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An Examination of Active Learning Environments: A Non-parametric Analysis on Student Learning Assessments

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Flipped learning has an almost 20-year history. However, the research is as ambiguous as it has been since its inception. This pedagogical model lacks consistent results. One key component that does have an impact, but not the only factor, has been an active or dynamic component included into the learning environment. The goal of this study was to examine the impact of active learning environments compared to traditional learning environments on student learning assessments. Using non-parametric analyses, the findings in this study did demonstrate that an active learning environment increased scores on student learning assessments. This, like previous studies, demonstrated inconsistent results in that not each assessment was statistically significant. Because this model keeps appearing in the research, further studies need to address the issues to hone the model to be consistent across the research.

Keywords: Flipped learning, active learning, traditional learning

INTRODUCTION

In 2000, Baker began to write about the classroom flip. In this model, students would access lecture notes, class discussion, and quizzes from a learning management system platform as outside-class activities. Then, during classes students engaged in learning time. However, this flipping trend did not witness a spike in activity until around 2012. According to Google Trends (2018), the flipped learning became a popular web search category in March 2012. This model of learning has had its ups and downs over the years and is in a current downtrend. Most simplistically, it would appear that Baker demonstrated that school work and home work were reversed for students and that outcomes or success would be improved because of this pedagogical model. According to the Flipped Learning Network (FLN, 2014), flipped learning is a pedagogical model in which instruction spaces are redesigned, "direct instruction moves from the group learning space to the individual

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learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter" (p. 1). In other words, implementing a flipped learning environment should create a model where students can apply higher-ordered learning at the guidance of teachers and educators. If this model holds true, why has flipped learning had sporadic engagement, and why is the research ambiguous?

Two years ago when I began to review flipped learning, I asked "What are we 'flippin' doing?" (Lee, 2016, p. 1). In 2016, the research was divided. Some researchers had significant findings, others did not, and other had partially significant findings, otherwise there was no differences between flipped and traditional learning environments (Lee & Liu, 2016). The sentiment seems to have remained the same. For instance Barral, Ardi-Pastores, and Simmons (2018) found that students in biology courses who engaged in flipped learning scored better on post questions as compared to the control (traditional) classroom. However, upon further review, the improvement was only on lower-ordered learning questions, and did not address student's ability to analyze, apply, or evaluate information (Barral et al.). More specifically, Anderson, Krathwohl, and Bloom (2001) defined lower-ordered learning as the ability to remember and understand acquired knowledge. Furthermore, if students/learners reach higher-ordered learning, they can apply, analyze, and evaluate using the knowledge they learned. Huang, Hew, and Lo (2018) found that students in the flipped learning group completed tasks earlier than the control group and had statistically higher scores. However, gamification was added to the flipped learning environment which provided an active learning element. Therefore, the statistical change could have been due to the use of gamification as a dynamic component.

Flipped learning trends have ebbed and flowed, and the research has been ambiguous. However, this has not reduced the number of educators trying to implement a flipped learning environment. According to the FLN (2014.), the flipped learning community has grown and continues to engage in and welcome new research.

LITERATURE REVIEW

Flipped learning has not been met with open arms across the research and educational communities. For instance, Cobb (2018) stated that educational trends like self-directed learning such as flipped learning disrupts lifelong and continued learning. Schell (2016) acknowledged that flipped classroom models fail and one reason is the inability for students to apply knowledge which was reaffirmed by Cobb. For example, Hu and Hsu (2018) revealed that most students claimed that flipped learning was a favorable approach. However, over 10% of the respondents did not like the flipped learning environment. Flipped learning ambiguity is further increased when the outcomes were not significant and participants were dissatisfied with the pedagogical model (Hu & Hsu).

FLIPPED LEARNING

Flipped learning, minimally, is a pedagogical approach in which learning spaces are reversed. Individual and group learning is shifted. According to the Flipped Learning Network (2014), changing spaces should transform the learning into a dynamic and interactive learning space. By definition, flipped learning should include active learning components and the non-significant finding could be a result of flipping spaces without adding a dynamic or interactive component.

