Technologies for Formative Assessment:

Can Web-Based Applications Transform the Allied Health Science Classroom and Improve Summative Assessment Outcomes

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Abstract

Quizzing has traditionally been viewed by students as a negative aspect of education; however, quizzing, also known as formative assessment, is a useful tool for both the student and the teacher, in that it reveals deficiencies in understanding and pinpoints areas where greater focus should be placed from the student as well as the teacher. Web-based technologies are a great way to deliver and give feedback on content understanding; however, there are multiple methods of delivery and numerous online resources that can be utilized. This paper explains a very simple research study that was conducted to determine success factors between synchronous and asynchronous web-based formative assessment. It was discovered that synchronous and asynchronous web-based formative assessment can serve to increase summative assessment performance in allied health science curricula. Furthermore, it was demonstrated that students preferred asynchronous web-based formative over synchronous delivery in face-to-face classrooms.

Introduction

Students hate quizzing. More accurately stated, students abhor any traditional form of learning assessment. And why shouldn't they? From an educational vantage point, teachers and school administrations have historically spun assessment, negatively, as a method of evaluating and probing into student performance. "You will have a multiple choice quiz tomorrow on everything that we have covered in this unit. Make sure that you review your notes, because this quiz is 15% of your course grade." What student wants to be haphazardly slapped under the microscope of status quo, picked apart to find proof of learning, and then assigned a number that is suppose to be a score of that proof? The negative view and connotation of testing completely negates the whole intended purpose of formative assessment, which is so critical to ensure that summative evaluation accurately reflects what the student has mastered during the course. Why not think outside of the pedagogical box and help students see the positive aspect of quizzing? What if students were to be praised for making a mistake on a formative assessment and then taught how to learn from it? Or better yet, what if students were not even aware that they were engaged in formative assessment? Is there a possibility that through failed formative assessment, summative assessment prevails and demonstrates that students remediated mistakes?

Teachers who practice out-of-the-box thinking are risk takers, viewed as potentially subversive to authority, and standard apart from their status quo colleagues, because students typically learn in their classrooms. These teachers try, fail and repeat until they find formative assessment tools that result in content retention, mastery of skills, and student success. Student learning shifts from an acquisition process, based on teacher transmission, to a process where

students are "actively constructing their own knowledge and skills" (Vaughn, 2013, p. 2) by reflecting on information acquired, or in the vein of formative assessment, not acquired.

This paper focuses on how innovative instructors find and utilize technologies for formative assessment and how their implementation impacts summative assessment in allied health science curricula. Traditionally, curricula in this field of health science, such as Radiography, Medical Laboratory Technology, and Respiratory Therapy, were created in a manner that delivered information to the learner - teacher transmission. Sadly, many of these higher education degree programs are still taught in this manner, a very passive approach to learning. This research seeks to probe into the efficacy of web-based tools, applied as formative assessment, and how these technologies for formative assessment create active learning environments that result in more successful course outcomes. Can web-based technologies for learning and technologies for learners increase summative assessment performance? It is believed that the integration and implementation of web-based technologies, used exclusively for formative assessment, will result in higher summative assessment scores.

Literature Review

E-learning environments incorporate information and communication technologies (ICT) as cornerstones of instructional design foundations (Penman & Thalluni, 2014). In order to ensure effective instruction, it is imperative to choose the correct and most relevant technologies while avoiding technologies that will serve to hinder learning. Online communication tools are vital components that establish and maintain clear channels of shared information and arguably one of the most important implemented tools in online learning (Penman & Thalluni, 2014).

This is not solely exclusive to distance learning but is relevant to any mode of instruction delivery that implements online tools for learning. Instructional designers, developers and educators bear the responsibility of choosing Web 2.0 tools that create a student-centered and student-engaging learning environment while effectively delivering course content. The the technologies are utilized within and support a social constructivist pedagogy, often term Pedagogy 2.0 (Cochrane, 2009).

Essential information technologies are included within the framework of course design. There are a number of design principles that support effective integration of technology as well as assessment through technology (Baleni, 2015). Some of the most critical are listed in Table 1.

