Running Head: ACTIVE LEARNING CLASSROOM

More than Chalkboards: Classroom Spaces and Collaborative Learning Attitudes

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Abstract

The well-known benefits of collaborative learning have prompted the development of active learning classrooms that are designed to facilitate peer interaction. Given the expense of designing active learning classrooms, examining student perceptions of these learning spaces is critical. Furthermore, it is not well understood how the type of classroom (active learning or traditional lecture) relates to students' perceptions of collaborative learning. In this study, aviation students (N = 46) were enrolled in the same course taught in the same active-learning manner by the same professor with one section taught in an active-learning classroom and one taught in a traditional lecture classroom. Results indicated that students perceived the active-learning classroom as much better suited to collaborative learning than the traditional lecture classroom. In addition, students in the active-learning classroom reported higher-levels of perceived value of collaborative learning, both in terms of enjoyment and usefulness, than did students in the traditional lecture classroom. Implications for designing learning environments and promoting the value of active learning to students are discussed.

Keywords: learning space, student perceptions, active learning, college students

More than Chalkboards: Classroom Spaces and Collaborative Learning Attitudes

Active learning classrooms, which are designed to facilitate student-centered instruction, are replacing many traditional lecture classrooms, which are designed to facilitate instructor-centered instruction, in institutions of higher education (Adedokun, Parker, Henke, & Burgess, 2017; Lee, Morrone, & Siering, 2018; Walker & Baepler, 2017). The development of active learning classrooms is part of a broader movement in education to move towards active learning in which students are involved and engaged in their learning (Brooks, 2011). Collaborative learning is considered a key component of active learning that is intended to be facilitated by (Beichner, 2014). Although collaborative learning has many benefits (Fung, To, & Leung, 2016; Saville, Zinn, & Elliot, 2005; Smith et al., 2009), students are often have negative attitudes towards collaborative learning (Clinton & Kelly, in-press Machemer & Crawford, 2007). It is possible that a classroom physically designed to promote collaborative learning would ameliorate student attitudes, but it is currently not known how these spaces may relate to student attitudes towards collaborative learning. Knowing the relationship between active learning classrooms and attitudes towards collaborative learning would inform understanding of students experiences in these learning spaces--an area that is in need of inquiry (Bolden, Oestreich, Kenney, & Yuhnke, in-press). The purposes of this study are to compare student attitudes about both classroom space and collaborative learning between students in an active learning classroom and students in the same course in traditional lecture classroom.

Active Learning Classrooms

The physical space in which students learn has been long regarded as an important factor for students learning behaviors and attitudes (Choi, van Merriënboer, & Paas, 2014; Weinstein, 1979; Whiteside, Brooks, & Walker, 2010). For examples, students report that uncomfortable and poorly lit classrooms interfere with their learning (Ramprasad & Subbaiyan, 2017) and the spatial layout of the desks and chairs in a classroom relates to the quality of their course experience (Han, Kiatkawsin, Kim & Hong, 2018). Indeed, students consider their physical learning spaces to be an important aspect of their education (Beckers, van der Voordt, & Dewulf, 2016).

Historically, classrooms have been designed to facilitate lectures through rows of student desks all facing the instructor at the front of the classroom. However, numerous studies have indicated that learning passively through listening to a lecture is less effective than active learning through group work, questions response, case studies, or other activities (Freeman et al., 2014). To facilitate active learning, many institutions have redesigned their physical learning spaces from traditional lecture classrooms to active learning classrooms (Peberdy, 2014). These active learning classrooms have flexible seating with movable chairs around tables, and whiteboards or technology that afford opportunities for students to share their work with the class (Beichner, 2006). The design of active learning classrooms is intended to promote interactions among students and decrease focus on the instructor (Park & Choi, 2014).

