-year study took place in a Business & Economics school in the Netherlands, where 3,900 students participated. This study was designed to use formative assessments to improve instruction for students in an e-learning classroom. Students entering the

university were given two pre-assessments to determine their levels of proficiency in mathematics. After the pre-assessments, students had the opportunity to join a summer course designed to help them succeed in their first-year mathematics courses. The student groups were broken into three groups after this choice: students who participated and met expectations, students who participated but did not meet expectations, and students who chose not to participate. Students who participated received instruction in mathematics with interwoven formative assessments that helped guide future instruction. The author also recommends the use of pre-assessments, or broad interim assessments, to identify strengths and weaknesses of student understanding. The findings from this research indicate that first-year students using these formative assessments and participating in the summer course, which implemented the formative assessment strategy, were substantially more successful in future courses than students who do not. The findings were found to be statistically significant to prove this statement (Dirk et. al, 2012).

A study of 83,799 students at 413 schools in North Carolina who utilize an online formative assessment program (OFAP) further demonstrates positive effects of formative assessment on student achievement. Kline (2013) studied the effects of online formative assessment type and frequency on student achievement on end of year summative assessments. In this study, students participated in an online formative assessment program in reading and mathematics. The formative assessments were frequent, and there were multiple forms of assessments utilized throughout the school year. Students were then assessed using a summative assessment. The summative assessment data was obtained from the North Carolina Department of Public Instruction (NCDPI) in the form of a standardized assessment. The formative assessment data was acquired from the OFAP vendor. According to the author, the results

suggest that formative assessments are positively related to student achievement in reading and mathematics. Results suggest that, short-cycle reading formative assessments can result in positive growth for students in reading. In fact, both student and school-level short-cycle reading formative assessment frequency were suggested to have a positive effect on student achievement in reading. There were also positive gains for mathematics students, as the results indicate that long-cycle mathematics formative assessments have positive effects (Kline, 2013).

Moreover, a study by Shore, Wolf, & Heritage (2016) examined the effects of formative assessment systems on planning, instruction, and learning. The teachers in this study were provided with the English Learners Formative Assessment System (ELFA) materials prior to training. Next, teachers participated in training to introduce the ELFA system and provide guidance on how to use it for formative assessment purposes. For two to four lessons, each teacher used the ELFA assessment forms. At least two of the researchers observed each lesson. Interviews of the teachers were recorded before and after each lesson. The authors suggest that teachers not only found value in the system, but they also felt that its use improved their knowledge and practice. The results indicated that five of the eight participating teachers positively remarked on the value in the ELFA system as an approach that expanded their current resources and their understanding of skills, and that ELFA could readily be integrated into instructional planning (Shore, Wolf, & Heritage, 2016).

Using peer and self-assessments as a formative assessment tool can also help improve self-efficacy in math. A study by Adediwura (2012) examined the effect of peer and self-assessment on the self-efficacy and students' learner autonomy in the learning of mathematics as well as determining the attitude of male and female students towards the use of peer and self-assessment. Sixty senior secondary students participated in the study where two

questionnaires were given to students, one at the beginning of a unit and one at the end. The questionnaires tracked the students' study habits, self-efficacy, and attitudes on peer and self-assessment. After the beginning questionnaire, students took part in a 3-exercise course on peer and self-assessments. Students completed a short quiz on the exercises before completing the second questionnaire. The use of peer and self-assessment in math lessons are believed to enhance students' self-efficacy and promote learner autonomy in learning mathematics (Adediwura, 2012).

The use of formative assessments, coupled with self-directed learning models, can improve self-efficacy and achievement for students as well. Sumantri & Satriani (2016) studied the effects of formative assessments and self-directed learning on student achievement and self-efficacy for seventy-two fourth grade students. In this study, students were placed into four sections based on formative assessment and self-directed learning type. Students were either provided with essay type formative assessments or multiple-choice formative assessments. They were placed in groups of high self-directed learning or low self-directed learning models. Data was collected via assessment results and a self-directed learning questionnaire. Students with high-levels of self-directed learning who were given essay formative assessments scored higher than those using the multiple-choice formative assessment, while students with low self-directed learning scored better using multiple-choice formative assessments (Sumantri & Satriani, 2016).