Table 1

Critical Design Principles Needed for ICT Integration

Critical Design Principles	Explanation
Assessment	The technology should support and establish effective formative assessment that ensures learners are moving toward content mastery.
Authentic and relevant material	Technology should be transparent to the information that is is used to deliver.
Engaging and supportive	Integration of the resource should support course content and engage the learner in order to effectively facilitate the learning process.
Support knowledge construction	The technology should not simply deliver information but should allow students to construct meaning from the information.
Formative and timely feedback	Formative assessment should be appropriate for the course content, and feedback related to formative assessment should be delivered in a timely manner to ensure student understanding modification.
Integration of transparent rubrics	Clear grading criteria and guidelines provided to students.
Reflective	Instructional tools should provided opportunities for student reflection, which functions to construct knowledge.
Flexible and purposeful	Technology should provide learners will the ability to tailor usage in order to achieve maximum efficacy.

(Baleni, 2015)

One of the most important principles of digital course design is providing learners avenues to test their understanding and comprehension. Formative assessment establishes a means whereby students and teachers assess learning throughout various sections of the course.

Quizzing, writing assignments, and simple projects can all serve to achieve these tasks; however, there are some learner skills that cannot be easily assessed by these modes of testing; paper assessment being less effective than online technologies (Bennett, et.al, 2010). Online, student-conducted formative assessment, for online or face-to-face classes, can be an effective method for determining student understanding; however, students often engage in these learning assessments for credit and not for the more important reason of qualitative survey of understanding (Reiners, 2011). Critical application of formative assessment must include frequent, timely, and relevant feedback for maximum instructional efficacy, and educators must discern and distill both the drawbacks and benefits of this resource to the student, seeking to minimize one while maximizes the other (Reiners, 2011).

Feedback is the primary factor that influences the efficacy of formative assessment (Cassady, et.al., 2001). The quicker, clearer, and more relevant the feedback for formative assessment, the higher the likelihood that students will apply that feedback to the information learned and modify knowledge and understanding that may not have been completely mastered. With this said, immediate feedback is best and one of the easiest tools in an educator's toolbox, and Web-based applications can facilitate and streamline feedback creation and delivery if educators learn how to choose wisely and implement effectively.

Methods

The purpose of this research is to determine if implementation of web-based resources as technologies for formative assessment will increase summative assessment scores in allied health science courses and the likelihood that students will use a web-based tool. It is believed that utilizing technologies for formative assessment will result in increased student performance on

unit and course summative assessment and that if students typically use a web-based learning tool that they will readily try any web-based resource for learning.

In order to test this hypothesis, an Immunology course, taught at Sandhills Community College in Pinehurst, North Carolina, was used to determine if implementation of these tools impacted unit summative assessment averages. Average summative assessment scores of 16 students, 2 male and 14 female, were analyzed prior to and after implementation of web-based formative assessment. Pre-test results were determined by averaging two summative assessments for each student, while post-test results were determined by averaging the last two summative assessments of the course. There were only four summative assessments (course unit exams), and all summative assessments were delivered in the form of multiple choice, paper-based tests administered in class and over a one hour time frame.

Since there are many web-based resources that can be utilized as formative assessment, it was determined that limiting the choice and usage of this broad range of tools would facilitate a leaner and and more user-friendly experience for the test group. KaHoot! , Plickers and online practice quizzes were the three tools chosen for this test group. This choice was made based upon the method of classroom use that defines each tool. Online practices quizzes were asynchronous and delivered through a learning management system (LMS). KaHoot! requires that students possess a mobile device and downloaded application, while Plickers does not, requiring only that the teacher possess a mobile device with camera and downloaded application. The rationale for choosing these two specific synchronous technologies was to determine the efficacy of tools that require or do not require students bring their own devices (BYOD) to class.

Detailed explanations of both applications will be included in the discussion section of this paper.