Because of the substantial cost of redesigning existing space into active learning classrooms or building new classrooms, it is critical to empirically examine potential influences active learning classrooms have on student learning and experiences compared to traditional classrooms (Lee & Tan, 2013). For example, there is evidence that these active learning classrooms may benefit student learning relative to traditional classrooms even when the instructor and course is held constant (Baepler, Walker, & Driessen, 2014). Moreover, students indicated they had higher levels of active engagement and participation in active learning classrooms than traditional classrooms despite participating in the same activities (Bolden et al.,

in-press; Park & Choi, 2014). Students consider active learning classrooms to be comfortable and that their design helps their concentration to learn the course material (Adedokun et al, 2017). However, this field of research is relatively young and more work, especially that geared towards better understanding of student opinions of and experiences in their learning spaces, is needed (Cleveland & Fisher, 2014). Student perceptions of their learning spaces appear to influence student attitudes towards and performance in their courses (Yang, Becerik-Gerber, & Mino, 2013). Moreover, the comfort of a classroom--in terms of seating, temperature, and lighting—is a positive predictor of student learning (Barrett, Zhang, Moffat, & Kobbacy, 2013). Students and faculty have indicated that active learning classrooms are comfortable, but there has been limited research on this topic (Granito & Santana, 2016).

One area in need of more examination is the potential influence of the physical learning space on students' perceived value of the collaborative activities active learning classrooms are intended to facilitate. Vercellotti (in-press) compared the perceived usefulness of a variety of learning activities, including small group discussions and interactions with peers, with students in the same course taught by the same instructor in either an active learning or traditional lecture classroom. No differences in the perceived usefulness of collaborative learning (either small group discussions or interactions with peers) were found; however, the sample was quite small and the study findings were more descriptive than comparative (Vercellotti, in press). Further examination of type of classroom on the perceive value of collaborative learning is important, given that students' perceived value of collaborative learning tends to be quite low (Hillyard, Gillespie, & Littig, 2010). Students frequently state a preference for working alone (Gillespie, Roos, & Slaughter, 2006; Waite, Jackson, Diwan, & Leonardi, 2004). Indeed, one study found that students considered collaborative learning to be the least useful learning activity in their course (Buchanan & Palmer, 2017). Given this, it is not surprising many faculty are hesitant to incorporate group work in their classes out of concerns that students will be resistant (Seidel & Tanner, 2013; Tharayil et al., 2018). Faculty concerns about student attitudes are not unfounded given that one study found less favorable student evaluations of teaching when active learning pedagogical techniques were adopted (Lobo, 2017).

It is possible that the perceived value of collaborative learning would be greater in active learning classrooms than in traditional classrooms. The reasons for this possibility are grounded in sources of perceived value: intrinsic and utility (Eccles & Wigfield, 2002). Intrinsic value is based on how inherently enjoyable or interesting the activity is (Eccles et al., 1983; Eccles & Wigfield, 2002). An active learning classroom could increase intrinsic value of active learning because design and furniture of active learning classrooms are intended to facilitate collaboration and provide affordances for interaction (Rands & Gansemer-Topf, 2017). For this reason, collaborative learning may be more pleasant in an active learning classroom, which could subsequently evoke greater enjoyment (intrinsic value) of collaborative learning in an active learning classroom than a traditional classroom. In contrast, utility value involves how useful the activity is thought to be or how relevant to one's personal goals it is (Hulleman, Durik, Schweigert, & Harackiewicz, 2008). The learning space is a cue to occupants as to what is valued—is the value placed on what the instructor has to say (implied by having all student seats facing the instructor) or on interactive learning with peers (implied by having student seats facing each other; Granito & Santana, 2016; Oblinger, 2005; Savin-Baden, McFarland, & Saving-Baden, 2008). Given this, students in an active learning classroom may infer that collaborative learning is more valuable and useful based on the physical classroom layout and

subsequently have higher levels of utility value for group work than would students in a traditional lecture classroom.

The Current Study

In this study, we seek to close gaps in the literature on student experiences in active learning classrooms by examining students perceptions of their course classroom as well as their perceived value of the collaborative activities in their course classroom. To address these gaps, we ask the following research questions:

