USING TECHNOLOGY TOOLS FOR FORMATIVE ASSESSMENTS

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ABSTRACT

Assessment is and has been a deliberate and essential piece of education. However, with the recent emergence and popularity of online education, faculty members have to find new ways to engage online learners with formative assessments. While much of the online learning environment can be self-guided, faculty interventions can make the content more engaging for the learner. Biggs and Tang (2011) note the term "backwash" which refers to the direct effect assessments have on a student's learning. Baleni (2015) further expounded on this point by stating that the assessments, not the curriculum, can define how and what a student learns. Using technology to create engaging formative assessment is one way that faculty members can enhance student learning while helping learners prepare for a summative assessment. However, one of the important findings of this study is the time and effort saved by online faculty members using this type of technology for formative assessment. Using an independent samples t-test, this study found a nonsignificant difference in quiz scores between the two formats (paper or Socrative) for formative assessment. The results suggest that Web 2.0 tools can be just beneficial in helping students prepare for a summative assessment. In addition, when chosen wisely, these tools can also influence participation, student wait time for feedback, and teacher grading time.

Keywords: online education, formative assessment, Web 2.0 tools, instructor efficiency, immediacy

INTRODUCTION

Instructors for beginning level undergraduate online courses can continuously struggle with helping the student master certain concepts on their summative assessments. Using formative assessment with personalized feedback has been commonly regarded as a way to increase student performance (Santamaría Lancho, Hernández, Sánchez-Elvira Paniagua, Luzón Encabo, & de Jorge-Botana, 2018). It was not known if and to what extent integrating technology as a formative assessment would impact student summative assessment test scores and/or how it could benefit the instructor's best practices for effective feedback. Previous interventions included elements such as study guides that were used in the discussion forum along with the paper formative assessments that produced limited results. These interventions were somewhat difficult for the instructors to maintain and time-consuming for the instructors to implement. Quizzes or exams tend to be the main summative assessment tool and can lack personalization (Santamaría Lancho et al., 2018) Thus, the instructors sought to use a form of technology to assess students in a more engaging formative assessment style. The purpose of this quantitative study was to determine the effectiveness and efficiency of selecting and using technology as a formative assessment in the online classroom.

BACKGROUND

It is well known in the education world that there is a high value in having effective and efficient formative assessments, making them a

key dimension of learning (Spector & Yuen, 2016). Most of the prior research on formative assessment has not focused on technology (Bhagat & Spector, 2017). There is an eminent value in using a technology tool as a vehicle to deliver the formative assessment in the online classroom because it creates a way to make the content more interesting and makes it possible for students to get specific individualized feedback. In addition to immediate and elaborative feedback, the use of technology offers an opportunity for data analytics. According to Dakka (2015), data collection and analytics are helpful for teachers because they provide a fast, graphic way to see where students are excelling and struggling.

Additionally, students can further develop their critical thinking skills while reviewing and reflecting on the class results and feedback. Bhagat and Spector (2017) further concluded that technology can support formative assessment by enhancing learning performance, attitude, and motivation across various disciplines. Furthermore, today's students live in a digital world with technology in all facets of life. Bhagat and Spector (2017) found that there is a need for further research on the use of technology in support of formative assessment.

While technology is often used to connect students to resources, it can also be used to support formative assessment. The challenges that can derive from determining the effectiveness of formative assessments can arise from how and when the formative assessments are provided. For example, Bhagat and Spector (2017) found that if feedback is delayed, it may not support student learning or engagement and that constructive feedback could be perceived the wrong way and have a negative impact on the learning process. Consequently, immediacy was one of the biggest instructors and student benefits of using the technology tool. Skordis-Worrall, Batura, Haghparast-Bidgoli, and Hughe's (2015) study conducted a thematic analysis in the online learning environment, and one of the five major themes that arose was the immediacy of feedback. Finally, effective technology tools can boost the instructor's presence with little effort and minimal time commitment on the part of the instructor.

