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Abstract

The purpose of the current research was to determine the types of educational technology preferred by students and instructors, and to compare formative and summative scores within student classes. During a unit of study within a semester-long class, 44 volunteer student participants were administered four technology-based assessments designed to help them prepare for the summative exam. Following the summative assessment, students were asked to complete a feedback form to explain what type of technology assessment they felt was most helpful in providing them with feedback on their knowledge and which was most interesting to use. Instructors also provided feedback on ease of use and collected students' scores on formative and summative assessments. The results of this study suggest that technology-based formative feedback can be effective in helping students prepare for summative exams and that students mostly preferred competitive and fun tools that provide immediate feedback.

Introduction

Use of technology in the classroom continues to expand (Cortez, 2017) and has reinvented the way we teach by allowing teachers more flexibility and opportunities to differentiate (Collins & Halverson, 2018). With the endless stream of new technologies, teachers have the power to change the landscape of their teaching both inside and outside of the classroom. As technology transforms the traditional models of education, teachers are called to find new opportunities to utilize the vast array of technology tools.

One instructional area that has been impacted by the technology surge is the use of technology as a formative assessment tool. Educators frequently use tools, such as Kahoot or Google Forms to solicit feedback and assess content knowledge from students. With the rapid changing of technology, much research has been conducted to demonstrate the advantage of educational technology as a superior tool for formative assessment, when compared to paper-based and web-based formative assessment tools. Technology has greatly improved the way assessments are given and graded for feedback, and the learning gains and student motivation are also evident (Alzaid & Alkarzae, 2019).

In higher education, instructors spend time mostly focusing on summative assessment methods, such as exams, projects, or final papers. Though college instructors have less time in class with students compared to elementary or secondary teachers, technology assessment tools can be used to provide valuable formative feedback to instructors and to students (Byran & Clegg, 2006) and may help better prepare students for

summative assessments. Many of the available technologies make it easy for instructors to give weekly assessments to determine whether students have an understanding of the content taught, and many formative assessments allow instructors to provide students with immediate feedback to track student performance and to improve student engagement in the college classroom (Serhan & Almeqdadi, 2020).

More specifically, educational technology assessments are interactive and provide students with immediate feedback regarding their understanding, in addition to providing students with an interactive and fun learning environment (Hooshyar, Ahmad, Yousefi, Fathi, Horng, & Lim, 2016). Like all technology, educational assessment technologies are also continually developed for classroom use, and the need exists to examine different effects of technology assessment tools in a variety of classroom settings (Alzaid & Alkarzae, 2019). Therefore, the purpose of this research was to investigate the differences between several different educational technologies, to determine educational technology preferences of students and instructors, and to determine if formative technology assessments impact students' scores on summative assessments.

Literature Review

As more schools improve their digital infrastructure and have moved to one to one digital device learning, acceptance and desire for digital learning tools has increased (Richards, Stebbins, & Moellering, 2013). Most students and teachers possess a positive attitude toward technology use and integration in the classroom (Durak & Sartipeci, 2017), and a variety of technology tools are available for instruction and assessment. These technology tools include web-based tutoring systems, such as MathLab (Hooshyar et al., 2016) and game-based assessments, such as Kahoot! (Alzaid & Alkarzae, 2019; Wang, 2015). These different types of technology provide a variety of positive and negative outcomes for the learner.

Research has found that the use of technology in the classroom can improve student engagement (Schindler et al., 2017) and may improve student learner outcomes (Bond & Bedenlier, 2019). However, researchers have also noted that classroom technology may cause college students to be overwhelmed and frustrated, especially due to technological issues (Bedenlier, Bond, Buntins, Zawacki-Richter, & Kerres, 2020). Differences result from the different systems and preferences of the user (Hooshyar, Pedaste, & Yang, 2020).

Importance of Technology for Formative Assessment

The use of technology in the classroom allows for streamlined assessment and provides students and teachers with immediate feedback (Alzaid & Alkarzae, 2019). This immediate feedback is beneficial to students and teachers to check for understanding, determine concepts needing further review, and prepare for summative assessments (Winstone & Carless, 2020). The teaching environment changes and students are able to share their learning while the lesson is occurring, creating a more student-centered environment (Irving, 2015). Intelligent Tutoring Systems (ITSs) have demonstrated the benefits of increasing student engagement and learning through online formative assessment games, and these games may also lead to increased problem-solving skills (Hooshyar, et al., 2016). Furthermore, mobile learning and technological assessment tools have been touted as

effective for behaviorally engaging students in higher education (Bedenlier et al., 2020).

