ANALYZING THE EFFICACY OF THE TESTING EFFECT USING KAHOOT™ ON STUDENT PERFORMANCE

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ABSTRACT

Lower than expected high-stakes examination scores were being observed in a first-year general psychology class. This research sought an alternate approach that would assist students in preparing for high-stakes examinations. The purpose of this study was to measure the effectiveness of an alternate teaching approach based on the testing effect to address low high-stakes examination scores. This was accomplished through the introduction of an online quizzing application that utilized a game show-like user interface called Kahoot™. The results showed a significant difference in high-stakes examination scores for students who utilized Kahoot™ versus students who did not. It can be suggested that pedagogical tools like Kahoot™ have the potential to enhance and improve high-stakes examination scores at the college and university level. Students that used Kahoot™ felt positive about their experience. The results of this study also suggest that creating a fun and engaging environment also supports improved academic performance.

Keywords: **Educational technology, self-regulation, formative assessment, gamification, testing effect.**

INTRODUCTION

As a professor in higher education for a number of years now, I have seen a common perplexing pattern of student behavior. Students who reportedly study diligently and are engaged in class are not always the ones that excel in summative course examinations. Two thoughts immediately come to mind. Either I am being deceived by the perceived practices of my students or how my students study and prepare for the examinations needs to improve. I decided to focus on the latter and my inquiry led me to a memory retrieval practice called the testing effect. Will the practice of the testing effect in a higher education setting influence high-stakes examination scores? Finding an answer to that question was the motivation behind this study.

The objective of this pilot quasi-experimental action research study was to measure the effectiveness of an alternate teaching approach based on the theory of the testing effect to address low high-stakes examination scores. The sample groups are from an undergraduate level psychology course in a four-year university located in the south Pacific. The intervention used to implement the testing effect utilized an online quizzing application that utilized a game show-like user interface called Kahoot™. This research assessed the effectiveness of this approach by comparing high-stakes examination scores and also by surveying the sample groups for their feedback on their experiences through this study.

LITERATURE REVIEW

The testing effect is a robust and reliable phenomenon that demonstrates that taking an initial test improves performance on subsequent tests (Chan & McDermott, 2007). The testing effect (or retrieval practice effect) has traditionally been measured in the laboratory setting, however, evidence of the testing effect has recently been shown in real-world settings (Agarwal, Bain, & Chamberlain, 2012). Low-stake quizzes have shown improved summative exam scores over the course of a semester relative to not being quizzed (Roediger, Agarwal, McDaniel, & McDermott, 2011a). Roediger et al. (2011a) found that sixth grade social studies students performed better on material they had been quizzed on throughout the semester, performed better than students who were tasked to re-read material, and also performed better when tasked to self-quiz themselves outside of the classroom. The time-delay between exposure to material, and chapter and final exams, were typically one to two months, which was much longer than previous studies conducted in a laboratory setting. This showed evidence of the long-term benefits from retrieval practice learning. The testing effect was also demonstrated in eighth grade science students who underwent a longer time-delay of five to eight months between the teacher's lessons and chapter and final exams (McDaniel, Agarwal, Huesler, McDermott, & Roediger, 2011).

McDaniel, Anderson, Derbish, and Morisette (2007) also demonstrated the testing effect among college students. Students took weekly quizzes followed by unit tests and a final cumulative exam. Quizzes were both short answer and multiple-choice format with the unit tests and exam in a multiple-choice format. Improved performance was seen with quizzing versus additional reading.

The testing effect has also been shown in novel situations (McDaniel, Thomas, Agarwal, McDermott, & Roediger, 2011). Experiments conducted in seventh and eighth grade science classrooms utilized different quiz and exam items as opposed to previously reported experiments where questions were the same with random assignment of multiple-choice items. Performance on quizzed material was significantly greater than non-quizzed material as the previous studies demonstrated. Significant testing effect was also demonstrated whether quizzes and exams were in the same or different formats.

McDaniel et al. (2011) discovered that the testing effect was seen when students had items of an applied nature on a quiz and items of a conceptual nature on an exam, but not vice-versa. The testing effect stands to dispel the misconception that test and retest is a form of rote memorization. The test and retest cycle, which improves encoded information recall, shows that active processing of information is required for the testing effect phenomenon to occur (Yigit, Kiyici, & Cetinkaya, 2014).

Roediger and Butler (2011b) have identified five points regarding the testing effect. First, testing produces better retention relative to passive studying methods (e.g., re-reading material). Second, testing repeatedly is more beneficial than taking a single test. Third, the

testing effect can be seen when no feedback (providing correct answers) is given after a test, however, providing feedback yields greater benefits. Fourth, sometime is required between being exposed to material and testing for retrieval practice to be beneficial. Finally, the benefits of the testing effect are not constrained to learning a specific response, rather, can be generalized to different contexts.