Providing teachers with professional development opportunities in formative assessment may improve teaching practices and teacher-efficacy. A study by Andersson & Palm (2018) suggests that giving educators opportunities for professional development can improve motivation for educators. This study of twenty-two fourth grade teachers in Sweden implemented a professional development program in formative at the beginning of the school

year. Participating educators took part in surveys and interviews before the process began. Then, the educators met with the leader of the development program for six hours, once a week for a term of the school year. Teachers also had an extra seventy-two hours of preparation of materials for formative assessment. At the conclusion of the school year, teachers completed another survey and interview for comparison purposes to the initial survey. The results of the surveys and interviews showed the PDP the teachers were highly motivated to make significant changes in their teaching towards a more formative classroom practice. According to the authors, having a process-oriented PDP, with appropriate planning time provided possibilities for the teachers to actively engage in the activities above as self-regulated learners in a collaborative and supportive environment (Andersson & Palm, 2018).

Formative Assessment Strategies

Camahalan & Young (2015) suggest that the use of math journals as a formative assessment technique can improve instruction and student achievement. One teacher, one learning assistant, and seventeen kindergarten teachers participated in a seven-day study about the effects of math journals as a formative assessment tool. In this study, Students were given a pretest and a post-test. During the five instructional days, students were asked to track answers and understanding in a math journal that they would use to hold discussions with peers. The teacher used these journals to formatively assess student understanding and to identify students who needed further review/interventions. The use of math journals helped the teacher to identify students who needed further help, which led to significant gains from the pretest to post-test for all students (Camahalan & Young, 2015).

Formative assessments may impact higher education students as well. A study by Paz-Albo & Escobar (2016) explored the impacts of Exit Tickets as a formative assessment strategy on student achievement and motivation according to one hundred fifty-eight prospective teachers. The use of exit tickets to improve student achievement and motivation. Two teachers implemented the use of Exit Tickets as a formative assessment strategy in two, twelve-week preservice education classes. Students then completed a questionnaire at the end of the course about their perceptions of the use of Exit Tickets. The author suggests that the results of the questionnaire indicate that exit tickets provide evidence of mastered content and students' challenges, improve students' behavior and academic achievement, and have the most positive impact on students' learning outcomes (Paz-Albo & Escobar, 2016).

Feedback

A study by Kickmeier et. al (2014) used gamification to provide students with feedback when assessed on division facts. Forty second grade students completed two sessions on the gamification tool, followed by a student survey. The tool tracked usage, progress, and errors, giving feedback to both the teachers and the students. According to the findings, students who used the gamification tool scored slightly higher than those who did not. In addition, Kickmeier et. al (2014) suggest that the gamification tool increased student motivation as well. These findings indicate that feedback increased student achievement (Kickmeier et. al, 2018).

The research of Leenknecht & Prins (2018) presents similar findings in the effectiveness of feedback. In their study, 95 sixth grade students from four primary schools in the Netherlands participated in a peer feedback activity. The experimental group defined the standards and assessment criteria that would be used within the classroom through a class discussion before providing peers with feedback for a brochure that was created. The control group did not

participate in the definition of the criteria or standards. After peer feedback, the brochures were scored, and a manipulation check was completed to determine bias in feedback for the two groups. It was found that students in the experimental group scored better on the manipulation check and were less likely to compare their own work with their peers' work while providing feedback (Leenknecht & Prins, 2018).

Chiu & Alexander (2014) asserts that immediate, corrective feedback has a positive impact on student performance. In their study, eighty, five-year-old students were broken into two groups of students, an experimental group and a control group. Both groups were assessed using an Interactive Analogical Measure (IAM) with the experimental group receiving immediate, corrective feedback. The control group received no feedback.The findings suggest that feedback significantly influenced student performance. Students who did not receive feedback did not respond as consistently and demonstrate understanding throughout the assessment. On the other hand, the students in the experimental group performed at a higher level more consistently (Chiu & Alexander, 2014).

A study by Rakoczy et. al (2019) suggests that formative assessment feedback can help build self-efficacy. This study consisted of 26 teachers and 620 students in 18 middle track schools in Hesse, Germany. During the 13 weeks for the unit of study, students were given pre-tests and post-tests for both achievement and self-efficacy. The study results indicate that while there was no significant increase in student achievement, there was evidence that students' perceptions about their abilities improved (Rakoczy et. al, 2019).

Not all studies indicate positive use of feedback in the classroom. Havnes et. al (2012) completed a qualitative study to determine the use of feedback practices in six secondary schools in Norway. One hundred ninety-two teachers and three hundred ninety-one students completed

surveys, questionnaires, and interviews to determine feedback practices in vocational training as well as three core subject areas: Mathematics, English, and Norwegian. The surveys deemed that formative feedback was deemed rare in this study, as teachers focused on providing feedback more when a grade was given for an assessment or assignment. Context of teaching and nature of learning was important, as feedback was more prevalent in vocational training and language classes than mathematics. The interviews showed that systematic feedback as a support for student learning was weak (Havnes et. al, 2012).

