The Effectiveness of Kahoot! as a Pre-lesson Assessment Tool

Joshua Borrell, Nicholas Cosmas, James Grymes, Joel Radunzel

This paper was completed and submitted in partial fulfillment of the Master Teacher Program, a 2-year faculty professional development program conducted by the Center for Faculty Excellence, United States Military Academy, West Point, NY, 2017

Introduction

Background on EV203
EV203 Physical Geography is a core course at the United States Military Academy. Every student at West Point must complete this course in order to obtain a degree from this institution. The Department of Geography and Environmental Engineering (GEnE) at the United States Military Academy (USMA) offers teaches and directs EV203. The audience for this course recently changed from yearlings (sophomores) to plebes (freshmen) during the first semester of the 2016 academic year. The teaching pool for EV203 consists of a mix of first year and more experienced instructors, but all first year GEEnE instructors in their first semester of instructing teach EV203, which is affectionately known by the cadets as “Dirt.”

The EV203 course encompasses one semester of 40 lessons, which are divided into 5 blocks of unequal lengths. These block include: 1) Introduction, 2) Weather, 3) Climate, 4) Geomorphology, and 5) Culture. Cadets complete nineteen graded events worth 1000 total points as an assessment on their ability to learn the material. Each lesson is 55 minutes long and classed occur every other day, based on USMA’s 1-Day/2-Day Schedule. Class sizes vary between 14-18 cadets, averaging around 16 cadets per section.

First year instructors undergo New Instructor Training (NIT) prior to teaching cadets. During this training, they receive guidance on “what right looks like” from experienced instructors. These experienced instructors “teach” the new instructors all 40 lessons, providing “best practices” for each lesson. Student Performance Objectives (SPOs) and Key Concepts and Terms, which are listed by lesson in the syllabus, are concepts cadets should know by the end of each lesson. The SPOs also guide new instructors on the content they should emphasize, though instructors are at liberty to modify lesson plans as they see fit. Personal examples, style, etc. are encouraged as long as the instructors are covering the SPOs and Key Concepts and Terms during each lesson.

Instructors expect cadets to employ the “Thayer Method,” named after an early USMA superintendent named COL Sylvanus Thayer, the “Father of West Point.” The Thayer method prescribes that cadets should come to class having prepared themselves by doing pre-lesson readings, online homework, and other tasks indicated in their syllabus.
Reason for this Study
As new instructors in EV203 during the 2016 -2017 Academic year, the authors of this study noticed that many cadets arrived in class unprepared for the day's lesson. Indeed, they seemed to expect that the instructor would teach them all the material in the 55 minutes of lecture allowed by the class period. As a result, they were not learning the material to the depth that is required to excel on the graded events.

The authors tried several techniques during AY 16-1 to encourage cadets to practice the Thayer Method. These included pop quizzes, email engagement with students outside of class, and board work. The Master Teacher Program (MTP), a 2-year program offered to USMA faculty to improve their teaching methods, addressed several of these methods and indicated that they may not be the most effective ways for instructors to engage students with the material.

One of the authors learned about an online quiz program called Kahoot! during an MTP session. He utilized Kahoot! as a pre-lesson quiz for his EV203 sections beginning in the second semester of the 2016 academic year, while at the same time cadet class performance improved from one semester to the next. This led to the question: “Were the Kahoot! pre-lesson quizzes at least partly responsible for the success as a whole of first semester cadets versus second semester cadets in EV203?”

This paper poses the hypothesis that a Pre-Lesson Quiz, delivered using Kahoot! improves cadet preparation for EV203 lessons and ultimately lead to improved grades. Central to this proposal is the assumption that alternative evaluation techniques have an impact on student performance and ultimately on their learning.

Literature Review: Summative versus Formative Assessment
In the pedagogical literature, student evaluation (also known as testing or assessment) is one of the most widely researched themes. In his work on curriculum development, Michael Scriven (1967) argues that nearly all human endeavor involves a constant process of evaluation. But in the field of pedagogy, the evaluation process has become a central function for determining whether students can perform to the satisfaction of their teachers, the school, or a broad range of other external stakeholders. In general, pedagogical literature considers two general processes of assessment, summative assessment and formative assessment, both of which can fill a range of functions. The authors of this study explored these two modes of assessment in designing their research.