A foil to the testing effect is the negative testing effect, where recall is poorer after subsequent restudy (Mulligan & Peterson, 2015). Tests consisting of free-recall items more consistently showed a negative testing effect in participants of Mulligan and Peterson's study. They believed the negative testing effect takes place due to the lack of mnemonic effect of episodic retrieval. Semantic retrieval of testing items were also not present in free-recall. The positive benefits of the testing effect are not present when test items are not actively encoded and given meaning (Jang, Pashler, & Huber, 2014).

The testing effect is not without factors that can contribute to an increase in memory recall and decrease in time-dependent forgetting. Teachers are also factors in the testing effect phenomenon. The ability to encode information in a mnemonic and semantic manner can also be catalyzed by teachers who move from testing for testing's sake, toward a focus on the importance of what is being tested (Watson, Johanson, Loder, & Dankiw, 2014). Essentially, testing is a valuable tool that teachers can use to promote learning rather than merely evaluating what has been learned.

Teachers are not the only part of the equation in developing a mastery-level approach to learning; student motivation is also a strong component. Self-regulated learning is a process that involves a learner transforming their mental abilities into academic skills (Zimmerman, 2002). It refers to the behaviors and thought processes that learners engage in to attain goals they set for their learning. Hargis (2000) argues that students who are able to regulate their own learning with structure and discipline or have appropriate support ultimately perform better. Students that are better able to self-regulate have higher chances of learning, especially in an online environment.

One such tool that supports the testing effect is an Internet-based application called Kahoot™. Kahoot™ is an online application where quizzes can be developed and presented in a "game-show" type format. Points are awarded for correct answers and participating students will immediately see the results of their responses. Game-based learning has the potential to be an effective tool for learning because it stimulates the visual and verbal components of our processing. (Woo, 2014).

Laski and Siegler (2014) found the active encoding within game-based learning platforms to be effective in student learning by utilizing different styles of game in their study. A passive style of game, which did not provide meaning was less effective than game styles that utilized mental preparation and consideration. Plass, et al. (2013) found that although competitive nature of game-style learning activities did not have a noticeable trend in outcome, it did have a positive effect for a mastery goal orientation for learning. A study conducted on 58 eighth-grade students showed that there was an increase in mastery goal orientation toward learning when the game featured competition and collaboration (Plass, et. al., 2013).

The purpose of this pilot quasi-experimental action research study is to introduce and assess the effectiveness of an alternate pedagogical approach for high-stakes test preparation that utilizes gamification through the use of Kahoot™. The basis of this pilot study is to see if the testing effect applies to students in higher education and if its use results in improved multiple-choice exam scores when compared to a control group. Confirming the efficacy of the testing effect by using a fun and engaging online application like Kahoot™ adds an empirically

supported pedagogical tool to the repertoire of university professors that has the potential to improve academic performance on high-stakes summative exams in a fun and engaging way. This pilot study will also add to a very limited amount of literature on the testing effect and gamification in a higher education setting.

METHOD

In order to address the challenge of low student scores on a high-stakes examination, two research questions were developed for this pilot action research study. The first question asked,

- **What is the difference in exam scores between students receiving course content through lecture, group discussions, and Kahoot™, and students who receive course content through only lecture and group discussions?**

The second question asked,

- **What kind of change can be brought about by engaging introductory psychology students with Kahoot™, an online quizzing application?**

RESEARCH DESIGN

This pilot quasi-experimental action research study occurred in this researcher's General Psychology class, which consisted of two separate sections. Prior to the start of the semester, the researcher flipped a coin to determine which section would be the experimental group and which would be the control group. The online application Kahoot™ was introduced to the students in the experimental group.

Both groups received the same syllabi, lectures, viewed the same videos and presentation slides, and conversed about the same topics during in-class group discussions. The difference between the two groups occurred in the last 10 minutes of pre-determined classes. For the experimental group, the researcher would close up the discussion approximately 10 minutes prior to the end of class. The control group would continue on through the end of class.

During those final 10 minutes, the experimental group participated in the online no-stakes quizzes (7 multiple-choice questions per chapter) through the use of Kahoot™. Questions for Kahoot™ were written by the researcher based on the key concepts that were going to be on the upcoming high-stakes exam. Questions in Kahoot™ aligned with the key concepts, but the actual wording of the questions were not identical to the questions used for the high-stakes exam. Questions for the high-stakes exam were chosen from a test bank that was associated with the assigned text for the course.