A study by Rathje (2018) adds to the study by Havnes et. al (2012) in suggesting a gap between research and practice in terms of feedback from assessment. The author of this study observed three mathematics teachers across six sections of various levels of mathematics. The teachers provided the author with curriculum, assessments, and lesson plans. The teachers also took part in interviews to discuss formative assessment and the importance of feedback. The author communicates that the findings suggest that there is a gap between theory and practice for formative assessment. While the teachers appropriately described and discussed effective formative assessment in the interviews, practice showed a summative manner of student learning. Similarly, the teachers' beliefs about feedback were disconnected from practice. The author recommends further training for how to use assessments and feedback (Rathje, 2018).

A study by Beesley et. al (2018) suggests that professional development can be used to increase the use of formative assessment practices. Forty-seven teachers in seven middle schools in Colorado took part in the Assessment Work Sample Method professional development over the course of a year. During the development sessions, data was collected through teacher work samples for assessing teacher practice in formative assessment, a pretest of content and pedagogical knowledge in mathematics, a district-wide mathematics assessment to assess the

impact of AWSM on student mathematics achievement, and teacher focus groups to assess teacher perceptions of the impact of AWSM on their knowledge and practice of formative assessment. According to the authors, the findings of this study indicate that the AWSM model increased formative assessment practices, especially in the areas of feedback and assessment criteria, regardless of the teachers' previous pedagogical knowledge (Beesley et. al, 2018).

Technology in the Classroom

McClung (2019) presented a study about the impact of one-to-one technology on test scores in seven middle schools in Arkansas. Two thousand sixty students and sixty-three staff members participated in the one-year study. Students were either in the control group (no intervention) or the experimental group with 1:1 technology. Students were assessed across content areas using the summative ACT Aspire assessment at the end of the school year. Results were compared between the control group and experimental group. Surveys were also provided to teachers to determine their thoughts as to whether there was a positive relationship between technology use and student achievement. The author describes the results of the analysis by stating that the findings indicate students who used one-on-one technology performed higher in all tests in all subjects compared to the traditional use of technology, the differences were found to be statistically nonsignificant. Comparisons between all groups indicated the mean scores for students in core content areas using one-on-one technology conditions were higher than scores for students in the same subjects using traditional technology. Taken together, these results suggest one-to-one technology does positively influence students' test scores. As for the surveys, the general perception of teachers is that technology has a positive effect on instruction and student learning (McClung, 2019).

Harris, Al-Bataineh, & Al-Bataineh (2016) further suggest that one-to-one technology may have an impact on student achievement, specifically in the mathematics classroom. This twelve-week study consisted of forty-seven fourth grade students in a school in Chicago. There were two groups of participants. Twenty-five students participated in the experimental group, while twenty-two students were in the control group. The experimental group not only had access to 1:1 technology, they were engaged with the Discovery Education program, which used assessments and data to inform instructional decisions. Teachers were able to use the data from the assessments to differentiate instruction and identify students' strengths and weaknesses in mathematics. The control group used traditional instructional methods. While the experimental group started out scoring significantly higher on common assessments, by the end of the study the control group's scores outperformed the experimental group. The author suggests that this is due to the control group being further along in the curriculum than the experimental group (Harris, Al-Bataineh, & Al-Bataineh, 2016).

A study by Erbas & Demirer (2019) added to the results by McClung, finding that the use of augmented reality in a 9th grade biology class can increase student motivation and engagement. There were two groups in this study, a control group and an experimental group. Both groups completed a pre-test, post-test, a motivated strategies for learning questionnaire, and an interview. The control group, between assessments, followed the traditional lecturer-centered classroom. Meanwhile, the experimental group incorporated the use of augmented reality (AR) into the lessons between assessments. Data was tracked via the pre-test, post-test, questionnaire, and interviews. The research suggests that the use of augmented reality did not make a significant difference in student achievement on the post-assessment. However, the questionnaire indicated that student motivation and engagement increased due to the use of AR in the

classroom. The interviews also suggest that students' self-efficacy and inclination to participate were improved through the use of AR (Erbas & Demirer, 2019).