There is a wide range of flipped learning research from tech trends and practitioner journals to academic journals and books. The trends in flipped learning research have been non-significant differences between groups, the flipped group preformed significantly better, or a mixed bag of results. Multiple research showed that all things being equal, there were no significant differences between groups (Baepler, Walker, & Driessen, 2014; Davies, Dean, & Ball, 2013; Velegol, Zappe, & Mahoney, 2015). More specifically, Velegol et al. (2015) found that grades were the same across groups.

Shyr and Chen (2018) designed a flipped learning course that included technological enhancements as a method of facilitating self-regulation and increasing student performance. They used a quasi-experimental design in which the technological-enhanced course used the Flip2Learn system and the control group was a non-dynamic flipped environment. The added enhancements produced a dynamic classroom more closely fitting the FLN definition of flipped learning. Specifically, Shyr and Chen found that the students in the enhanced course outperformed those in a flipped-only environment. Huang, Hew, and Lo (2018) conducted a similar study in which students in a flipped-only environment was compared to a dynamic gamification flipped learning course. Huang et al. determined that students in the gamification flipped environment preformed more pre-class exercises, more students completed quizzes as the course progressed, and increased knowledge from the pre-test to the post-test.

Maycock (2018) compared a "chalk and talk" course to a flipped learning course in architecture. The results were ambiguous. The assessment for both groups included three grading areas: (a) bi-weekly, open book assessments; (b) an open book/note examination; and (c) a terminal examination. Students in the flipped learning environment performed better on the first and second assessments. However, there were no significant differences between groups on the third assessment, the terminal exam.

The flipped learning research tends to follow the history of this pedagogical model: Simply adding a flipped component to the course does not result in a better outcome for students. There must be an "active" or dynamic factor that engages the students, such as gamification, Flip2Learn, and other active models.

ACTIVE LEARNING

According to Stonge, Grant, and Xu (2015) the United States has under-performed in 21st century skills, mathematics, and sciences even as millennials are a technological generation. The lack of skill and student learning can be attributed to the more passive learning environments found in U.S. higher education (Weiss & Pasley, 2004).

In 2004, Prince defined active learning as "instructional method that engages students in the learning process" (p. 1). Prince further explained that collaborative and cooperative learning was a method for small groups of learners to assist in developing and meeting goals. Curwen (2013) indicated that active learning environments develops specific learner habits. Students should

1. be responsible for their learning;
2. develop clear goals;
3. engage in cooperative and collaborative ways;
4. listen to and understand classmates as part of the collaborative group; and
5. continually engage in the learning environment.

Active learning has been used in conjunction with flipped learning. The findings demonstrated some success. Hung (2015), in a quasi-experimental design used WebQuests and found that students in the active learning environment prospered. Harrinton, Basch, Schoofs, Beelbates, and Anderson (2015) compared flipped learning and traditional learning environments and found no differences when active learning was not a component of the flipped learning environment. Similarly, Fauzi and Hussain (2016) found that active and reflective processes were the most important feature to student learning.

The implications are that a class learning environment that is flipped, but other pedagogical tools are not employed, is a traditional learning environment. In other words, the areas of learning are flipped but the behaviors of the course are identical to a traditional classroom. The purpose of this study was to determine if the classroom environment (active learning and traditional learning) lead to differences between student learning outcomes on learning assessments.

EXAMINATION OF LEARNING ENVIRONMENTS ON STUDENT LEARNING ASSESSMENT

RESEARCH HYPOTHESIS

Three classroom environments were compared: active flipped learning, active-only learning, and traditional learning. The null hypothesis was that there will be no differences between the three learning environments on student learning assessments (H_0: AFL=AOL=TL). Alternatively, based upon the previous research there will be some differences and the differences should be significantly different ("better") for student learning assessments in the active learning environments.

1. More specifically the driving question was, how does "active" learning environments impact student learning outcomes on learning assessments?