1) Do students in active learning classrooms compared to traditional lecture classrooms perceive their classroom differently in terms of appropriateness for collaborative learning? We address perceived appropriateness for collaborative learning to ensure that student perceptions align with the intentions behind the active learning classroom. If students do not perceive the active learning classroom to be more appropriate for group work than the traditional lecture classroom, it is very unlikely their experiences with collaborative learning would differ at all between classrooms. We hypothesize that students will perceive the active learning classroom as more appropriate for collaborative learning than the traditional lecture classroom.
2) Do perceptions of comfort differ between students in active learning classrooms compared to traditional classrooms? Active learning classrooms are often newer than traditional learning classrooms and as such may be more comfortable (Granito & Santana, 2016). We hypothesize students would consider the more recently-constructed active learning classroom as more comfortable than traditional lecture classroom.
3) Does students' perceived value of collaborative learning differ between an active learning classroom and a traditional lecture classroom? If the learning space is physically designed to convey that collaborative learning is critical to learning, then it follows that students' attitudes towards collaborative learning activities would be more positive in a learning space designed for active learning as opposed to traditional lecture. Therefore, we hypothesize that students in the active learning classroom would report higher levels of both perceived intrinsic value and utility value of collaborative learning, than would students in the traditional lecture classroom.

Method

Design and Context

This quasi-experiment involved two sections of an undergraduate, fourth-year, aviation course in two different learning spaces. One section met in an active learning classroom and the other in a traditional lecture classroom. The active learning classroom had round tables at which the students faced each other during collaborative learning (round tables tend to be preferred by students for collaborative learning; Walczak & Van Wylen, 2013-14; see Figure 1). These tables and the seating were moveable depending on the needs of the group or learning objective. Additionally, all four walls of the classroom were covered with whiteboard space for group summary and display of learning elements. Conversely, the traditional learning classroom desks were fixed to the floor in long-rows of approximately 10-12 students, organized so that the students continually faced the instructor at the front of the room (see Figure 2). The seating in the classroom was also affixed to the desk spaces and had only limited ability to pull out and rotate to the side to facilitate seating and exit, but no ability to turn any other direction. The whiteboard space was limited to the front of the classroom and all group summary activity was focused in that limited space. The outcome was that the groups of students tended to leave the seating/desk space entirely and crowd in the front of the room, with some students not having a

task while other students summarized their learning elements on the whiteboard. This differed from the active learning classrooms where group members were more comfortably seated or standing, according to their role on that given day.

Figure 1 Active learning classroom

Figure 2 Traditional lecture classroom

Instructors may use similar levels of collaborative learning in active learning and traditional classrooms (Beery, Shell, Gillespie, & Werdman, 2013). In this study, the instructor taught the course (AVIT 428: Transport Category Aircraft Systems) in the same manner. For each class session, students were placed in groups to focus on one of three aircraft from the manufacturers Airbus, Boeing, or Bombardier. To prepare for class activities, students completed online modules about a common topic (e.g., hydraulics, pneumatics, fuel) for their assigned aircraft and completed a 3-5 question quiz specific to their aircraft and assigned module prior to class. Students met in their aircraft groups in class to prepare a brief summary (5-10 minutes) of the elements of their specific aircraft summary to present to the class. The instructor facilitated the presentation by highlighting the similarities and differences of each aircraft system's design and features. At the end of the presentations, students answered review questions from the instructor about all of the aircraft covered that day.

Participants

All students enrolled in the two courses were invited to complete the measures. Of the 53 students enrolled in the course, 46 completed all the necessary measures (20 in the lecture hall and 26 in the active learning classroom section). Of these 46 students, there were 5 who identified as women and 41 who identified as men, ages ranged from 20 to 34 (M = 21.73; SD = 2.27 years). Most of the students identified as Caucasian (78%), with 8.7% identifying as Asian

American, 2.2% identifying as Latino, 2.2% identifying as Native American, and 8.9% not providing racial background information. Reporting of demographic information was optional.

Measures

Learning space survey. We wrote a survey to assess students' opinions about their classrooms. This survey had ten items with two subscales. One subscale (7 items; Cronbach's α = .89) was for the appropriateness of the classroom for collaborative learning (termed group work in the measures). The second subscale (3 items; Cronbach's α = .69) was for the general perceived comfort of the classroom. For each of the items, participants were asked to indicate their level of agreement on a 1-5 Likert rating from Strongly Disagree to Strongly Agree. Students were also asked three open-ended questions about their learning space: "Thinking about the classroom space for AVIT 428, what aspects are helpful for your learning?," "What aspects of the classroom space for AVIT 428 are not helpful for your learning?," and "What would you like to change about your classroom space for AVIT 428?"