Summative Assessment
In pedagogy, summative assessment (SA) is generally regarded as a process of assessment that yields a judgement encapsulating all evidence up to a given point, and which point is regarded as a finality. Examples of this form of assessment include standardized, high-stakes testing such as the Scholastic Achievement Test (administered to high school juniors and senior in the United States by the College Board) or the American College Testing (ACT) test. In such
assessments, no learning takes place during or as a result of the test, or at the very least learning does not impinge on the stated purpose of the process: to assess student aptitude and/or readiness for college admission. Though assessments such as the SAT and ACT are widely villainized both in the popular press and in the academic literature, they continue to be widely used and justified by their demonstrated benefits of allowing both teachers and students to see and understand what concepts need further emphasis.

At West Point, summative tests colloquially known as WPRs (Written Partial Reviews) are typically administered two to three times per semester in each course and are the chief means of assessing student performance in the academic program. Faculty typically use these assessments to “shape teaching during and after the test...At the same time, students are alerted to [knowledge] gaps, which allows them to shape their own efforts to learn the information they missed” (Lahey 2014). Though these goals are laudable, Scriven notes that the benefits of a summative assessment are inseparable from its consequences. Indeed, Scriven notes that, “By stressing the constructive part, evaluation may play in nonthreatening activities (roles) we slur over the fact that its goals always include the estimation of merit, worth, value etc., which all too clearly contribute in another role to decisions about promotion and rejection of personnel and courses” (Scriven 1967, 42). Indeed, these latter roles can cause anxiety and other documented negative externalities for students (Cassady & Johnson 2002).

Formative Assessment
While the chief aims of SA are to make judgments and are treated with some level of finality, formative assessment (FA) emphasizes assessment as one of many steps in the iterative process of learning. D. Royce Sadler (1989, 120) argues that FA “is concerned with how judgements about the quality of student responses (performance, pieces, or works) can be used to shape and improve the students’ competence by short-circuiting the randomness and inefficiency of trial-and-error learning.” In this way, FA affords the opportunity for instructors to shape quality of student responses, but does not force it upon the learner. That is to say, FA grants agency to the student and is conditional upon his or her willingness to take action. If the learner does not seize upon this opportunity, FA becomes just another form of SA. Therefore, any discussion of FA presupposes that this condition is met.

According to Roediger and Karpicke (2006, 181), “Taking a test on material can have a greater positive effect on future retention of that material than spending an equivalent amount of time restudying the material, even when performance on the test is far from perfect and no feedback is given on missed information.” FA can come in a variety of formats including pre-class essays or web-based technologies. Employing the former method in a psychology seminar course, “the process of discussing the answers to the quiz begins the class dialogue, and teaching and testing are no longer distinct components” (Connor-Greene, 2000: 84) This process of continuous testing, requires “students to continuously engage themselves in a course; they cannot coast until near a midterm exam and a final exam and begin studying only then” (Roediger and Karpicke, 2006: 205). Similarly, using web- or computer-based quizzes can promote student learning through engagement and instant feedback. In a mathematics course,
computer-based FA can be used to encourage the “deliberate processing of verbal declarative knowledge required by self-explanation [which] complements students’ natural inclination toward example-based induction” (Brothen & Wambach, 2001: 171). Experiments in web-based quizzing (Daniel & Broida, 2004) offer cautionary tales about the incorrect use of web-based FA and concluded the while the benefits of FA can be achieved through the methods they used, it is important for researchers to adjust administrative requirements to account for the peculiarities of web-based FA.

**Methods**

**Kahoot!**

Kahoot! is an online quiz program that is free, easy to setup and use, and fosters learning in a group setting. Cadets do not require an account and must only enter a code on any device with an internet connection (computer, tablet, phone) to participate. Images can be added to each question, enhancing the effectiveness of the quiz. Questions consist of multiple choice answers, at least 2 and up to 4. An added benefit of Kahoot! is the cadet answers are preserved in a spreadsheet that can be analyzed later to determine concepts that need to be reemphasized, if certain cadets are struggling, etc. For these reasons, Kahoot! was chosen as the platform to provide the pre-lesson quizzes to test cadets on their preparedness for that lesson.