Synchronous technologies were used as tools for assessment of information delivered during previous class meetings, specifically associated with the current unit of instruction. Assessment was performed before delivery of new lecture material. Students were clearly instructed on the proper usage of each tool and assisted with downloading of the KaHoot! application as needed. In order to standardized method of formative assessment, all paper-based quizzes used for the first two assessment scores were similarly administered prior to delivery of new instructional material. Essentially, all administered formative assessment (web-based or paper-based) were performed at the beginning of class and were relevant to the current unit of instruction.

Finally, after completion of this test, students were asked to complete a short survey which assessed their preference in web-based tool, opinion of efficacy, and overall opinion of the method of formative assessment. Additionally, it must be stated that throughout the entire pretest and posttest phases, students had access to eight online practice quizzes, two per unit of instruction, that were set with unlimited attempts, provided immediate feedback, and were relevant to current lecture topics. Use of these practice quizzes was optional and available throughout the entire course.

Results

Statistical analysis of test results demonstrates that the use of web-based formative assessment will increase summative assessment performance and test scores. Of the 16 students in the Immunology course, 12 (75%) demonstrated an increase in post-test scoring, with an

average cumulative score of 83.8 as compared to a pre-test average score of 81.8. The null hypothesis was rejected based upon a *p*-value of <0.05 (df=2; x^2 test =5.3).

Comparing synchronous and asynchronous web-based formative assessment, 14 (88%) students used the online practice quizzes, 14 (88%) participated in the synchronous Plickers activity, and 10 (63%) participated in the synchronous KaHoot! activity. The null hypothesis fails to be rejected based upon a *p*-value of 0.05-0.1 (df = 2; x^2 test = 4.17); therefore it can be stated that students will not typically try a web-based resource just because they generally use web-based learning tools as formative assessment.

Table 2 outlines data collected from the experiment.

Table 2

Summary of Experiment

Cumulative Class Performance		
	Average test scores	**SD**
Pre-test (16 students)	81.8	11.2
Post-test (16 students)	83.8	11.1
Student Performance		
	# of students	**Percentage**
Increase in score average	12	75%
Decrease in score average	3	19%
No change in score average	1	6%
Use of Assessment Mode		
	# of students	**Percentage**
Use of asynchronous formative assessment	14	88%
Use of synchronous formative assessment	13	81%
Choice of Synchronous Technology		
	# of students	**Percentage**
Formative assessment with BYOD	10	63%
Formative assessment without BYOD	14	88%

Discussion

It is no surprise that web-based tools enhance instruction when effectively implemented in the classroom; however, little information has been shared about the usage of synchronous versus asynchronous tools within the allied health science classroom, specifically in the community college. Applied science education is the foundation of our nation's workforce; hands-on education not only creates effective workers but enhances those workers' critical thinking skills. Implementing web-based formative assessment in these classrooms can serve two main purposes: (1) to provide an effective and student engaging method for teachers to determine content understanding, and (2) to give students a reflective experience that will serve to pinpoint where greater concentration should be placed for maximum objective mastery. Automation of assessment can benefit students and educators by helping students focus on areas of needed improvement and facilitating grading for teachers (Reiners, 2011).

Feedback is a crucial component of any form of assessment - formative or summative. A true benefit of web-based formative assessment is the capability of giving immediate feedback during the assessment. Studies have shown that the quicker modification of learning is made, based upon mistakes during assessment, the more effective the assessment tool for affecting change in understanding (Cassady, et.al, 2001). Feedback during synchronous web-based formative assessment can actually be more valuable than feedback delivered on an online setting. Synchronous feedback can lead to further discussion and generate more questions that can further clarify content understanding.

The formative efficacy of the tool relates directly to the choice of tool. Will a tool used during a face-to-face class be more effective than a tool used after that class and online? This

simple research project sought to determine which method of formative assessment delivery (synchronous or asynchronous) was more effective at increasing summative assessment performance. Additionally, the research determined student preference of synchronous device usage. It was discovered that students who engaged in any method of web-based formative assessment increased their summative assessment scores by an average of 3%, and the majority of students preferred asynchronous web-based technologies for formative assessment over synchronous technologies utilized during class meetings. When synchronous technologies for formative assessment were used during class meetings, students preferred web-based tools that did not require the use of a personal mobile device.