Perceived value of collaborative learning. In this questionnaire, there were six items that composed the scale for intrinsic value (Cronbach's α = .95) and six items for utility value (Cronbach's α = .81; adapted from Hulleman & Harackiewicz, 2009). For each of these items, participants were asked to indicate their level of agreement on a 1-5 Likert rating from Strongly Disagree to Strongly Agree. There were also three open-ended items regarding the perceived intrinsic value ("What do you find interesting or enjoyable about in-class group work in AVIT 428?"), utility value ("What do you find personally relevant or useful for your career about in-class group work in AVIT 428?"), and cost of collaborative learning ("What are the costs or downsides of in-class group work in AVIT 428?").

Results

Do students in active learning classrooms compared to traditional lecture classrooms, perceive their classroom differently in terms of appropriateness for collaborative learning?

To test for differences in perceived appropriateness for collaborative learning by type of classroom, a one-way ANOVA was conducted with classroom type as the independent variable and score on the appropriateness for collaborative learning subscale of the learning space survey as the dependent variable. As can be seen in Figure 3, students perceived the active learning classroom to be much more appropriate for collaborative learning than the traditional lecture classroom, $F(1, 45) = 37.95$, $p < .001$, Cohen's $d = 1.36$, which is consistent with what was hypothesized.

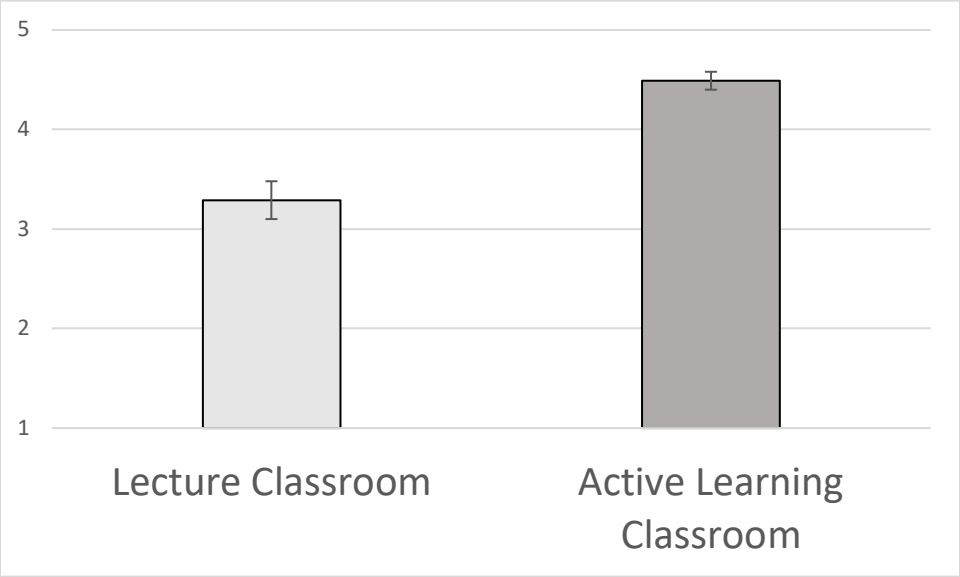

Figure 3 Perceived appropriateness of the classroom for active learning (means and +/- 1 standard error bars by condition)

The open-ended items were coded through a content analysis in an inductive manner based on themes, in order to understand student perspectives on their learning spaces (see Barry, Murphy, & Drew, 2015, for a similar approach). In terms of the helpfulness of the classroom, students in the active learning classroom frequently commented on the round tables and whiteboard space (see Table 1). Students in the traditional active learning also commented on the whiteboard space. Visibility was noted as helpful in both classrooms although it functioned differently. In the active learning classroom, students appreciated being able to see their peers during collaborative learning. In the traditional lecture hall, students appreciated being able to easily see the presenters and instructor. Students in both classrooms thought there was ample space for learning activities.

In terms of what was not helpful for learning, the layout of the classroom was frequently commented on for both classrooms (see Table 2). However, students in the active learning classrooms expressed frustration with difficulty seeing some of their peers present, whereas students in the traditional lecture classroom expressed frustration with difficulty interacting with their peers. Students in both classrooms felt the size and/or layout of the tables was not optimal for the size of the groups. In addition, students in both classrooms commented that their seating was uncomfortable. No answer or that nothing was unhelpful was frequently commented on by students in both classrooms.