**Pre-lesson Quizzes**

There are many ways to assess cadet performance. Some of these classroom assessment techniques (or CATs) are: minute papers, chain notes, memory matrices, direct paraphrasing, one sentence summaries, exam evaluations, application cards, and student generated test questions (Angelo and Cross, 1993). The authors decided to use a pre-lesson quiz administered at the beginning of every lesson with Kahoot! as the platform to administer the quiz, for reasons mentioned in the above section. Each quiz consisted of 5 questions with each question based on a SPO or Key Concept for that lesson. Each question was either a True/False question or a 3 or 4-answer multiple choice question. Cadets were given 30 seconds per question. This allowed the quiz to be completed within the first 5 minutes of class. Cadets were allowed to use their hand-written notes to complete the quiz (as opposed to searching the textbook). This was to encourage them to prepare for class ahead of time.

**Sampling**

The authors taught a total of 8 sections of EV203 during AY 17-1 with a total of 123 cadets. One author taught 4 sections and the other 2 authors taught 2 sections each. Each author divided their sections into a control group that did not receive Kahoot! pre-lesson quizzes and a Kahoot! group that received the pre-lesson quizzes. 666 cadets were enrolled in EV203 during AY 16-2. Our sampling of 123 cadets represents 18.46% of the population of cadets enrolled in EV203. Grouping by sections allows for the sampling to be randomly generated because a vast majority of the students have the same likelihood of being in one particular section versus any other section. There are only a few cadets who have reduced scheduling flexibility and are forced into certain sections.
EV203 is divided into 5 blocks. Block 1 is an Introduction (3 lessons), Block 2 is Weather (13 lessons), Block 3 is Climate (5 lessons), Block 4 is Geomorphology (12 lessons), and Block 5 is Culture (7 lessons). The authors decided to test their hypothesis by comparing student performance collected after the first 3 blocks to data collected during Block 4 as well as cumulative data collected from Blocks 1-4.

**Design of Experiment**

The experiment was designed to assess the impact that the pre-lesson quizzes had on an individual cadet's performance. Overall the statistic of interest was the average difference in performance; comparing students overall performance in the course with and without the Kahoot! experience. To accomplish this comparison the sections were divided into two sub-groups; a control group and a treatment group. The control group sections did not have exposure to Kahoot! at any point in time in the course whereas the treatment group did not have Kahoot! exposure for the first 3 blocks of the course and then received the pre-lesson quizzes during block 4 of the course. This process allowed for the analysis of performance between blocks 1-3 and block 4.

Using developed statistical design, we conducted the following statistical tests: two-sample hypothesis tests and multiple linear regression to determine the treatment effects. The first and most direct assessment used was a two sample hypothesis test (t-test), testing if the average change in a student's score in the class is different between the control and treatment groups. Multiple linear regression models were also designed to assess if other factors besides being in a treatment group have a more significant impact to ensure we were not making a false claim regarding treatment effects.

**Results**

Results of the experiment and analysis indicate that the pre-lesson quizzes improved a student's overall performance in the course. A two-sample hypothesis test confirms that students who were subjected to the Kahoot! Pre-lesson quizzes improved their overall performance in the class. We can say with statistical significance that students in the treatment group had a larger change in course performance than those without the specified treatment. The test produced a t-statistic of 1.8375 and a p-value of .03511 which imply that the results we obtained were extremely unlikely if indeed the Kahoot! pre-lesson quizzes were ineffective. The results of the hypothesis test are shown in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>$\mu_{WPR1}$</th>
<th>$\mu_{WPR2}$</th>
<th>$t_{\text{statistic}}$</th>
<th>$P_{\text{value}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>WPR1 vs WPR2</td>
<td>0.0203</td>
<td>0.0079</td>
<td>1.8375</td>
<td>0.0351</td>
</tr>
</tbody>
</table>
The boxplot in Figure 1 illustrates that while there is an overall increase for both groups, there is a larger increase in student performance with the treatment group than the control group.

![Figure 1](image)

Additionally we can conclude with statistically significant results that the introduction of Kahoot! pre-lesson quizzes reduces the overall variability in student test performance. Two tests were performed to render this conclusion. The first test was an F-test comparing the variability of the performance on WPR2 for students who were administered Kahoot! Pre-lesson quizzes with the variability of students who did not receive the pre-lesson quizzes. The second test was also an F-test which compared the variability of the performance on WPR1 for students who were administered Kahoot! Pre-lesson quizzes with the variability of the performance of WPR2 for the same population. Table 2 displays the summary results of the first F-test where we wanted to see how having the pre-lesson quiz affected the variability on the performance of the second WPR. Table 3 displays the summary results of the second F-test which looks at the variability between WPRs 1 and 2 with only the group that started receiving the pre-lesson quizzes directly after WPR1.