Students who chose to participate by logging into Kahoot™ would create a screen name (using their real name was discouraged to encourage anonymity) using any Internet browser on any type of mobile device (e.g., laptop, smart phone, tablet). As questions appeared on the screen, students would select their response on their mobile device. Once all of the students responded or the preset time (20 seconds) elapsed, students received immediate feedback on the correct answer. The top five screen names who responded accurately and the quickest would appear on the screen for all to see. Students were made aware that the results of these online quizzes had no impact on their course grade.

Both the control and experimental groups took the same high-stakes multiple-choice exam in their respective classes on the same day. In preparation, the control group received a study guide with all of the key concepts that were also covered in the Kahoot™ questions. In addition, an entire class period (50 minutes) was spent reviewing all of the concepts in a

lecture-based format. Students in the control group were allowed to ask questions any time during that class period. In addition, the researcher was available during office hours for students who wanted to discuss the material in more depth. The experimental group did not receive a study guide. Instead, the experimental group spent an entire class period (50 minutes) replaying all of the Kahoot™ quizzes. After all of the quizzes were completed, students were allowed to ask questions. In addition, the researcher was available during office hours for students who wanted to discuss the material in more depth. Both groups received the key concepts that were going to be tested on the high-stakes exam, but the control group received it in writing and through a lecture versus the experimental group who received it in the form of no-stakes quizzes using Kahoot™.

The mean score of both groups were analyzed to determine if a statistically significant difference between the two data sets existed. In addition, the researcher gathered qualitative feedback from all participants through the use of a questionnaire. Qualitative responses were thematically analyzed to determine trends and also to receive feedback about their preparation experience leading up to the high-stakes exam.

Recruitment Strategy

As the primary stakeholder for the findings from this study, this researcher's positionality as a scholar-practitioner is a key element of this quasi-experimental action research study (Herr & Anderson, 2005). Since the purpose of this action research study was to determine an alternate pedagogical approach to increase student performance in the researcher's class, utilizing a convenience sample that consisted of the researcher's students was found to be appropriate. Although a convenience sample is commonly defined as a sample that is easiest to access, having the researcher's students be involved appropriately addressed this study's two research questions by providing useful qualitative and quantitative data directly from the study's target population.

Post-secondary students (18 years or older) from this researcher's undergraduate General Psychology course were sampled for this pilot quasi-experimental action research study. The only exclusion criteria is that participants cannot be considered a minor (under the age of 18). Students who decide to opt out of the study will not receive any type of penalty or loss of points. Their exam score (dependent variable) will not be included in the calculation of the mean score.

Sample

The sample size was 49 undergraduate psychology students enrolled in a first-year general psychology course. The student population at this research site consists of 68% females and 32% males. Sixty-seven percent is Asian/Pacific Islander, 17% White, non-Hispanic, 6% Hispanic, 4% African-American, and 6% other. The diversity within the sample groups was representative of this.

Data Analysis

The exam is multiple-choice utilizing Scantron software for grading. The mean exam scores will be statistically analyzed using an Independent-Samples T-Test. An Independent-Samples T-Test tests for statistical significance when comparing the mean scores of two groups consisting of interval and ratio level data.

The researcher gathered qualitative feedback through the use of the following questionnaire:

1) **What helped you in class prepare for the exam?**
2) **During class, what helped you comprehend the material being presented?**
3) **What would have supported your learning more if implemented?**

For the experimental group only:

4) **What effect did the Kahoot™ quizzes have on your preparation for the exam?**

Qualitative responses were thematically analyzed to determine learning trends and for feedback about the efficacy of the preparation methods implemented by the researcher. In addition, responses were analyzed for common words and phrases using a text analyzer developed by online-utility.org (The text analyzer can be accessed through http://www.online-utility.org/text/analyzer.jsp). This questionnaire is a form of Classroom Assessment Technique (CAT) created by the primary author.

Confidentiality

Exam scores

- **Administered using Scantron;**
- **Participants' results data were entered into SPSS (Statistical Package for the Social Sciences) by the researcher to administer T-Test, which compares mean scores of the experimental and control group;**
- **Electronic data were password protected on this researcher's office computer;**
- **All paper copies of student scores were protected with a double lock system in this researcher's private university office; and**
- **All of the examination data were kept securely for one year after the completion of this study.**

Questionnaire

- **Upon completing the questionnaire a thematic analysis was conducted to assess the students' perceptions and practices in preparing for the exam;**
- **After the analysis has been conducted by this researcher, all of the questionnaires were protected with a double lock system in this researcher's private university office; and**
- **All of the questionnaires are kept securely for one year after the completion of this study.**

Informed Consent

This researcher introduced the study in each class. Students were able to ask questions. The researcher provided each student a link to a Google Form, which included the informed consent form as the first page the student would see. Students needed to agree with the informed consent form prior to gaining access to the survey. No participants were minors. The researcher emphasized when introducing this study to each class that no penalty of any kind will be received if a student wishes to opt out of this study.