In terms of what students would like to change about their classroom space, the most common answer for the active learning classroom was that there was nothing they thought should be changed; this was a less frequent response by students in the traditional lecture classroom (see Table 3). For both classrooms, students commented that their classroom space would benefit from improved visibility so students could more easily view what is projected or what is written on the whiteboards. In the traditional lecture classroom only, students expressed a desire for moveable and flexible seating.

Do perceptions of comfort differ between students in active learning classrooms compared to traditional classrooms?

To test for differences in comfort by type of classroom, a one-way ANOVA was conducted with classroom type as the independent variable and score on the general comfort subscale of the learning space survey as the dependent variable. The perceived quality of the classroom did not reliably differ by type, $F(1, 45) = .96$, $p = .33$; see Figure 4), which was not what was hypothesized given that the active learning classroom was newer than the traditional classroom.

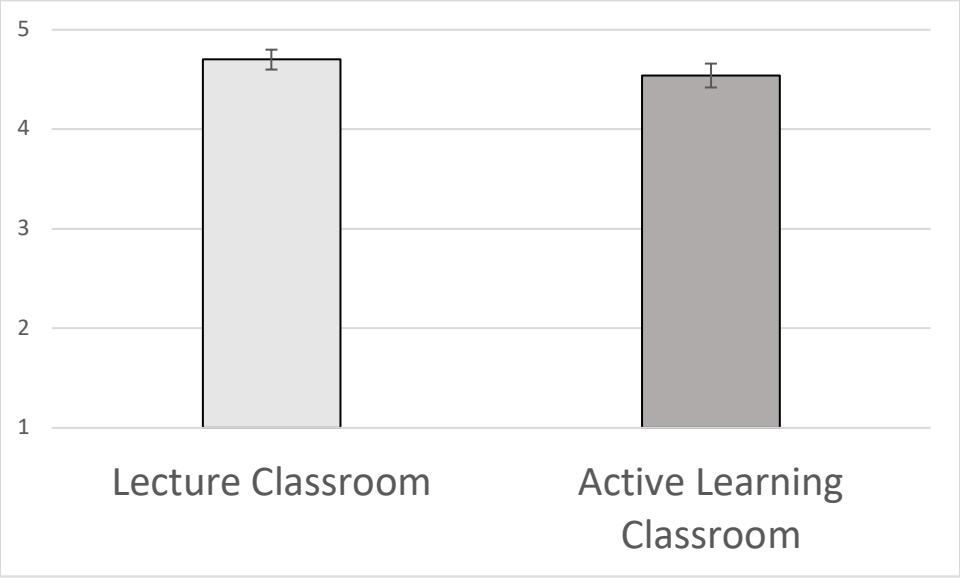

Figure 4 Perceived level of comfort of classroom (means and +/- 1 standard error bars by condition)

Does students' perceived value of collaborative learning differ between an active learning classroom and a traditional lecture classroom?

Two components of perceived value were examined: intrinsic value (inherent enjoyment or interest) and utility value (personally relevant or applicable towards goals). To test for differences in perceived intrinsic value, a one-way ANOVA was conducted with classroom type as the independent variable and score on the intrinsic value subscale of the perceived value of groupwork questionnaire. Students in the active learning classroom reported higher levels of intrinsic value of groupwork than did students in the traditional lecture classroom, $F(1, 45) = 5.323$, $p = .03$, Cohen's $d = .66$; see Figure 5).