Elaborative and Verification Feedback

One-on-one feedback can be especially challenging to achieve in the online classroom. However, many recent technologies allow instructors to create formative assessments that can be used to give students and instructors feedback on student performance. Applications can offer one or both feedback options: verification or elaborative. Verification feedback is a great tool for students to progress towards learning objectives, but it only provides half of the needed details. Marsh, Lozito, Umanath, Bjork, and Bjork, (2012) found that verification feedback delivered directly after each question improved assessment scores in comparison to when an answer-key is posted for students to self-verify afterward.

The benefits of elaborative feedback take this one step further by allowing the student to see why an answer was right or wrong and how the student can master the concept moving forward. Traditionally, instructors had to tally and create their own charts and reports to summarize class achievement. With Web 2.0 tools, data analytics is built into the application to allow instructors and students a fast, graphic way to see where they are excelling or struggling, and it even gives tips and hints for improvement. Furthermore, elaborative feedback reports allow instructors to tailor lesson content or guide the discussion toward the needs of the individual student.

Dakka (2015) found the element that supports teachers most when integrating technology-based, one-on-one feedback is the immediacy of that feedback. Additionally, students can further develop their critical thinking skills while reviewing and reflecting on individual or class results and feedback (Dakka, 2015). Thus, the researchers for this study determined that the technology tool used for formative assessment must provide both elaborative and verification feedback that is immediate. Both of these elements allow the student to adjust their thinking towards the objective before the summative assessment.

The Determination of a "Good Formative Assessment Tool"

There are over 80,000 education applications available for download in Apple's App Store (www.apple.com/education/teaching-tools/). However, even though these applications are categorized as "educational," there is no evaluation criteria or statistical proof that these technology tools are improving teaching and learning. It is up to teachers to assess these tools and determine if they are fit

for classroom use and, in fact, educational. While trial and error, reading reviews, or using personal evaluation methods are commonly employed by teachers looking for a technology tool, research has shown that there are specific criteria to use when assessing a technology tool. It is also important to note that there is a lack of research specific to the evaluation of assessment technology tools.

After an extensive literature review and discussion, the research team created a list of items that an effective technology tool needed to encompass. These priority items are immediacy, elaborative feedback from the instructor, personalized feedback for the student, reusability, accessibility, interface design, interaction, and cost. These items and the score given by researchers are listed in Table 1 below. Though all eight criteria are of importance, immediacy was initially thought to be the most valuable as instructors already had a paper design that did the same thing but students had a significant wait for feedback. The team also stressed the importance of personalized elaborative feedback for students so that the students knew why the questions they got wrong were wrong and how to improve moving forward. Finally, the cost was also one of the top eight criteria considered, as this was a self-funded study.

Reusability received a lower score but makes the formative assessment much easier to implement for multiple courses. The accessibility piece from a mobile learning perspective was crucial because a technology tool is worthless if students are not able to access it. Furthermore, the team wanted a friendly and easy-to-navigate interface design. The researchers also wanted to be able to personalize their feedback for the student. Personalization, in this case, means that the instructor is choosing what and how the feedback is delivered to the student.

After determining the eight criteria, the team reviewed already existing evaluation tools to find the Learning Object Review Instrument (LORI) was a very close model to the list the team had composed through the literature review (Akpinar, 2008). Nine criteria comprised the LORI evaluation: standards compliance, reusability, accessibility, interaction usability, presentation design, motivation, feedback and adaptation, learning goal alignments, and content quality. Some of the criteria listed, such as content quality, was thought by the researchers to be more in control of the instructor, not the tool. After additional discussion, the LORI ended up being adopted with a couple of minor modifications based on the determination of criteria through the literature review, the needs of the student population, and the LMS.

