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The Impact of Flipped Learning and Think-Pair-Share on aviation student academic performance

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Previous studies have shown that the flipped classroom technique and active learning strategies that employ collaboration can provide great benefits to students ranging from increased achievement, higher participation, and improved academic perceptions. The purpose of this study was to explore if flipped learning and Think-Pair-Share (TPS) had an impact on the aviation students' academic performance in a Private Pilot Theory course. Student participants of the flipped learning instruction, including TPS, achieved statistically significant higher final exam scores ($M = 81.52$, $SD = 8.869$, $SE = 1.77$) than those who only underwent flipping ($M = 68.57$, $SD = 13.40$, $SE = 3.58$), $t(37) = -3.63$, $p < .001$. These findings were accompanied by positive student testimonials on the overall experience with the course and the active learning strategy used.

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There have been multiple ways to define learning. The Federal Aviation Administration (FAA) defines learning as a change in behavior which results from experience (2020). In other words, the student or learner must experience or practice something. He or she must be actively involved in this learning process. Research has shown that when active learning strategies are used information is more likely to be remembered because it required learners to generate some or all of the material themselves, versus reading or listening to what others had prepared or said (Bertsch & Pesta, 2014). There are many ways an instructor can deliver a lesson using active learning. One of these methods is by a form of instructional design called the flipped classroom technique.

In a traditional classroom students are exposed to content during class sessions and are later required to complete homework or exercises in their own time. Every so often, while completing assignments at home, students have difficulties applying the information they learned during class. Flipping reverses the traditional method of teaching and learning. In a flipped classroom students are exposed to content before arriving to class and are prompted by the instructor during class to complete exercises, analyses, and other forms of higher order thinking skills (HOTS). Consequently, flipping helps students acquire prior knowledge of a topic before applying that information in a class setting with the help of peers and instructors. Prior knowledge is "one of the most influential factors in student learning because new information is processed through the lens of what one already knows, believes, and can do" (Ambrose & Lovett, 2014, p. 7). In summary, during flipping, readings and lectures are pre-done by students at home, while instructional sessions are devoted to exercises, projects, or discussions (Educause, 2012).

Literature Review

A recent U.S. survey confirmed the growth of the flipped classroom (Bart, 2013). Flipping can be done with or without technology. However, the use of technology can greatly assist the learning process. For example, instructors who flip either record their class sessions or use a combination of other technological tools such as videos on YouTube, podcasts, Massive Open Online Courses (MOOCs), e-books and other various open educational resources (OERs).

Although educational research has shown that flipping can be used to increase student achievement, grow student engagement, and improve emotional readiness toward learning (Flipped Learning Network, 2013; Yarbro, Arfstrom, McKnight, & McKnight, 2014), very few studies have translated these practices into the aviation classroom setting. Furthermore, results have been mixed. Velazquez (2017) reported a statistical significant increase in student final exam scores and overall course passing rates; whereas, Dusenbury and Olson (2019) found that students in the lectured classroom performed better than those flipped and had higher overall course satisfaction.

In 2019, a college professor of an aviation program used a MOOC called *Aviation 101*, developed by Embry-Riddle Aeronautical University (ERAU), to flip a classroom and see if student performance would increase. The course was *AWSC 2115 Private Pilot Theory* which presents the foundational knowledge essential to become a certificated FAA Private Pilot. The information in AWSC 2115 is entirely brand new to students; thus, using a MOOC to flip the

course allowed them to become familiar with course content before arriving to class. The MOOC incorporated nearly all of the university course topics. During class the instructor used guided discussions and Think-Pair Share (TPS) to allow for active learning.

In guided discussions the course instructor integrates the learners by engaging them in a lively exchange of ideas (FAA, 2020). The instructor initiates the dialogue with concepts and makes sure to steer the conversation in the right direction. Guided discussions promote participation which makes the learning active. Guided discussions are also a form of informal testing or formative assessment during class. Testing has been shown to promote learning and retention by allowing students to evaluate information and verify their own level of understanding about concepts and principles (Pyc, Agarwal, & Roediger 2014).