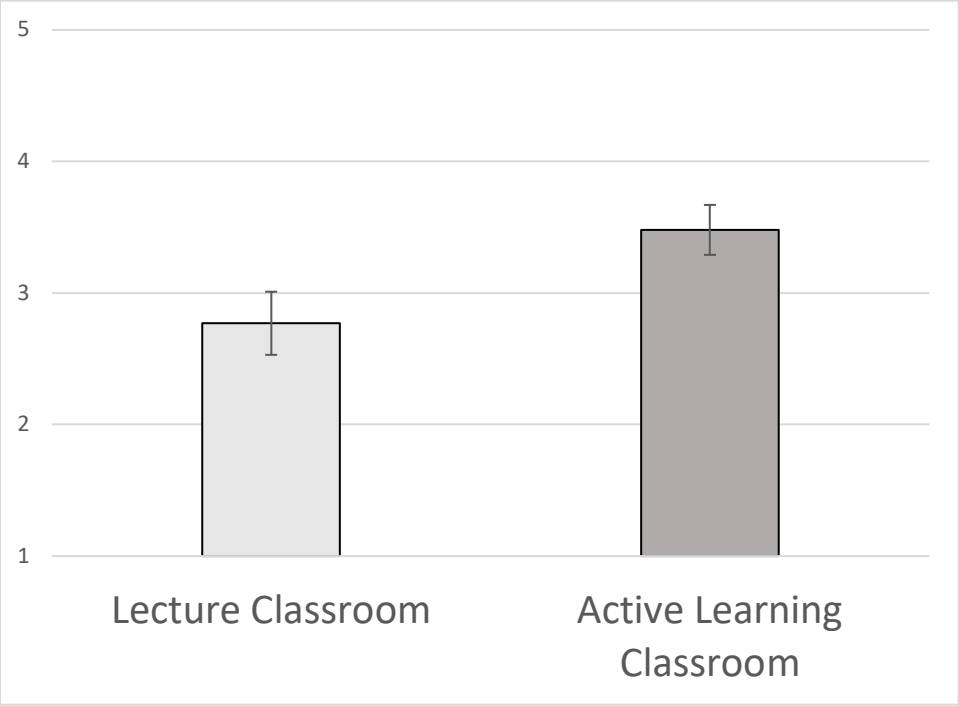

Figure 5 Perceived level of intrinsic value of collaborative learning (means and +/- 1 standard error bars by condition)

To test for differences in perceived utility value, a one-way ANOVA was conducted with classroom type as the independent variable and score on the utility value subscale of the perceived value of groupwork questionnaire. Similar to the findings with intrinsic value, students in the active learning classroom reported higher levels of utility value than did students in the traditional lecture classroom, $F(1, 45) = 5.68$, $p = .02$, Cohen's $d = .67$; see Figure 6).

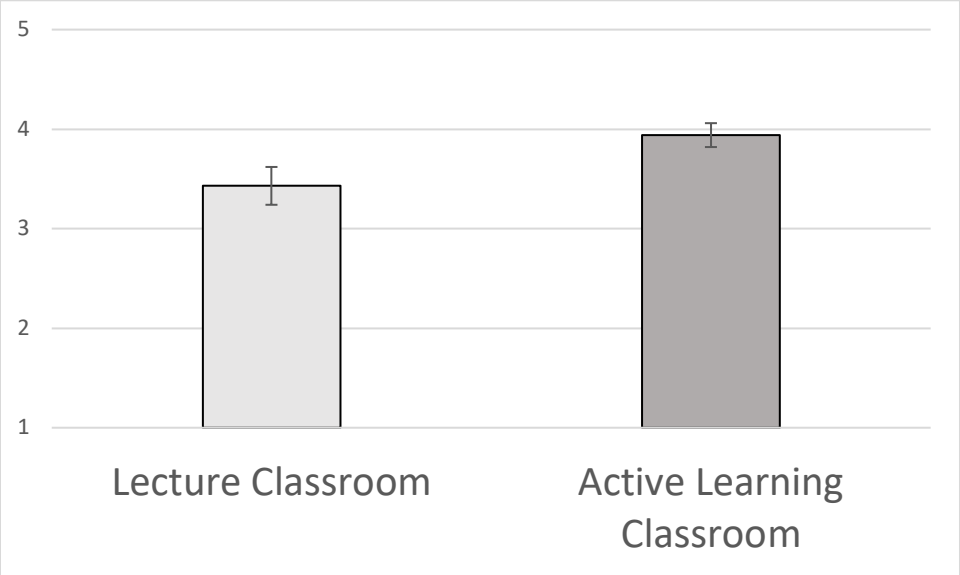

Figure 6 Perceived utility value of collaborative learning (means and +/- 1 standard error bars by condition)

The open-ended items regarding the intrinsic value, utility value, and costs of group work in the course were coded through a content analysis in an inductive manner based on themes, in order to understand student perspectives on the value and cost of collaborative learning. The frequency of these codes was tallied for each item (note that some students provided more than one response so there are more tallies than students). As can be seen in Table 1 (located after the references), students commonly noted how collaborative learning helped their learning (although this would be considered more of an aspect of utility value) and that they enjoyed hearing others' ideas. They also frequently commented on the opportunity to interact with their peers as inherently interesting or enjoyable aspects of group work. In addition, they enjoyed the information in the task itself, namely about the different kinds of aircraft, which is not inherently part of collaborative learning.