Both KaHoot! and Plickers were tested as synchronous web-based technologies. KaHoot! participation requires that students download a simple application that provides each student with a clicker application. To participate in the synchronous formative assessment, students activate the mobile app, enter the quiz code (which is displayed on a classroom screen/smart board), type their name (or alias), and select corresponding letter or shape for the correct answer. Points are awarded for correct answers, and the classroom display orders student scoring from highest to lowest. Points can be converted to recorded grades if needed.

Plickers utilizes similar characteristics of KaHoot!; however, students are not required to have access to a mobile device for participation. Teachers print off answer cards from the Plickers website (various size options and quantities are available), and assign card numbers to each student. There are up to four answer choices with each question, and in order to make an answer selection, students change the orientation of the card to their choice prior to hold up the card. Once cards are held up, the instructor activates a camera-enabled mobile device and scans

the classroom. The mobile device's camera captures each student's assigned card and each student's answer. As answers are gathered, a tally of answer choice is display on a smartboard or projection screen, and student scoring is tallied and displayed.

After the experiment, students were surveyed about their personal opinions of use and preference of formative assessment tool. It is critically important to evaluate student perception of formative assessment and its impact upon their learning and eventual summative assessment. All respondents indicated that they would likely use web-based resources as tools for increasing course content understanding. Comprehensive survey results are outlined in Table 3.

Table 3

Post-Experiment Survey Results

Preference of Formative Assessment Method		
	# of Responses	**Percent**
Asynchronous web-based tool	3	27%
Synchronous web-based tool	5	45%
In class paper quizzing	3	27%
Student Likelihood to Use Web-Based Resource		
	# of Responses	**Percent**
Use	11	100%
Not Use	0	0%
Student's Summative Assessment Perceptions		
	# of Responses	**Percent**
Positive Impact	10	91%
No Impact	1	9%

Limitations

There were a number of limitations to this experiment; however, the most obvious one was student access to mobile device technology. Possession of a personal mobile device for use in a synchronous web-based formative assessment can be considered a confounding variable, in that students who lack access to the technology had no choice in participation during the assessment. This directly impacted both participation in formative assessment (independent variable) and summative assessment results (dependent variable).

Considerations for Future Studies

In order to truly and more effectively assess the impact of web-based formative assessment on summative assessment outcomes in allied health science curricula, it would be beneficial to conduct research on different sections of the same course across varying curricula. For instance, using two semester sections of the same course, designate one section as the control group (non-web-based formative assessment) and the other section as the test group (web-based formative assessment). Additionally, it would be highly beneficial to observe performance characteristics across various disciplines, such as Radiography, Respiratory Therapy, and Medical Lab Technology. This would serve to assess if specific allied health science curricula benefit over other curricula.

Conclusion

Based upon the observed experiment it can be stated that web-based formative assessment can serve to increase student performance on summative assessment if it is

specifically tailored to course content and carefully implemented based upon student preferred method of delivery and choice of tool. In order to increase and maximize the efficacy of formative assessment, educators must create a student-centered and student-driven assessment process. Not every method works for every student, the one size fits all traditional method of quizzing is not an effective tool for shaping and molding student learning. It is easier for teachers to create one iteration of a formative assessment, deliver that to the entire class, and grade from one common key; however, this type of formative assessment creation fails to personally and individually support and encourage students to shape and mold their understanding of content. It can serve to show the teacher which answers students mark correctly; however, for every written question there are hundreds of other ways to ask it. The implementation of technologies for formative assessment can have the potential to reach learners of various skill levels and have a positive impact upon their personal learning outcomes.

People learn what they do and do what they learn. Creating and delivering formative assessment of the past, on paper and without new innovation, can serve to teach students how to simply take a quiz, not how to effectively assessing their own learning with the goal of increasing understanding. Innovative educators desire to facilitate instructional content that result in students who create their own learning environments; web-based tools can help achieve this desire and will serve to stimulate student creativity and innovation beyond the current course of instruction.

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