As a panel, the three faculty members used the convergent model for collaborative evaluation using LORI criteria to select and evaluate the technology that would be used for the formative assessment. While there were a variety of tools that could have been assessed using the modified LORI model, the research team decided to focus on evaluating three tools: Quiziz, Quizlet, and Socrative. Socrative was chosen as the best fit. Quiziz and Quizlet scored lower regarding reusability and elaborative feedback for the instructor, both of which are a focus for this study. The modified LORI criteria and the team's rank for Socrative are below in Tables 1 and 2 respectively.

Table 1. Technology Tool Scores

Technology Tool Criteria	Rank (1-5) 1= low, 5=high
Immediacy	5
Elaborative feedback from Instructor	5
Personalized feedback for student	4
Reusability	3
Accessibility	4
Interface Design	4
Interaction	4
Cost	5
Total Score	34

Table 2. Score Criteria for Technology Tools

Score Range	Ranking
0–14	Not worth it
15–29	Another tool in the shed
30–40	It's a gem

RESEARCH METHOD

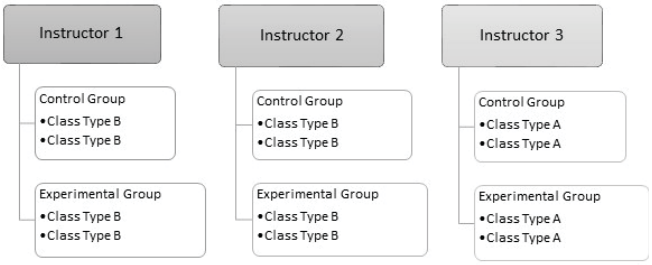
With Socrative selected as the Web 2.0 tool suitable for a formative assessment, research questions were developed to guide the researchers in designing the study and collecting data. The research questions included:

1. Does the delivery of a formative assessment (using a Web 2.0 tool versus traditional paper format) entice more students to interact/participate?
2. Does this added technology (Socrative) make any difference in student posttest scores in comparison to a traditional formative assessment delivery method (paper practice quiz)?
3. How does student wait time for traditional formative feedback compare to the wait time for formative assessment using Socrative?
4. How does teacher grading time differ for traditional versus Web 2.0 formative assessment?

Participants

The sample consisted of first-year undergraduate students, age 18–64, enrolled in either an introductory information literacy course (course type A) or a critical-thinking general studies course (course type B) from an online program at a university in the Southwest United States. A total of 286 students comprised all 12 classes used to complete the study. Of those students, 114 agreed to participate. Participants spanned across eight sections of course type B and four sections of course type A (see Figure 1).

Figure 1. Distribution of Classes Per Instructor



Design

The two class types used are typically a student's second or third course in the undergraduate online program. Though these are two different classes, these classes are very similar in design and share some of the same objectives. Course type B was was more often assigned to the volunteer instructors than course type A. Using both rather than one class type allowed the researchers to collect enough participants and complete the study within one school semester.

Based on the research questions and resources available, researchers determined that a quantitative, experimental design was most suitable. Each course was slotted into either the control or experimental group once the course was scheduled to start but before students were recruited to participate. Each study group contained an equal number of classes: two course type As and four course type Bs. In addition, each of the three volunteer instructors taught two classes within the experimental group and two within the control group (see Figure 1).

Materials

The formative assessment created for course type A was the same in both the experimental and the control group and differed only in the delivery approach (Socrative versus Word document). Formative assessment quizzes in all type A courses had the same ten multiple choice questions. The same thing was also true of the formative assessment quiz used for course type B. An answer key was generated for each formative assessment quiz. Answer keys were provided to the three volunteer instructors for their control group class sections based on the course type they taught (see Figure 1).

A Socrative account was created by the researchers. Both courses' formative assessment quizzes were assembled within the Web 2.0 tool for use within the experimental group. The answer keys were then used to set up scoring within the tool before data collection began as well.

Lastly, an email with attachments of the recruitment script, directions per study group, Word document formative assessments, and answers keys was sent out to each volunteer instructor prior to the study.