Developed in 1981 by Frank Lyman, Think-Pair-Share (TPS) also promotes participation by allowing students to reflect alone on an open-ended question posed by the instructor and later, pair-up with a classmate to share his or her thoughts (Cowling, n.d.). This form of social learning promotes self-testing and open discussions in the classroom amongst students and instructors. The first step in TPS is self-explanation. Self-explanations or making sense of new information by explaining to oneself, helps learners construct new meaning by elaborating upon presented information, relating them to existing knowledge, making inferences, and making connections among given information (Chiu & Chi, 2014). After this step is accomplished, the student connects and refines said knowledge by sharing his or her ideas with a peer. Figure 1 presents a photograph of students working under TPS.

Figure 1

Engaged students chat amongst themselves during TPS

Methodology

The purpose of this study was to explore if flipped learning combined with Think-Pair Share (TPS) had an impact on the students' academic performance in an aviation Private Pilot Theory course. This research used an experimental two-group post-only design. The study consisted of an experimental group, or cohort of students, who were exposed to a stimulus which

in this case is the flipping pedagogical technique combined with TPS. The control group, or cohort of students, although flipped did not use TPS. Students were randomly assigned to both groups and both groups were comparable in that they: (1) all met the same determined criteria for matriculation and (2) were instructed by the same professor. Given proper randomization in the assignment of students to the experimental and control groups, there was no need for pretesting (Campbell & Stanley, 1963).

Initially 63 students started in the course; however, because of student attrition, a total of 39 students participated across 15 weeks and took the Final Exam: 25 students in the flipped /TPS section and 14 in the flipped-only section. The students in the flipped/TPS section met twice a week (Tuesdays and Thursdays) during the afternoon (1230-1450) while the flipped-only group also met twice a week (Monday and Wednesday) during the night (from 1800-2020). Student final exam scores were used for comparison. In addition, testimonials were collected.

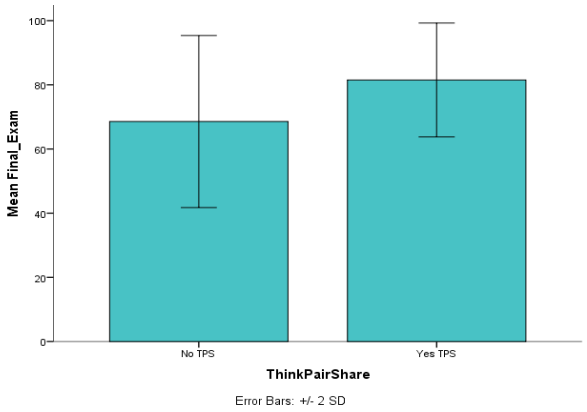
The specific research question of this study was: Will there be a significant difference in final exam scores between students experiencing a flipped course (with the aid of the TPS) versus those students undergoing only the flipped classroom technique? The research hypothesis stated that there was a significant difference in final exam scores between these two groups of students. The null hypothesis is: $H_0$1: There is no statistically significant difference in *final exam scores* between students experiencing a flipped course (with the aid of the TPS) versus those students undergoing only the flipped classroom technique.

Results

Student participants of the flipped learning instruction, including TPS, achieved significantly higher final exam scores (M = 81.52, SD = 8.869, SE = 1.77) than those who only underwent flipping (M = 68.57, SD = 13.40, SE = 3.58), $t(37) = -3.63$, $p < .001$. The alpha level for the statistical test was set at .05, and effect size was calculated for the results which rejected the null hypothesis (significant). See Figure 2. A large effect size was noted and calculated using Hedges'g (g = 1.211).

