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Active Learning Classrooms vs Computer Labs: Student Learning, Emotion, and Classroom Settings

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Using undergraduate students in the research methods course in Child Development as participants and keeping the instructional approach consistent, this study examined two research questions. The first research question tested the effect of two classroom settings, active learning classrooms (ALCs) versus computer labs, on students' learning. The results found that students in ALCs performed marginally better than computer labs for overall course grades and papers, but not for exams. The second research question tested the relationship between the reduction of negative feeling state and learning and investigated whether the relationship differed based on the classroom setting (ALCs vs computer lab). There were differential relationships between the reduction of negative feeling state and the performance of specific assignments by classroom settings. This study highlights the complexity of the impact classroom settings might have on students' learning and how it might be related to students' emotional states and their learning.

In higher education, instructors are historically expected to become the "sage on the stage" (King, 1993) who transmit information and knowledge to students who passively listen and receive the information and knowledge. However, many studies (e.g., Bonwell & Eison, 1991; Michel et al., 2009) suggest that this passive instructional approach may not be the most effective way for students' learning. Recent research has shown that the instructional approach, called active learning, that involves and engages students has been found to be more effective for students learning (Prince, 2004; Walker et al., 2011). Active learning is defined as an instructional approach that engages students in the learning process (Prince, 2004) and is considered one of seven principles of good practice in higher education (Chickering & Gamson, 1987; Trowler, 2010). Watkins et al. (2007) define active learning as having three components; behavioral (students' engagement in class activities), cognitive (students' critical thinking and decision-making during the activities), and social (students interact with other students in a small group). Active learning changes instructor roles from the "sage on the stage" to a facilitator of student learning by making students more responsible for their own learning (Niemi, 2002). Active learning is rooted in three theories; constructivism (Piaget, 1936) stating that knowledge is constructed by activities and self-exploration, social learning theory (Vygotsky, 1978) stating that knowledge is constructed by socially interacting with other individuals, and observational learning theory (Bandura, 1977), stating that knowledge is gained by imitating and modeling other individuals. Implementing active learning in college and university courses has consistently been shown to enhance learning. For example, active learning has been shown to promote students' short and long-term retention of materials (Ruhl et al., 1987), conceptual understanding (Beichner et al., 2007; Hake, 1998), learning (Deslauriers et al., 2019; Dori & Belcher, 2004), and reduction in failure rates (Beicher et al., 2007; Dori & Belcher, 2004). Active learning has been shown to be especially effective for traditionally underrepresented groups (Beichner et al., 2007; Fredericksen, 1998). The benefits of active learning are not only academic but also extend to social and psychological aspects. For example, the implementation of active learning facilitated liking among peers in the class, increased psychological adjustment (e.g., self-efficacy and self-esteem), and better attitudes toward university and learning (Johnson et al., 2014). Laal and Ghodsi (2012) showed that active learning increased the awareness of diversity, reduced anxiety, and increased positive attitudes toward instructors. Courses with active learning also facilitated students' communication skills, problem-solving skills, innovative or creative thinking, and better working with their team (Terenzini et al., 2001).

Recently, specific classroom settings that facilitate the implementation of active learning have been built in some universities. One such example is the student-centered activities for large enrollment undergraduate programs (SCALE-UP) project at North Carolina State University, where the classrooms include round tables to make it easier for students to interact with their peers in a small group and an assigned whiteboard and a laptop computer for each group to facilitate collaboration among group members (Beichner et al., 2007). Another example is the technology-enabled active learning (TEAL) classroom at Massachusetts Institute of Technology (Dori & Belcher, 2004). In general, these classrooms are called active learning classrooms (ALCs). Research conducted so far on the effectiveness of these ALCs compared to traditional classrooms (TCs) have shown that ALCs improved students' problem-solving and conceptual understanding, and reduced failure rates (Beicher et al., 2007; Brooks, 2011; Dori & Belcher, 2004). For example, comparing ALCs

and TCs and keeping the instructional approach the same across classroom settings, Walker et al. (2011) found that Biology students in ALCs earned better grades than predicted by ACT scores compared to students in TCs. They also found that instructors and students behaved differently in the ALCs compared to TCs. For example, instructors spent more time away from the podium and spent more time consulting individual and small groups of students in ALCs than TCs. Students in ALCs also stated that they actively participated in the course by spending more time in group activities than TCs. These studies have illustrated that classroom settings might matter for student learning.