Educational Technology in Higher Education

In addition to the value of formative feedback provided by technology educational assessment, the feedback also provides students in higher education with opportunities to develop self-regulating learning skills through seven principles of good feedback practice: helps clarify what good performance is; facilitates the development of reflection and self-assessment in learning; delivers high quality information to students about their learning; encourages positive motivational beliefs and self-esteem; provides opportunities to close the gap between current and desired performance; provides information to teachers that can be used to help shape the teaching (Nicol & Macfarlane-Dick, 2006). Omar (2017) found that a technology-based assessment tool, Kahoot, met four principles of good feedback practices. In his study, he explained that Kahoot effectively facilitates the development of reflection and self-assessment in learning, encourages positive motivational beliefs and self-esteem, provides opportunities to close the gap between current and desired performance, and provides information to teachers that can be used to help shape their teaching (Omar, 2017). In a review of learning technologies, Hooshyar, Pedaste, Saks, Leijen, Bardone, & Wang (2020) reviewed 64 articles relating learning technologies to self-regulated learning and explained that though most learning technology support cognition, metacognition, and motivation, many do not support preparation and emotion, which is a large part of self-regulation.

Though increasing students' self-regulation is an important component of higher-level education, improving student understanding demonstrated on summative assessment scores remains a critical part of higher education. Hooshyar et al. (2016) examined formative assessment feedback with technology for an experimental and control group. While the control group saw few knowledge gains and interest, the experimental group indicated much interest in learning from the consistent feedback received and also achieved much greater learning gains when compared to the control group. Students and instructors can use these characteristics of such technology-based assessment to optimize and improve their preparations for summative assessments.

Types of Formative Assessment Technologies

Technology has also diversified classroom assessments by allowing teachers to assess students in multiple ways. Learning Management Systems, such as Moodle, offer a variety of content, quizzes, and assignments to assist students, though these technologies may lead students to procrastinate because they require self-pacing (Hooshyar, Pedaste, & Yang, 2020). When considering in-class assignments, instruction has moved from students filling out multiple choice in-class quizzes to students completing quizzes live via Kahoot, Quizlet, Menti or Socrative. Other technology-based tools for formative assessment, like Plickers, encourage student engagement and individualized learning (Elmahdi, Al-Hattami, & Fawzi, 2018). The inclusion of these methods not only allows for a more creative assessment but also motivates and engages students even more in the classroom (Rafool, Sullivan, & Al-Bataineh, 2012).

Technology-based assessments are generally more hands-on and require a deeper level of understanding from students. Game-based assessments also lead to greater long-term usage when used as formative assessment following a lecture (Wang, 2015). Technology assessments provide students with various types of assessments, such as multiple choice or short answer to allow for a deeper level of understanding. Without technology, assessment would still consist of pencil and paper, which limits the ability to provide consistent, formative feedback necessary for learning and understanding new knowledge (Alzaid & Alkarzae, 2019). Given that there are many benefits to the integration of technology in the classroom and that educators have been charged with integrating more technology into their pedagogy, it is imperative to investigate the quality of educational technologies for responsive pedagogical integration. The following research questions were addressed in this study:

1. Which educational technology assessment do students feel is most helpful to provide them with feedback on their knowledge of course concepts?
2. Which educational technology assessment do students find most interesting and easiest to use in the classroom?
3. How do instructors feel about the ease and use of formative technology assessment for feedback and assessment?
4. How do students' formative assessment scores compare to students' summative assessments?

Method

In the current research, instructors utilized four different types of educational technology to create weekly formative assessments related to the summative exam given at the end of the unit of instruction. Two college education classes were selected for the research study because the instructors regularly use a variety of technology for assessment. Students enrolled in these classes were invited to participate in the research (n = 59) at the conclusion of the instructional unit which included a summative exam. A total of 44 students completed all parts of the research and were included in the analyses and were mostly female (n=40) with an average age of 21 years old.