Procedure

All participants were recruited through written announcement within the discussion forum and announcements sections of the class at the start of the third week of all classes. In classes within the experimental group, the recruitment script provided a link to complete the formative assessment using Socrative. Classes within the control group were provided the same recruitment script and a Word document attachment of the formative assessment. Classes within the control group were also provided

Table 3. Additions to the Recruitment Script Based on Study Group

Study group	Recruitment script as a class discussion post and announcement	Link to Socrative formative assessment	Attachment with Word document formative assessment	Additional instructions for formative assessment submission
Control	Yes	No	Yes	Yes
Experimental	Yes	Yes	No	No

instructions directing participant to submit their completed Word document as an attachment to the instructor within the "individual" private forums (see Table 3).

Students who chose to participate in the study were then provided a seven- day window to complete the formative assessment. During this time, instructors within the control group graded the Word document participant submissions and returned these back to the students. In addition, instructors kept note of participant formative assessment and quiz scores as well as the gap of time between when the participant had submitted the assessment and when the instructor had returned feedback and the score. Last, instructors were asked to keep track of how many minutes it took them to grade each assessment and how long they took to compile elaborative feedback on the class's performance per quiz question. By the end of the second week of the study, participants in both the control and experimental groups had completed both the formative assessment and the required class quiz.

RESULTS

The first research question of the study asked: Does the delivery of a formative assessment (using a Web 2.0 tool versus traditional paper format) entice more students to interact/participate? Tables 4 and 5 below show participation rates ranging from 33% to 71.4% from class section to section, with the highest participation rate of 71.4% found within the experimental group (Socrative). Interestingly, the control group had a higher average participation rate across all six courses. Figure 2 provides a visual of the difference in average participation rates between both groups.

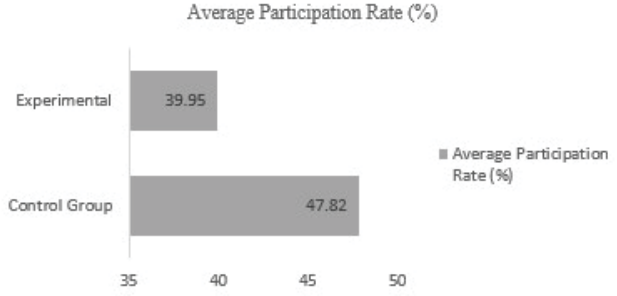
Table 4. Participation Rates: Control Group (Paper Formative Assessment Form)

Course Type	Total students in class	Number of students to participate	Participation rate (%)
B	20	9	45.00
B	25	12	48.00
B	23	10	43.50
B	26	17	65.40
A	23	12	52.00
A	21	7	33.00

Table 5. Participation Rates: Experimental Group (Formative Assessment Using Socrative)

Course Type	Total students in class	Number of students to participate	Participation rate (%)
B	21	15	71.40
B	24	8	33.30
B	25	9	36.00
B	25	5	20.00
A	25	10	40.00
A	28	10	39.00

Figure 2. Participation Rate Summary



The second research question asked: Does this added technology (Socrative) make any difference in student posttest scores in comparison to a traditional formative assessment delivery method (paper practice quiz)? Tables 6 and 7 provide the average formative assessment scores, average student quiz scores, and the difference between those scores per course.

To answer the second research question, an independent samples t-test was implemented using SPSS to compare the average quiz score in each class between classes who were provided Word document (paper) versus those who were provided Socrative as the format for their formative

Table 6. Pretest and Posttest Scores: Control Group (Paper formative assessment form)

Course Type	Average formative assessment score	Average quiz score (summative assessment)	Difference between average pretests and posttests
B	6.6	8.2	1.6
B	5.9	7.3	1.4
B	5.8	7.9	2.1
B	6.8	7.7	0.9
A	6.4	7.3	0.9
A	7.3	7.4	0.1

Note. The average difference between formative assessment and quiz scores was 1.17 points on a ten-point test within the control group.