Drew and Mackie (2011) suggested that affect (emotions) should be added as a fourth component of active learning to the original three components provided by Watkins et al. (2007). Emotions (affect) are one of the key factors to determine student learning outcomes (Rowe et al., 2015; Su & Chung, 2015). For example, negative emotions, such as anger and anxiety can negatively impact student learning (Falchikov & Boud, 2007; Goralnik et al., 2012; Kahu et al., 2015). Negative emotions also impact cognitive processing (Falchikov & Boud, 2007) in a similar manner as the stress response interferes with cognitive functions (De la Fuente et al., 2014). Therefore, it is important to understand emotional well-being in learning and academic outcomes (Geertshuis, 2019). However, educational theorists have argued that negative emotions including discomfort and stress are necessary for the process of learning (see English & Stengel, 2010, for review). Based on these theorists, when students are challenged, which is an important aspect of learning, they tend to feel these negative emotions (see English & Stengel, 2010, for review). This implies that managing negative emotions might be critical for student learning. One of the ways to reduce negative emotions, such as anxiety, is the use of cooperative learning strategies (one of the active learning approaches), which has been shown to reduce anxiety and improve student learning (Oludipe & Awokoy, 2010; Suwantarathip & Wichadee, 2010). One of the courses that trigger students' negative emotions across fields and disciplines is a research methods course. Studies have shown that students often perceive research methods courses to be difficult, challenging, and novel, which triggers negative emotional responses, such as stress and anxiety (Papanastasiou & Zembylas, 2008). A previous study (Kuwabara, 2019) has found that more reduction in negative feelings over the academic term was related to better course performance in an undergraduate research methods course. This makes the research methods course optimal course to study students' learning and emotionality and makes the finding from the course applicable to many disciplines and fields.

Using students in a research methods course as participants and keeping the instructional approach consistent, this study tested two research questions about negative subjective feeling states, learning, and classroom settings. The first research question was to test the effect of classroom settings (ALCs vs computer labs) on students' learning. Based on previous findings on the effect of ALCs (e.g., Walker et al., 2011), the hypothesis could be that students in ALCs perform better than students in computer labs. However, if the technology-rich environment is a contributing factor to better learning in ALCs, then, computer labs should improve students' learning as much as ALCs. This research question is important because previous studies (e.g., Walker et al., 2011) investigating the effect of classroom settings were done in STEM fields. Expanding the finding to a research methods course that is applicable to other fields and disciplines are necessary to generalize the benefits of ALCs. It is also important to compare ALCs with computer labs, which test whether a technology-rich environment is one of the key contributing factors for better learning in ALCs; because previous studies investigating the effect of classroom setting typically compare ALCs with TCs, where TCs are not technology-rich environments.

The second research question focused on the relationship between negative subjective feeling state and learning and investigated whether the relationship differed based on the classroom setting (ALCs vs computer lab). Based on a previous study (Kuwabara, 2019), the hypothesis was that more reduction in negative feelings over the academic term was related to better course performance in an undergraduate research methods course. This relationship would be expected to be observed for ALCs based on a previous study (Laal & Ghodsi, 2012) but no clear hypothesis can be set about computer labs since there are no previous studies comparing ALCs and computer labs. This question is important because no previous studies have investigated how classroom settings (ALCs vs computer labs) might influence the relationship between emotionality and learning. As stated by Drew and Mackie (2011), if affect would be a component of active learning and emotions (affect) are one of the key factors to determine student learning outcomes (Rowe et al., 2015; Su & Chung, 2015), then, there should be a differential relationship based on the classroom settings depending on how much the classroom settings facilitate the active learning because active learning reduced anxiety in previous studies (e.g., Laal & Ghodsi, 2012).

Methods

Participants

Ninety-eight students who enrolled in a research methods course in the Child Development program participated in this study. The requirement for consent was waived by the California State University, Dominguez Hills Institutional Review Board because this study involved the use of educational tests and survey procedures. Half (49 students) took the course in Active Learning Classrooms (ALCs) and the other half (49 students) took the course in computer labs (non-active learning classroom). All of the instructional materials (assignments, assessments, lecture materials, and group activities) and the instructor were identical across classroom settings (ALCs vs computer labs). The only differences between these two groups were the days of teaching (Mondays/Wednesdays or Tuesdays/Thursdays) and classroom settings (ALCs or computer labs).