RESEARCH PARTICIPANTS

The participants in this study consisted of undergraduate students who completed introductory sociology courses. Participants came from three different introductory sociology courses over two semesters (N = 162). The participants came from an active flipped learning group (n_1 = 64), an active-only learning group (n_2 = 34), and a traditional learning group (n_3 = 64). Students enrolled in a degree program were required to complete three credits of a social science. Therefore, participants had varied disciplines. None of the students in the course were sociology majors or minors.

SETTINGS AND PROCEDURES

The groups were preestablished based upon student enrollment, self-selection. All students completed the same assignments, quizzes, exams, and other work as assigned in the courses. All learning assessments were given same instructions, worth the same number of points, and assessed the same. Participants who opted out of the study completed the same course requirements. However, their scores were not used in this study. Two of the of the ten quizzes and one of the unit exams were the learning assessments used in the study. The quizzes included test bank questions that focused on lower-ordered learning (i.e., understanding and remembering). The unit exams covered similar content but the focus was on higher-ordered learning (i.e., application, analysis, etc.). Students completed the learning assessments during regular spring and fall semester course offerings at the Intuition.

The learning environments consisted of two active learning environments (flipped learning and active-only learning) and a traditional classroom environment. In the active flipped learning environment, students reviewed recorded lectures; these were the same lectures used in the active and traditional course. However, the lectures were live in the active and traditional environments. Upon reviewing the recorded lectures, active flipped learning participants were directed to pause the lecture and answer questions, provide examples, and write discussions about content. During class, the students would ask questions, students were asked questions to determine understanding, and mini-lecture materials were conducted during class to ensure comprehension. In addition, students would complete handouts during class to help ensure cognizing. Furthermore, students would engage in group work to address scenarios and other applied stylized learning. Finally, individual homework assignments were composed during class for the active flipped learning group.

In the active-only and traditional learning environments, lectures occurred during class. In the active-only learning environment, stops/pauses were made during the lecture to ask students to respond to prompts, provide examples, and open discussions for complex concepts. The active-only learning group structure mirrored the flipped learning aside from lectures and assignments. Students engaged in group work scenario solving, handouts, and various applied stylized learning. However, homework assignment were completed at home rather than during class, as in the flipped learning environment, and time for questions was provided during class.

The traditional learning environment was traditional. Students engaged in lecture during class. They could ask questions, students were asked to provide examples, and were encouraged to discuss the content in an entire class setting. Homework assignments and handouts were completed outside of class. Time was provided in class for questions regarding homework, handouts, etc. The focus during the course was the lecture and providing content information to students.

In each group, quizzes were administered online through the Institution's learning management system (LMS). The quizzes were timed. However, students could have referred to notes and text to complete the learning assessments. The unit exams were proctored during class and students could not use books or notes to complete the learning assessments.

DATA ANALYSIS AND RESULTS

The null hypothesis was that the groups were equal and no significant differences occurred between groups on assessment outcomes (H_0: AFL=AOL=TL). In order to address the null hypothesis, and research question, data was collected from two of the 10 student quizzes and one of the unit exams. Although the sample size was not small per se, the groups were unequally sized. Therefore, non-parametric tests, more specifically Kruskal-Wallis *H* tests, were used. For the pairwise comparisons, alpha levels were set at .05. Because three tests were run a Bonferroni correction was conducted and the resulting *p*-value was .017 (Cohen, 2001).

A Kruskal-Wallis *H* test was conducted to evaluate the differences among groups on assessment scores. The results of the analysis indicated there was a significant difference between the mean scores. Table 1 showed the differences between groups on the three learning assessments (see Table 1). These three learning assessments were used to determine student learning outcomes because they were identical in the three courses. Other learning assessment tools may not have been identical across all three courses. Three pairwise comparisons were conducted to determine which group performed significantly different.

Table 1. *Kruskal-Wallis H Test Results*

	Quiz 1	Quiz 2	Unit Exam
Chi-Square	.517	52.257	6.893
df	2	2	2
Asymptotic Sig.	.772	.000	.032

The first Mann-Whitney *U* test indicated that assessment mean rank scores were slightly higher for the active flipped learning group for quiz one and two. Table 2 showed the specific mean rank scores for the groups (see Table 2).