Formative technology assessments were created using Kahoot, Plickers, Socrative, and Google Forms. Kahoot is a game-based assessment module in which students read a question on the screen and choose the answer on their device. The questions were timed and allowed the teacher an opportunity to review after each answer. Kahoot created a score for each student based on accuracy and speed and the winner was displayed at the end of the game. Plickers allowed teachers to show a question on the screen, while students chose the answer by holding their personal QR code in the corresponding way. No points are calculated, but teachers reviewed the question immediately afterwards and displayed a graph to demonstrate correct and incorrect answers for the overall class.

Socrative also allows the teacher to provide students with different types of questions (i.e. multiple choice, true/false, short answer) on the screen, and students answer on their own devices. When students answered, the teacher displayed the correct answer and answer choices were discussed. Google Forms is a tool in the Google

Suite of online tools and allows for the creation of quizzes. The students were given a link to a timed quiz. The instructors were able to create different types of questions and the quiz is immediately graded upon submission. The data can be accessed through a spreadsheet or as aggregated data. All assessments were completed by students individually during the provided class time. Assessments were 5-10 questions each and were given during or immediately following course instruction.

After students completed their exams over the units of study, those consenting completed a survey in Google Forms. Students responded to Likert items and an open-ended response question, ranked the technologies, and provided their summative exam grade to researchers. Instructors were also given a survey in Google Forms to provide feedback on their beliefs about the ease of use for each type of technology.

Results and Discussion

Both qualitative and quantitative data were analyzed by the researchers. To answer the research questions regarding students' beliefs about technology assessments as helpful, quantitative data analysis methods included calculations of means and standard deviations. The researchers created scales for students to indicate their beliefs. To answer the research question regarding the impact of formative scores' influence on summative assessments, a paired-samples t-test of students' test scores was utilized (deWinter, 2013). To understand instructors' beliefs about formative technology assessment as helpful, and students' beliefs about technology assessment as interesting, qualitative data were analyzed using the coding of open-ended responses for interpretational analysis (Creswell, 2007).

Student Responses

To determine how helpful the students perceived the technology, students were asked to indicate how helpful they perceived each technology from a scale of 1-5 (1 = not at all helpful to 5 = very helpful) for each technology type. Then, means were calculated for each item. Results suggest that students felt that all types were at least moderately helpful, but students indicated that Kahoot was the most helpful (see Table 1 for means and standard deviations).

Table 1. Descriptive Data of Students' Perception of Technology

Technology Type	M	SD
Kahoot	4.07	1.0207
Socrative	3.70	0.8513
Plickers	3.89	0.9205
Google Forms	3.82	1.0404

To determine which technology students found most enjoyable, students ranked each technology in order from most enjoyable to least enjoyable. Results suggest that students found Kahoot most enjoyable and Google Forms least enjoyable (see Table 2 for total rankings).

Table 2. Rankings of Students' Enjoyment of Technology Tools

Technology	1st	2nd	3rd	4th	Overall
Kahoot	24	6	4	10	1st
Socrative	4	17	15	8	2nd
Plickers	6	15	11	12	3rd
Google Forms	9	7	14	14	4th

To determine whether students' summative assessment scores were higher than their formative assessment scores, a paired samples t-test was conducted (deWinter, 2013). Results suggest that there was not a significant difference between formative and summative scores ($t(43)$ =.37, p=.71). However, researchers decided to compare formative and summative assessment scores in each class independently, and found a significant difference in one of the classes ($t(18)$ =4.30, p<001) (see Table 3 for means, standard deviations, and t-values).

Table 3. Paired t-test Results Comparing Assessment Scores

Group	Formative Assessments		Summative Assessments		t value
	Mean	SD	Mean	SD	
Overall	74.27	14.36	73.16	14.93	.37
Class 1	70.75	12.75	84.00	11.29	4.30***
Class 2	76.95	15.18	64.92	11.84	-3.53

Note. Significant at the p<0.05 level.