Materials and Procedure

Students were asked to fill out a survey at the beginning and the end of the semester. For this study, two survey questions asking how students felt about research were used. At the beginning of the semester, students were asked to rate how fearful and worried they were about a research methods course using a scale of 0 (not at all) to 10 (very much). At the end of the semester, students were asked to rate how fearful and worried they were about conducting research and understanding research in the future using the same scale of 0–10. The mean scores of negative feelings at the beginning of the semester and the end of the semester were calculated for each student. The difference score of negative feeling (the beginning minus the end of the semester) was calculated as this score indicates the reduction in the negative feeling over the semester. The mean scores of two major assignments (exams and papers) in this course and overall course grade were used as measures of students' learning. The mean of exam scores (midterm and final) and the mean of paper scores (midterm and final) were calculated for each student.

Results

To test the first research question of whether the students in ALCs learn better than in computer labs, the mean exam scores, the mean paper scores, and overall course grade were entered as dependent variables, and settings (ALCs or computer labs) were entered as an independent variable in ANOVA. The results show that exam scores did not differ significantly between ALCs (M = 41.73, SD = 8.10) and computer labs (M = 40.19, SD = 7.63), $F(1,97) = 0.33$, $p = 0.57$. However, the students in ALCs scored marginally better on the papers (M = 145.45, SD = 23.14) and the overall course grade (M = 85.00, SD = 7.02) than the students in computer labs (M = 134.06, SD = 34.17 for papers; M = 82.00, SD = 8.71 for the overall course grade); $F(1,97) = 3.73$, $p = 0.056$ for papers and $F(1,97) = 3.52$, $p = 0.064$ for the course grade.

The mean score of negative feelings at the beginning of the semester did not differ significantly between ALCs (M = 7.18, SD = 2.19) and computer labs (M = 7.17, SD = 2.42), $F(1,97) = 0.00$, $p = 0.98$. Also, the mean score of negative feelings at the end of the semester did not differ significantly either between ALCs (M = 4.33, SD = 2.71) and computer labs (M = 4.65, SD = 2.65), $F(1,97) = 0.35$, $p = 0.55$. The difference score of negative feeling (the beginning minus the end of the semester) was calculated as the reduction in the negative feeling over the semester. The reduction of negative feelings over the semester did not differ significantly between ALCs (M = 2.85, SD = 2.92) and computer labs (M = 2.52, SD = 2.79), $F(1,97) = 0.33$, $p = 0.57$. To test the relationship between negative feeling state and learning, the reduction in negative feeling over the semester, exam scores, paper scores, and the overall course grade were entered in Pearson Correlation. There was a significant correlation between the reduction in negative feelings and the overall course grade, ($r = 0.21$, $p<.05$), marginally significant with paper scores ($r = 0.19$, $p = 0.056$), and not significant with exam scores ($r = 0.16$, $p = 0.11$). The results indicate that the more reduction of the negative feeling students reported over the semester, the better students performed, which is in line with a previous research finding (Kuwabara, 2019).

To test the second research question, whether the relationship between negative feeling state and learning differs by the classroom setting (ALCs or computer labs), the reduction in the negative feeling, course grade, paper scores, and exam scores were entered into Pearson Correlation for each setting (ALCs or computer labs). As seen in Table 1, for ALCs, the reduction of the negative feeling was significantly correlated with exam scores ($r = 0.35$, $p<.05$), but not significantly related with paper scores ($r = 0.08$, $p = 0.57$) or course grade ($r = 0.17$, $p = 0.25$).

As seen in Table 2, for computer labs, the reduction of the negative feeling was marginally correlated with paper scores ($r = 0.27$, $p = 0.06$), but not significantly related to exam scores ($r = -0.06$, $p = 0.71$) or course grade ($r = 0.24$, $p = 0.10$). The results indicate that there are differential relationships in different classroom settings between the reduction in the negative feeling to student learning that was measured by different types of assessments.

Table 1
Descriptive Statistics and Correlations for Exam Scores, Paper Scores, Course Grade, and Reduction in Negative Feeling in ALCs

Variable	*M*	*SD*	1	2	3	4
1. Exam Scores	41.73	8.10	—	—	—	—
2. Paper Scores	145.45	23.14	0.62**	—	—	—
3. Course Grade	85.00	7.02	0.78**	0.92**	—	—
4. Reduction in Negative Feeling	2.85	2.92	0.35*	0.08	0.17	—

Note. $^{*}p < .05$. $^{**}p < .01$.

Table 2
Descriptive Statistics and Correlations for Exam Scores, Paper Scores, Course Grade, and Reduction in Negative Feeling in Computer Labs

Variable	*M*	*SD*	1	2	3	4
1. Exam Scores	40.19	7.63	—	—	—	—
2. Paper Scores	134.06	34.17	.27	—	—	—
3. Course Grade	82.00	8.71	0.45**	0.89**	—	—
4. Reduction in Negative Feeling	2.52	2.79	-.06	.27	.24	—

Note. $^{*}p < .05$. $^{**}p < .01$.