Similarly, DiCicco (2016) studied whether the use of Google Classroom would increase achievement for students with learning disabilities. This three-week study, consisting of thirty middle school students, examined the use of Google Classroom in a special education social studies classroom. Students were split into two groups, an experimental group and a control group. Both groups of students were provided a pre-test to determine students' background knowledge on the topics being taught. The experimental group then participated in a three-week unit plan that incorporated Google Classroom as the main platform for instruction. This included the use of Google Slides, Google Docs, Google Forms, and G-Mail. The control group was taught using a textbook and additional traditional instructional strategies. After the three-week unit, students were given a post-assessment on the content that was taught. Students in the experimental group were also given a survey to determine their feelings on the use of Google Classroom. The findings indicated that the experimental group scored an average of 7 to 9 points higher on the post-assessment than students who were in the control group. The student survey also suggests that students enjoyed the use of Google Classroom, as 11 of the 15 students recorded positive results in their surveys (DiCicco, 2016).

Not all studies present evidence that technology tools are more effective than traditional instructional methods. Mattoon et. al (2015) studied the use of digital versus traditional manipulatives for pre-kindergarten students. The six week study use of digital versus traditional manipulatives in improving learner's computational concepts and skills. Students were placed into two groups: the traditional manipulative group and the digital manipulative group. Each group was given a pre-test, instructed with the choice of manipulative, and a post-test. After

students were given the pre-test, they were instructed on five key computational skills while using the manipulatives: computational skills included concrete modeling of addition, solving "missing addend" problems, mental addition, equal division, and counting on strategies. The teacher used the same planning format, vocabulary, and instructions for both groups, the only difference was the type of manipulative. Immediate feedback was provided for both student groups. According to the author, the findings suggest that while both the traditional manipulatives and the digital manipulatives were effective in improving students' computational skills, but neither more significantly successful than the other (Mattoon et. al, 2015).

Technology-based Formative Assessments

A study by Vasquez et. al (2017) suggests that technology-based formative assessment can have a positive effect on student achievement. This six-week study of ninety students explored the use of technology-based self-paced learning programs for spelling. There were two phases of research completed, with students using different technologies for each phase. The first phase had students complete the intervention using Tablet PCs, while the control group of students used traditional review methods. In the second phase, the students used Tablet PCs, while the control group used interpersonal computers (IPCs). The results of the study indicate that students who used self-paced Tablet PCs for formative assessments showed significant gains over those who did not in both phases (Vasquez et. al, 2017).

NG, Shi, & Ting (2020) explored the impact of different technology-based geometric learning tools on student achievement. Seven teachers and one hundred seventy-four students participated in a five-month study where two groups were given different technology tools, dynamic geometric environment (DGE) and 3D pens, for formative assessment and feedback

purposes. There were two experimental student groups in this study. One group was provided 3D pens to explore geometric learning, while the other was offered a dynamic geometric environment (DGE). The DGE setting provided students with instantaneous feedback, while there was no immediate feedback for the 3D pen group. Both groups were given a pre-test, post-test, and delayed post-test. After completing the pre-test, students were able to explore geometric shapes using the identified technology interventions (DGE & 3D pen) during two, seventy-minute sessions. After the exploration, students were provided a post-assessment to determine their understanding of the geometric shapes. The delayed post-test was given five months after the original post-test to determine retention rates for both student groups. The results indicate that students who participated using the DGE improved at a higher rate between pre-test and post-test than students using the 3D pen. According to the authors, the post-test showed that the DGE group outperformed the 3D group across multiple categories and had a stronger effect on higher-level geometric learning. However, the delayed post-test suggested that students who participated in the 3D pen group outperformed the students in the DGE group in retention rates (NG, Shi, & Ting, 2020).

Another technology tool investigated was the use of the TI Navigator as a classroom connected technology (CCT) for formative assessment in a study by Shirley & Irving (2015). The authors conducted in class observations, as well as multiple interviews of the participating teachers and a student focus group. Interviews of teachers and students in participating classrooms provided evidence regarding how CCT assisted teachers in collecting evidence of student learning, interpreting it, and making decisions about instruction. The author asserts that CCT facilitates the implementation of instructional tasks, that CCT helps students and teachers

know more about student learning, and that CCT supports teachers' pedagogical decision-making (Shirley & Irving, 2015).