Potential Risks to Participants

The pilot research study is not more than minimal risk. Research occurred in an established educational institution and setting, which involved normal educational practices.

Potential Benefits to Participants

Participants learned an alternate studying tool to assist them in taking future high-stakes exams. In addition, the literature on the testing effect consistently shows that practicing taking tests enhances a person's memory retrieval skills when taking a high-stakes exam. Kahoot™ is used primarily in the K-12 setting and after an exhaustive literature review no studies involving Kahoot™ were conducted in a higher education setting. Because Kahoot™ engages students through game play, the experience of taking frequent low to no-stakes test should not be as threatening or intimidating when compared to frequent low to no-stakes tests administered traditionally through paper and pen/pencil. The primary benefit is adding an empirically proven tool that university professors can implement that will have a positive influence on academic performance in high-stakes exams.

FINDINGS

The source of the data was derived from the following:

(a) multiple-choice examinations, and

(b) a student dispositional survey.

An Independent-Samples T-Test was conducted to compare the effects of the online application Kahoot™ on the mean test scores in the experimental and control groups. Significance was determined between the two groups at the $p<.05$ level ($F(1, 47) = 7.801$, $p = .008$). These results suggest that the use of Kahoot did have a significant effect on test scores beyond chance.

Through the utilization of the online text analyzer the following was also determined. In response to the first question, "What helped you in class prepare for the exam," participants in the control group (n=23) mentioned "PowerPoint" 11 times followed by "notes" (9) and "study guide" (8). Participants in the experimental group (n=24) mentioned "Kahoot™" 17 times (see Tables 1 and 2).

Tables 3 and 4 indicate results of the 2nd survey question, "During class, what helped you comprehend the material?" Participants in both the control group (n=22) and experimental group (n=24) mentioned "videos" (14 and 7 respectively), however the experimental group responded with "Kahoot™" 10 times.

The third survey question that was asked to both control and experimental groups was, "What would have supported your learning more if implemented." The control group (n=23) mentioned both "quizzes" and "activities" 3 times. The experimental group (n=24) responded with "discussions" 4 times (see tables 5 and 6).

The final question was asked only to the experimental group, "What effect did the Kahoot quizzes have on your preparation for the exam?" Table 7 shows that participants responded with "helped" 17 times, followed by "fun" (3), "good" (3), and "positive" (2).

Table: 1
Control Group: What helped you in class prepare for the exam? (n = 23 responses)

Word Used	Times Mentioned
PowerPoint	11
Notes	9
Study Guide	8
Videos	6
Lectures	3
Discussion	2
Labs	2
Textbooks	2

Table: 2
Experimental Group: What helped you in class prepare for the exam? (n = 24 responses)

Word Used	Times Mentioned
Kahoot	17
Notes	5
Review	4
Quizzes	3
PowerPoints	2

Table: 3
Control Group: During class, what helped you comprehend the material being presented? (n = 22 responses)

Word Used	Times Mentioned
Videos	14
PowerPoints	7
Group	3
Labs	3
Discussions	2
Lecture	2
Relate to Real Life Situations	2

Table: 4
Experimental Group: During class, what helped you comprehend the material being presented? (n = 24 responses)

Word Used	Times Mentioned
Kahoot	10
Videos	7
PowerPoints	3
Notes	2
Discussions	2

Table: 5
Control Group: What would have supported your learning more if implemented? (n = 23 responses)

Word Used	Times Mentioned
Quizzes	3
More Activities	3

Table: 6
Experimental Group: What would have supported your learning more if implemented? (n = 24 responses)

Word Used	Times Mentioned
Discussions	4

Table: 7
Experimental Group: What effect did the Kahoot quizzes have on your preparation for the exam? (n = 24 responses)

Word Used	Times Mentioned
Helped	17
Fun	3
Good	3
Positive	2

DISCUSSION and CONCLUSION

Upon reflection of this study's findings, it became apparent that the common theme discovered from both the experimental and control group was the importance of applied learning. Participants consistently expressed the need for active reviewing, visual learning, and making the content meaningful to them by applying what they learned to a form of experience. Although the means of achieving this theme varied, the theme of applied learning was consistent in the analysis of the feedback provided by both groups of participants. The more active the learning process the more effective that method appeared to be. This was evident in the findings in response to the two research questions.