Discussion

This study examined two research questions. The first research question tested the effect of classroom settings (ALCs vs computer labs) on students' learning. The results found that students in ALCs performed marginally better than computer labs for overall course grades and papers, but not for exams. The results align with the previous finding that students in ALCs performed better than TCs (e.g., Walker et al., 2011). The results highlight new insight because it shows the differential effects of the classroom settings on types of assignments. Students in ALCs performed better for papers and overall course grades because the classroom setting might have made it easier for them to collaborate and complete research projects and group activities compared to computer labs. There was no difference in exam scores by classroom settings suggesting that the classroom settings that facilitate collaboration and engagement (ALCs) might not influence as much assessments that measure individual performance, such as exams. The results also expanded to a comparison between ALCs and computer labs, which are both technologically-rich environments. Having computers for each student in computer labs might not facilitate the course performance on assignments that require collaboration and engagement. The seating setting in computer labs might also hinder collaboration and engagement, and provide more distractions to stay on the group tasks when other students might be using the computers for non-class related tasks, such as online shopping. The differences found in this study highlight that not all technology-rich environments facilitate students' learning. How the technology is intentionally embedded in the classroom to facilitate collaboration and engagement might be one of the key contributing factors to better learning in ALCs.

The second research question tested the relationship between the reduction of negative feeling state and learning and further investigated whether the relationship differed based on the classroom setting (ALCs vs computer labs). This is an important question to test because managing negative emotions might be critical for student learning and the finding from the research methods course is applicable to many disciplines and fields. Across settings, there was a relationship between course performance and the reduction in the negative feeling state over the semester: the more reduction in the negative feeling students reported over the semester, the better students performed. This result replicated a previous research finding between the negative emotional states and student learning in a research methods course (Kuwabara, 2019). Although students in ALCs reduced their negative feeling state more than students in computer labs, the difference between ALCs and computer labs was not significant. This makes sense since the instructional approach was consistent across classroom settings (both included active learning) and Laal and Ghodsi (2012) found that implementing active learning pedagogical approach reduced students' anxiety.

This study further examined the potential differences by the classroom settings and found interesting differential relationships based on the classroom setting that have not been explored before.

There were differential relationships between the reduction of negative feeling state and the performance of specific assignments by classroom settings. For ALCs, the more reduction of negative feelings students reported over the semester, the better they performed on exams. For computer labs, the more reduction of negative feelings students reported over the semester, the better they performed on papers. It is not clear how these differential relationships are manifested by classroom settings and assignment types. One possibility is that classroom settings impacted how students felt at the moment of taking the exams or writing papers, which in turn impacted the grades of those specific assignments. Some researchers suggest that negative feeling impacts students' learning due to attentional differences during the task (see Wine, 1971, for review). For example, the students in ALCs might feel fewer negative feelings (e.g., calmer and more relaxed) while taking exams, which allowed them to focus on the task, which in turn impacted their exam scores. One of the reasons why students in ALCs might feel calmer and more relaxed during exams might be due to the classroom settings. ALCs include round tables, which allowed students to see other students' faces while taking exams. This setting might create a sense of social support, which has been shown to decrease the feeling of anxiety among college students (e.g., Zhou et al., 2013). The same reason might also apply to computer labs. Students in computer labs sat next to each other while working on research papers because computer labs include computers for each student. This setting allowed students to feel social support from their classmates while working on the assignment. This possibility would be an interesting line of future work to examine.

This study includes a few limitations. Other measures, such as previous course grades, that might have influenced the results found in this study were not collected in this study. In addition, the survey questions were self-reported that relied heavily on their perception of their emotional states. This limitation was reduced by calculating the difference score of negative feeling within a student (e.g., if a student has a tendency to over-reporting, the tendency should apply for both measures—at the beginning and the end of the semester measure). This study also included a small sample size. A larger sample size would allow generalizability of the current results and should be considered for future research.

Overall, current research results highlight the complexity of the impact classroom settings might have on students' learning and how it might be related to students' emotional states and their learning. This study expanded the previous study by comparing ALCs with computer labs. This study also expanded the previous study to a research methods course. In addition, this study highlights the importance of students' emotional states, especially their negative feeling states; how the reduction of the feelings might be related to learning; and how these might differ by classroom settings. The results emphasize the need for instructors to be understanding of the influence of negative feeling states and think of ways to minimize them for students' learning in a course.

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