Figure 2

Mean final exam scores between both groups



Student comments on the Flipped Learning

Students were asked to voluntarily respond to a simple open-ended question at the end of the course: what were some of the things you liked best of the flipped classroom technique used in this course? Although only a few students answered, these were their reactions (the first two came from the flipped-only group while the remaining comments are from the group that also underwent TPS):

- *"…you came to class with an idea of what you're going to learn. […] therefore when it's time for the [..] class, the student is adding to what they had previous learned."*
- *"It allowed me to have an idea of what the material was before taking the class, so I wasn't lost when the material was given."*
- *"What I like the most about this technique is that it allows us to learn more on subject before we actually discuss it in class, allowing us to further 'connect the dots' in class, and retain that information. I do not have any complaints on it."*
- *"I really enjoyed your class and I don't recommend that you change anything about the class or your teaching style. "It allowed me to have an idea of what the material was before taking the class, so I wasn't lost when the material was given."*
- *"…class information is better processed and absorbed. I can't say anything negative about this technique."*
- *"I could learn on my own at home and study."*
- *"I feel the flipped classroom technique is the future of teaching and I very much enjoyed the way the course was given."*
- *"I love this technique because we [could] anticipate what [was] going to happen in the classroom."*

Discussions

Flipping a class and using active learning strategies, especially collaborative ones, is never an easy task. Providing students with content beforehand is just part of the equation for effective flipping to take place. During class, the course instructor must be masterful when guiding students and facilitating the learning experience. Not only must an instructor relinquish a degree of control that is typically attained when lecturing (Honeycutt & Garrette, 2013) but students might be reluctant to participate fully in this autonomous learning environment. On the faculty side, lecturing still remains the preferred teaching delivery style. On the student part, for active learning, pupils are responsible for generating new knowledge. Moreover, flipping increases the burden on students by requiring them to do the necessary pre-work before arriving to class.

This study agrees with Sampsel (2013) who found that TPS increased student participation, albeit in math and class discussions. One reason why the TPS group outperformed the regular flipped group is because the former were involved in in-class discussions more heavily than the flipped-only group, as noted by the course professor. The greater the participation the more effective learning will be (FAA, 2020). Increased participation also allows for more opportunities for the course instructor to provide feedback to students. Beginners, as is the case with students in the Private Pilot Theory course, need feedback to build upon basic knowledge. Feedback to learners can double the rate of learning and is among the top 10 influences on achievement (Hattie & Yates, 2014).

Finally, TPS can be considered a form of metacognition. Metacognition is the ability to observe one's own mode of thinking and learning. It provides a student the opportunity to monitor and evaluate thought processes and depth of understanding. Metacognitive skills have shown to improve academic performance across a variety of disciplines (Zohar & Ben-David, 2008). TPS allowed the student to accomplish metacognition during the first step of self-explanation (i.e., Think) and later again by sharing his or her thought processes with a classmate (i.e., Pair-Share). Peer work where students compare different strategies and solutions, and requires them to verbalize their thinking and thus to subject it to more explicit checks of comprehension, provides metacognitive advantages (Garfield, 1993; Girash, 2014).

Conclusions and Recommendations

The objective of this study was to discover if flipped learning, combined with Think-Pair-Share (TPS), had an impact on the aviation students' academic performance in a Private Pilot Theory course. Student participants of the flipped learning instruction, including TPS, achieved statistically significant higher final exam scores ($M = 81.52$, $SD = 8.869$, $SE = 1.77$) than those who only underwent flipping ($M = 68.57$, $SD = 13.40$, $SE = 3.58$), $t(37) = -3.63$, $p < .001$. These findings were accompanied by positive student testimonials on the overall experience with the course and the active learning strategy used. When students work with an instructor, in a flipped environment, they learn to think more critically, connect with others more successfully, and have a better appreciation for the subject (Velazquez, 2017).

This study also adds to the scarce amount of research in aviation education concerned with flipping and/or Think-Pair-Share. Future research should continue to explore the effects of flipping and active learning in aviation courses of all specializations (e.g., flight, management, safety, human factors, air traffic control).

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