The first research question asked "what is the difference in exam scores between students receiving course content through lecture, group discussions, and Kahoot™ and students who receive course content through only lecture and group discussions?" The statistical analysis comparing the examination scores of the experimental and control groups suggest that the testing effect, through the use of Kahoot™, had a significant impact on academic performance

of the experimental group when compared to the control group. The qualitative findings also supported this analysis by providing feedback to the researcher about the efficacy of a lecture-based versus applied learning form of preparation for high-stakes exams. In particular, students appreciated the immediate feedback from Kahoot™ as it provided them a real-time gauge of where they stood in the class. Students also felt that being exposed to questions leading up to the examination helped them feel more comfortable when taking the high-stakes examination. Students also mentioned looking forward to class because they enjoyed playing Kahoot™ as it helped them to memorize key concepts of the class. Kahoot™ was the only pedagogical tool used that had no criticism of any kind in the survey. Students in the control group, who did not have access to Kahoot™, listed visual versus auditory tools highest on their preferred list of preparation tools. This supports the growing scholarship of teaching and learning (SoTL) literature that finds lecture-based pedagogy as less effective then student-focused approaches.

The second research question asked "what kind of change can be brought about by engaging introductory psychology students with Kahoot™, an online quizzing application?" The general consensus of the experimental group felt that Kahoot™ was an effective pedagogical tool because the students found it fun and engaging. This finding was impactful as students do not always welcome and actively engage pedagogical changes (Iwamoto, et al., 2016). Students commented on how they enjoyed the competitive aspect of Kahoot™. Students who preferred not to engage in the competitiveness could still participate as they could remain anonymous by using a fictitious screen name. Students in the experimental group were observed having fun and showing enthusiasm especially when seeing their screen names on the leaderboard. There were also comments made in class where students would prepare for class (e.g., read the text) because they knew that Kahoot™ would be played. This level of enthusiasm was not observed in the control group. The energy level, engagement, and even relevant class dialogue was observed to be higher in the experimental group. An interesting side effect to this was an increase use of peer study groups. Students in the experimental group were observed working together and supporting each other more than in the control group. Because students in the class were having fun with one another, starting conversations with one another appeared to be easier and less intimidating. This was not observed in the control group. Comradery was not as evident.

The utilization of games in the classroom setting has been shown to be an effective pedagogical tool to improve academic performance. It appears that this form of teaching and learning aligns with our culture's current demand for mobile applications and video games. Students can regularly be seen around campus using their mobile devices for communication, entertainment, and learning. The vast majority of students have a high degree of comfort using technology to learn. There was a very small learning curve when Kahoot™ was introduced to the experimental group. In fact, approximately one-fourth of the class had played Kahoot™ at some point during their K-12 schooling.

It can be suggested that pedagogical tools like Kahoot™ have the potential to enhance and improve high-stakes examination scores at the college and university level. Students in the experimental group felt positive about their experience. The results of this study also suggest that creating a fun and engaging environment also supports improved academic performance. Students will learn what excites them. If a student cares about what she or he is introduced to, she or he will be motivated to learn.

LIMITATIONS

This pilot quasi-experimental action research study was limited by its relatively small sample size (*n*=49) and convenience sample. Although it began to answer the research questions for the researcher as it applied to the researcher's class, utilizing a larger sample size at various levels (first-year, second-year, third-year, and fourth-years and higher) and from additional institutes of higher education would substantially increase the transferability of this study. Also, the fact that there was familiarity with Kahoot™ prior to this study could be considered a confounding variable. Another limitation was that the students' self-regulation skills were not assessed. By assessing self-regulation skills, the students' study skills could be analyzed to determine if that was another confounding variable in the students' performance with the high-stakes exam.

RECOMMENDATIONS FOR FUTURE RESEARCH

Recommendations for further research emerging from this action research study include;

- **Future action research cycles should collect and analyze data over a longer period of time (e.g., the entire semester) versus just the first half of the semester.**
- **A study looking into the effectiveness of gamification at the higher education level would clarify if the significant findings from this study was due specifically to the online application Kahoot™ or the experience of learning through the gamification of the course's content.**
- **A study that looks into the self-regulation skills of students to determine how much time and energy they are putting into their examination preparation and if there is a positive correlation between that and academic performance.**
- **Develop a baseline assessment to determine the level of variance in the comparison groups. This will increase generalizability and transferability of the findings.**

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