To further determine students' perceptions of the technology, participants responded to an open-ended question that asked them to choose their preferred type of technology and explain why it was preferred. Open ended responses were analyzed and coded by three trained researchers according to patterns identified in the responses (see Table 4). Codes were member-checked and three themes emerged. The following themes were drawn from the analysis: (a) Kahoot was the most preferred technology because of its fun, competitive nature, (b) most students preferred technology assessments that provide immediate feedback (Kahoot, Plickers and Socrative), and (c) there is a group of students who prefer to work at their own pace in a non-competitive environment.

Instructor Responses

To determine how helpful the instructors perceived the technology, instructors were asked to indicate their perception on a scale of 1-5 (1 = not at all helpful to 5 = very helpful). The mean for Kahoot and Plickers was 4.5 (n=2), while the mean for Socrative and Google Forms was 5. The results suggest that instructors found that each technology was at least moderately helpful, but instructors found Socrative as the most helpful. When asked which form of technology was easiest to use, instructors agree that Kahoot and Socrative are the easiest to use when creating, giving, and grading these technology-based assessments.

Table 4. Themes and Quotes from Students about Most Effective Technology

Theme	Student Quotes
Kahoot was the most preferred technology because of its fun, competitive nature	*"Kahoot is engaging because it is fun, and it motivates you to get the answers right because it is competitive."*
	"Kahoot was just fun and you learned. You raced against others but learned at the same time."
Most students preferred technology assessments that provide immediate feedback (Kahoot, Plickers and Socrative)	*"Kahoot is like a timed quiz. You get prompted with the question and then must respond within a certain time. "*
	"Socrative because I can take it at my own pace and get feedback about whether or not my answer was correct."
	"For me, Plickers was the most effective because not only is it completely anonymous (to the students) as to who got the questions right or wrong, you can also see if you personally got the question correct and how many people got the correct answer."
There is a group of students who prefer to work at their own pace in a non-competitive environment	*"I chose Google forms because it is not timed and not everybody could see it so it took a lot of stress away and I could actually read the question and comprehend it rather than trying to rush through like the timed ones."*
	"I think the Google forms were the most effective because it wasn't timed so you could work on the problems at your own pace. I also liked how you could see all the questions and come back to a problem if you had a difficult time on it."

To further determine instructors' perceptions of the technology, participants responded to an open-ended question that asked them to choose their preferred type of technology and explain why it was preferred. Open ended responses were analyzed and coded by three trained researchers according to patterns identified in the responses. The following themes were drawn from the analysis: (a) Socrative was the most preferred technology because of its ability to formatively assess students in real time and show the correct answer to the students, and (b) the instructors preferred technology assessments that provide immediate feedback. Implications from the instructor's responses suggest that instructors may better provide timely feedback to students through Socrative or a similar technology assessment tool.

Conclusion

Technology can improve the way that we formatively assess in the classroom and may even lead to more motivated and engaged students (Alzaid & Alkarzae, 2019; Rafool, Sullivan, & Al-Bataineh, 2012). This

research confirms that students appreciate the immediate feedback that can be derived from using technology-based assessments (Elmahdi, et al., 2018), and that many students enjoy using the game-based learning platforms. The main purposes of this research were to investigate student and teacher technology preferences and to determine if technology-based formative assessment impacted summative assessment scores. The findings of this research suggest that students do enjoy technology-based formative assessments, and that most prefer the game-based technologies overall. However, when teachers utilize technology assessments for their classrooms, they need to keep in mind that students have different preferences and personalities. In order to meet all students' needs, teachers should use a variety of technology assessments. For example, some students prefer the competitive nature of Kahoot, while some prefer the self-paced non-competitive nature of Google Forms. If teachers rely on only one type of assessment, the assessment may be ineffective and uncomfortable for certain students. In addition, there was some evidence to support the use of technology-based formative assessments to improve learning as some of the summative assessment scores were significantly impacted by formative assessment scores.

Limitations of the current research study do exist, most notably the small sample size. Also, researchers only utilized a few of the many different types of technology assessments because the current research study was conducted with two classes at the same university. Future research studies exploring technology assessments should consider analyzing a diverse student sample with different technologies. There are also many variables that may have influenced summative assessment scores which warrant further research. Therefore, future research may consider further studying relationships between educational technology and personality types in addition to learning gains related to these different types. Despite these limitations, the current research study demonstrates that technology assessments utilized in the classroom can provide students with quick feedback, while allowing them to improve learning in a fun, interactive way.

Notes

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