Table 2. *Mean Rank Scores from the Mann-Whitney U Tests*

Assessment	Group	N	Mean Ranks
Unit exam	Active-only learning	33	59.18
	Active, flipped learning	61	41.18
Quiz 2	Traditional learning	64	41.82
	Active, flipped learning	58	83.22
Quiz 2	Traditional learning	64	38.73
	Active-only learning	33	68.92
Unit Exam	Traditional learning	64	46.81
	Active-only learning	33	53.24

However, these scores were not significant different. There was a significant difference between the active flipped learning group and the active-only group. The students in the active-only group preformed significantly better (U = 59.18, n_1 = 57, n_2 =33, p = .002).

The second Mann-Whitney *U* comparison was conducted using the active flipped learning group and the traditional learning group. Students in the active flipped learning group performed significantly better on the second quiz (U = 596.50, n_1 = 58, n_3 = 64, p = .000). The final pairwise comparison was between the active-only learning group and the traditional group. The students in the active-only group performed significantly better (U = 398.50, n_2 = 33, n_3 = 64, p = .000). The active-only learning environment scored significantly higher on the unit exam than the traditional group (Z = 1.471, p = .026). However, the Bonferroni correction negated the use of this test.

As suggested by Corder and Forman (2014, p. 80), the effect size was calculated using $ES = |Z| / \sqrt{n}$. Corder and Forman listed out three potential effect sizes: *small* = 0.10, *medium* = 0.30, and *large* = 0.50. The effect size for the first pairwise comparison would be considered a medium effect ($ES = |-3.060| / \sqrt{94} = .032$). The effect size for the second comparison was large (ES = .60). Finally, their effect size would be considered large as well (ES = .52). The effect sizes for the three pairwise comparisons demonstrated that there was a better than medium association between the groups.

Overall, all three tests were significant. There were differences between groups on assessment scores. More specifically, the groups in which there were active learning components included, the scores were significant. The flipped learning group did not score more significantly than either of the active learning groups. The implication from these results were that adding an active or dynamic learning component has the potential to increase student scores on learning assessments. The research question, how does “active” learning environments impact student learning outcomes on learning assessments, was answered. The resulting answer was that an active learning component, whether administered in a flipped learning or not, brought about significantly higher scores on student learning outcomes. That is to say, students who engaged in active learning performed significantly better on learning assessments than students who were not engaged in active learning.

DISCUSSIONS

As was determined in the previous literature, the findings associated with flipped learning are ambiguous at best. The current study upheld the previous findings. Flipped learning and active learning environments were not consistently significant across all learning assessments. One driving finding was active learning. Both actively learning groups scored significantly better than the traditional learning group. Therefore, it does reify that active learning or dynamic learning environments are beneficial for student learning. Flipped learning alone, may not be the best tool for determining student’s success and the FLN suggested guidelines should be followed, rather than a switch to learning environments only.

The findings of the current student reify the status quo of flipped learning environments. As demonstrated in this study, and previous research, the findings were mixed; some of the student learning outcomes were significantly different based upon groups and others were not (Baepler et al., 2014; Maycock, 2018; Velegol, et al., 2015). However, students in the traditional learning had lower scores across all of the learning assessments.

LIMITATION AND FURTHER STUDIES

There are some limitations that (could have) impacted the outcomes of this research. First, each group of students was instructed by the same faculty member. Although, the materials were presented and concerns/questions addressed in a similar fashion, and quizzes, exams, and other assignments were the same. The only difference was the dynamics that made the courses active or non-active. This could limit the differences between groups. However, because the research was also the instructor, bias could have existed. Second, pre- and post-tests were not performed. Therefore, students’ existing knowledge about sociological concepts would not be known. There could have been floor or ceiling effects that were not accounted. Finally, similar to previous research the statistical differences were ambiguous. An implication from the current study could be that it is difficult for the research (who is also the instructor) to ensure that the groups are taught according to their group procedural protocols while maintaining student learning.

Further research will need to be conducted to address why differences are not consistent within groups. Additional research should include pre- and post-test measures to ensure groups have similar knowledge. Another option could be to use matching among participants. Before stating that flipped learning works across all groups, further research must be conducted.

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