Table 7. Pretest and Posttest Scores: Experimental Group (Formative Assessment Using Socrative)

Course Type	Average formative assessment score	Average quiz score (summative assessment)	Difference between average pretests and posttests
B	5.2	8	2.8
B	5.4	7.3	1.9
B	6.7	8.3	1.6
B	6.4	7.4	1
A	6.5	7.9	1.4
A	6.1	6.4	0.3

Note. The average difference between formative assessment and quiz scores was 1.5 points on a ten-point test within the experimental group.

assessment. Table 8 below provides the results from the paired samples t-test. There was not a significant difference in quiz scores ($t(10) = 0.265$, $p = 0.796$). No statistical significance was found, thus there was no statistically significant difference in quiz scores between the two formative assessment format variations. Table 9 shows that the mean quiz score was higher for classes provided the Word document (paper) format for the formative assessment ($M = 7.63$, $SD = 3.67$) than for classes provided the Socrative format for the formative assessment ($M = 7.55$, $SD = 6.77$).

For additional exploration, Table 10 provides a comparison of quiz scores for those who participated in either form of the assessment versus the quiz score for the remaining learners in the course. Note that participants who chose to complete a formative assessment, no matter the format, scored 1.5 points out of 10, or 15% higher, than their peers who did not complete a formative assessment.

Table 8.

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Posttest Score	Equal variances assumed	1.704	.221	.265	10	.796	.83333	3.14554	-6.17537	7.84204
	Equal variances not assumed			.265	7.701	.798	.83333	3.14554	-6.46955	8.13622

Table 9. Independent Samples Statistics

	Test_Type	N	Mean	Std. Deviation	Std. Error Mean
Posttest Score	Paper Formative Assessment	6	76.3333	3.66970	1.49815
	Socrative Formative Assessment	6	75.5000	6.77495	2.76586

Table 10. Comparison of Course Quiz Scores for Participants and Nonparticipants

Formative Assessment Approach	Course Type	Average quiz score for those who completed the practice quiz (Socrative or Paper)	Average quiz score for those who did not complete any practice quiz	Difference
Socrative	PHI 105	8.00	7.10	0.34
Socrative	PHI 105	7.30	7.00	0.30
Socrative	PHI 105	8.30	6.40	1.90
Socrative	PHI 105	7.40	6.95	0.45
Socrative	UNV 104	7.90	4.53	3.37
Socrative	UNV 104	6.40	4.77	1.63
Paper	PHI 105	8.20	7.10	1.10
Paper	PHI 105	7.30	7.00	0.30
Paper	PHI 105	7.90	7.71	0.19
Paper	PHI 105	7.70	4.78	2.92
Paper	UNV 104	7.30	3.90	3.40
Paper	UNV 104	7.40	5.28	2.12

Note: Average score difference was 1.50 points on a ten-point test.

The third research question asked: How does student wait time for traditional formative feedback compare to the wait time for formative assessment using Socrative? Student wait time for feedback using Socrative was zero while the average student wait time for feedback using a paper quiz in an online classroom was 14.45 hours. Tables 11 and 12 provide data to show the student wait time for feedback.

The last research question asked: How does teacher grading time differ for traditional versus Web 2.0 formative assessment? The time taken to grade both forms of the formative assessment is also noted in tables 11 and 12. Of note, Socrative completes grading automatically for the instructor. The time equated to zero minutes for teacher grading. The Word document form of the formative assessment took an average of 4.68 minutes to download, open, grade through, and provide feedback to the learner.