<table>
<thead>
<tr>
<th></th>
<th>$\sigma^2_{control}$</th>
<th>$\sigma^2_{treatment}$</th>
<th>$\sigma^2_{Ratio}$</th>
<th>$F_{statistic}$</th>
<th>$P_{value}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>WPR2</td>
<td>149.9</td>
<td>97.65</td>
<td>.65122</td>
<td>.65122</td>
<td>.04968</td>
</tr>
</tbody>
</table>

Table 2
In addition to a control group, there was an additional set of sections that received the Kahoot! Pre-lesson quizzes all semester. Comparative boxplots are shown in Figures 2 and 3 to illustrate that pre-lesson quizzes can reduce variability but specifically it can assist those that struggle the most. However it also highlights a concern with the findings. There is a chance that the improvement we are seeing from Kahoot is from another factor that has not been considered.

<table>
<thead>
<tr>
<th></th>
<th>$\sigma^2_{WPR1}$</th>
<th>$\sigma^2_{WPR2}$</th>
<th>$\sigma^2$ Ratio</th>
<th>$F_{\text{statistic}}$</th>
<th>$P_{\text{value}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>WPR1 vs WPR2</td>
<td>215.08</td>
<td>94.2</td>
<td>.44086</td>
<td>.44086</td>
<td>.01282</td>
</tr>
</tbody>
</table>

Table 3

Figure 2
Subjective Results

After completion of EV203, cadets were asked to voluntarily complete a short 3-question survey on the Kahoot! pre-lesson quizzes. The questions were: 1) how many hours per day they studied for EV203, 2) if knowing they had a Kahoot! pre-lesson quiz caused them to study more for EV203, and 3) general comments on Kahoot!. Even though the population of returned surveys was small, the subjective results of this survey were encouraging in support of our hypothesis. 12 of 123 cadets (9.75%) responded to the survey. Cadets responded they studied an average of 45 minutes to 1 hour per lesson for EV203, but 75% of respondents replied they studied more for EV203 because they knew they would have a Kahoot! quiz before class. Also, 100% of the respondents replied with favorable comments about Kahoot!. These positive results, while encouraging, don’t tell the whole story, unfortunately. With such a small population, the other 90% of cadets could have hated Kahoot! quizzes and did not reply to the survey due to their intense dislike of the quizzes! The cadets also knew the feedback was for MTP research. Perhaps they were unwilling to provide negative feedback on the research idea. The survey was conducted after the semester, so the cadets would not have felt a danger of grade repercussions if they answered contradictorily to the hypothesis. At a minimum, these subjective results support the data analysis and provide additional information that would point toward Kahoot! being an effective tool to encourage cadet preparation prior to lessons.

Some of the subjective comments are included here: 1) “I think the Kahoot! quizzes were great because it gave us an opportunity to have friendly competition and introduction to the class material”, 2) “The Kahoot! quizzes were a fun way to learn the material”, 3) “Kahoot! was very effective because it provided the extra motivation to not only complete the reading and homework, but also to take notes when reading”, 4) “I really enjoyed the Kahoot! Quizzes. I did not prepare so as to do well on kahoot, but I think that kahoot added a quiz-esque preparation
Conclusion
It can be a challenge to motivate cadets to prepare for their classes ahead of time. They have many competing interests for their time. Pre-lesson assessments are one tool to check cadet comprehension of material. In this study, Kahoot!, an online multiple-choice quiz program, was used as the pre-lesson assessment. Our hypothesis seems to stand up to analysis. That is, Kahoot!, used as a pre-lesson assessment tool, can improve overall cadet performance through motivating the cadets to prepare for class ahead of class. The pre-lesson quizzes, using Kahoot! as a platform, seemed to stimulate better performance from the cadets in EV203. Cadets who received daily Kahoot! pre-lesson quizzes performed marginally better than cadets who did not receive the daily quizzes. The Kahoot! quizzes seemed to narrow the performance gap between the lower performing students and the higher performing students. Specifically, the Kahoot! Quizzes seemed to raise the lower performing cadets' scores. While the results of the study were not as definitive as the authors would have liked them to be, there is a statistical significance to the results. There is certainly more to be explored on this topic as well, such as assessing the value of Kahoot! versus other types of formative assessments, or comparing the utility of Kahoot! across multiple courses.
Works Cited