Hudesman et. al (2013) further suggests that a technology-based formative assessment program, coupled with self-regulated learning, can impact student achievement. This three-year study of one thousand one hundred ninety-eight students in an urban college of technology examined the use of an Enhanced Formative Assessment Program (EFAP) and Self-Regulated Learning (SRL) to improve mathematics achievement on pass rates in developmental mathematics courses as well as the mathematics section of the Computer-Adaptive Placement Assessment and Support System (COMPASS). The study compared students enrolled in EFAP/SRL courses against those who are not. Observation of pass rates for students enrolled in EFAP/SRL courses versus students in the traditional developmental mathematics courses. The findings reveal students enrolled in the EFAP/SRL had higher pass rates in the developmental mathematics course, as well as the mathematics section of the COMPASS (Hudesman et. al, 2013).

Robertson, Humphrey, & Steele (2019) examined the impact of technology-based formative assessment on student achievement and participation, as well as feedback and grading effects on instructors. This study of three teachers and one hundred fourteen students tested the use of technology-based assessments in comparison to teacher created assessments. Participants in the study completed a pre-test, formative assessment, and post-test. The control group (not technology-based assessment) had higher participation rates than the experimental group. Students who participated in either type of formative assessment scored higher on average than those who did not. The results indicated that the use of technology-based formative assessments

cut down on feedback time for students, as well as grading time for instructors (Robertson, Humphrey, & Steele, 2019).

A study by Tay (2015) implies that the use of a technology-based formative assessment tool can increase student engagement. The study of three hundred forty secondary students participated in a study that investigated the use of technology-based formative assessment tools versus traditional writing methods. Students were asked to complete multiple formative assessment pieces. One piece was written using traditional paper and pen methods, while the other was completed using an online forum. Students were then asked to complete a questionnaire about the two types of assessments, the feedback from each, and their feelings on the process. Students were also interviewed about the process. The findings imply that students were more likely to engage in SRL when the formative assessment was provided in a real-world context through the use of the technology-based platform (Tay, 2015).

A study by Musti-Rao & Plati (2015) compared two separate formative assessment strategies to determine best practices for student success. The study, consisting of twelve third-grade students, provided students with two separate formative assessment interventions, the use of detect–practice–repair (DPR) versus self-mediated iPad instruction in mathematics. Students were given baseline assessments prior to receiving either the DPR or iPad intervention. After the baseline, students were placed into two groups. They received formative assessments, and corrective feedback. After the intervention was completed, a summative probe was administered and a generalization probe containing the inverse facts was administered 1 week after intervention ended. The author suggests that results show that iPad intervention resulted in substantially higher response rates than the DPR intervention for all students. Students showed a steady increase in the number of math facts they practiced during each of the intervention

sessions, making twice as many responses in the iPad intervention compared to the DPR intervention (Musti-Rao & Plati, 2015).

Future Research

After conducting a review of the literature, as well as the themes that emerged, it is clear that there are areas where future, and more current, research is needed. The first area is current research on traditional formative assessment strategies in mathematics. Many research articles that feature studies on formative assessment strategies in mathematics date back to over ten years. There is no overstating the importance of research of effective educational strategies. As Voinea (2018) states, "The formative assessment plays a powerful role in this direction, by making possible a continuous development of students' learning, including the knowledge and skills of learning assessment and improvement through feedback incorporation" (p.21). With the educational world changing by the minute, new research on the use of traditional instructional methods would enable educators to determine their current value.

Another area of future research is the growing impact of the use of technology tools and immediate feedback on student learning. It was clear that, through research, technology is becoming an ever-present tool in the classroom. With one-to-one technology becoming the norm for some school districts, educators are able to teach and assess in ways that they never were before. Providing immediate, targeted feedback during the formative assessment process is vital to teaching and learning. Technology can be a substantial support during the teaching and instructional process because it offers formative assessment of learners' skills and knowledge (Elmahdi et. al, 2018). As technology continues to evolve, new and innovative ways of assessing students will present themselves. As this occurs, research into the best tools and strategies for formative assessment will be needed.

Conclusion

The need for educators to shift focus from preparation for standardized summative assessments to an instructional model where formative assessments inform instruction and dictate learning is evident. The themes that emerged from this research show that formative assessment, and the feedback received as a result of the strategies used, is a vital part of the instructional process. Educators all over the world are utilizing formative assessment as a way to understand student knowledge and communicate with students about how they can improve. The advances in technology have added another dimension to this research. With technology becoming more readily available, educators are now able to use a variety of technology tools for formative assessment purposes. Access to the internet at home jumped from less than 20% in 1997 to almost 75% in 2012 in the United States, and to 78% of school-aged children in developed countries around the world (Bulman & Fairlie, 2016). As technology advances continue to progress, the way in which we learn about our students and make decisions about instruction must as well.

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