DISCUSSION

Impact on Students

It is well known throughout education that

Table 11. Instructor Time to Grade and Assess Formative Assessment: Control Group (Paper)

Quiz Form	Course	Time interval between quiz completion and score/feedback (in hours)	Average time taken by the instructor to grade practice test (in minutes)	Time taken by the instructor to chart elaborative feedback (in minutes)
Paper	PHI 105	14.80	2.44	6
Paper	PHI 105	15.40	2.33	7
Paper	PHI 105	16.10	3.10	10
Paper	PHI 105	15.90	2.18	6
Paper	UNV 104	14.10	7.70	10
Paper	UNV 104	10.40	10.35	10

Note. The average student wait time for feedback with the use of paper/Word document was 14.45 hours.

Table 12. Instructor Time to Grade and Assess Formative Assessment: Experimental Group (Socrative)

Quiz Form	Course	The time interval between quiz completion and score/feedback (in hours)	Average time is taken by the instructor to grade practice test (in minutes)	Time is taken by the instructor to chart elaborative feedback (in minutes)
Socrative	PHI105	0	0	0
Socrative	PHI105	0	0	0
Socrative	PHI105	0	0	0
Socrative	PHI105	0	0	0
Socrative	UNV104	0	0	0
Socrative	UNV104	0	0	0

Note. The average student wait time for feedback with the use of Socrative was 0 hours.

effective formative assessments are valuable and can improve a student's summative assessment (Spector & Yuen, 2016). However, the key challenge is finding effective and efficient ways for instructors to be able deliver these to their students and make it easy for them to complete.

The biggest benefit of utilizing a Web 2.0 tool for a formative assessment for students within the online classroom was the immediacy of scores and feedback. Students instantaneously received elaborative feedback that described what they got wrong, why it was wrong, and how it could be improved. Without the Web 2.0 tool, students would have ended up waiting an average of 14 hours and 45 minutes before finding out how they scored. This aligns with results from Bhagat and Spector (2017).

Furthermore, program scoring freed up instructor time to focus on providing interventions during the week for commonly missed questions. For example, in one course many students may miss question number three while in a different course they may miss question number five. While there was not a significant difference between the scores of students who took either assessment, this comes as no surprise for anyone who knows how formative assessment works.

An interesting question raised was whether or not the method of delivery impacted the participation rate. Surprisingly, average participation rates were lower for using Socrative than using the Word document. It could be that students felt the Word document had come directly from the instructor and since the instructor was handgrading the formative assessment, students felt more motivated to complete it, or perhaps in some ways they felt more of a connection with the instructor by completing it. Additional research may be needed to explore why participation rates were lower when the Web 2.0 tool was used.

Even so, the main benefits of using Web 2.0 tool were the immediacy of the feedback and the ability for students to take the practice quiz as many times as needed. Finally, an added benefit was that the technology was easy to use and allowed students to take the practice test on a mobile device if needed.

Instructor Time-on-Task

It is important to note that this study was not trying to determine if Socrative specifically outperformed "traditional" formative assessment delivery methods, but rather if a properly chosen Web 2.0 tool would be more effective for both students and teachers. In theory, any tool that fits the best practices for technology use will help to save teachers time and improve the student's learning experience in comparison to traditional methods of assessment, especially in the online classroom.

This particular Web 2.0 tool was not only able to increase the effectiveness of the delivery of the formative assessment, but it also allowed for the instructor to be more efficient by saving the instructor anywhere from 5 to 10 minutes per student submission. The time saved allowed the instructor to focus more time and energy into other areas of instruction while still helping students achieve the same results. The data from the technology tool provides instructors with a trove of valuable information that can be used to increase student performance and instructor practices.

Limitations

The first limitation was the sample size. The sample size for this study was small and consisted of 12 classes and 114 students from two beginning

level university courses. The students were all from two first-year series classes, which limited the content. However, different course content may be able to utilize different technologies to formally assess students. Other course contents may find other technology tools or approaches more beneficial to their content or teaching style.

Future research should consider the instructor's ability to use technology tools and the impact of the instructor's perception of technology on the implementation of it. Additional research could explore the impact on student motivation and satisfaction when technologies are incorporated. Ultimately, it is not about the technology used but how well it fits.

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