The findings from the open-ended item analyses for utility value are in Table 2. Students frequently commented on how developing teamwork skills is critical for a successful career in aviation. The importance of the knowledge they learned was also frequently commented on although that was not specific to collaborative learning.

The findings from the open-ended item analyses for cost are in Table 3. Students frequently commented on frustrations with classmates they perceived as not contributing to the group work and that they perceived group work as too time consuming or not as efficient as lecture. There were also concerns that peer-to-peer instruction could lead to misinformation being learned or information necessary for exam performance not being learned.

Discussion

The purpose of this quasi-experiment was to examine differences in student attitudes towards their classroom space and collaborative learning between active learning and traditional lecture classrooms. As hypothesized, students in the active learning classroom perceived their learning space as better suited for collaborative learning than did students in the traditional lecture classroom. However, student attitudes towards the general quality of their classroom space (e.g., lighting, comfort) were similar in the two classrooms. This was not what was expected given that the active learning classroom was built more recently than the traditional lecture classrooms. In terms of collaborative learning, students in the active learning classroom perceived greater intrinsic value (i.e., inherent interest and enjoyment) and utility value (i.e., personal relevance or usefulness) for collaborative learning than did students in the traditional lecture classroom.

The active learning classroom was purposefully designed to facilitate student collaboration. This design included movable chairs arranged around round tables to afford student interaction. Previous work based on focus groups and interviews has found that students see that active learning classrooms promote interactions with peers through the seating arrangements and opportunities to move around the space (Parson, 2017; Rands & Gansemer-Topf, 2017). This study adds to the literature by finding that students enrolled in the same course during the same term taught by the same instructor perceive that, as intended in their design, active learning classrooms are better for collaborative learning than are traditional lecture classrooms.

The comfort of a classroom in terms of seating, lighting, and temperature were examined based on findings that these are important factors in student satisfaction (Yang et al., 2013). The

active learning classroom was much newer than the traditional lecture classroom and as such was expected to be considered more comfortable by students. However, the findings show that students in the different classrooms considered their classroom space to be similar in terms of comfort level. Students in both classrooms commented on how the seating was uncomfortable, which could explain why the perceived comfort was rated similarly by classroom type. This is helpful in determining that classroom differences in perceived value of class activities (namely collaborative learning) were likely unaffected by differences in the classroom comfort level.

Students found collaborative learning to be more interesting and enjoyable in the active learning classroom than the traditional lecture classroom. One possible reason for this is that collaborative learning was better facilitated by design of the active learning classroom making it a more enjoyable experiences. Indeed, students frequently commented in the open-ended responses that an inherently enjoyable aspect of collaborative learning was getting to interact with their peers. In addition, students may have considered collaborative learning to be more useful in an active learning classroom because the layout of the classroom indicated that interaction with peers is valued (Granito & Santana, 2016; Oblinger, 2005; Savin-Baden et al., 2008). Because perceived value is an important component of motivation, active learning classrooms may be means to address student resistance to collaborative learning. However, students in both classes commented on how collaborative learning is useful in that it builds skills necessary for their future careers.

Limitations and Future Directions

One possible interpretation of the findings is that student engagement in active learning classrooms was enhanced through increases in perceived value of collaborative learning. Engagement is often higher in active learning classrooms than traditional classrooms (Bolden et al., in press; Sawers, Wicks, Mvududu, Seeley, & Copeland, 2016). Engagement was not examined in this study; however, a future study could examine whether perceived value provides motivation for engagement with active learning. Such a study would address the need to better understand how active learning classrooms function, in order to inform ideal design (Walker & Baepler, 2017).

A key limitation of this study was that students self-selected which section of the course in which they enrolled. Given that randomly assigning students to courses is not feasible, future work that incorporates pre-course measures would be helpful for a more robust examination of learning spaces and attitudes towards collaborative learning.

Conclusion

As postsecondary instruction shifts away from teacher-centered lectures to more student-centered active learning, the physical space in which students learn has become increasingly more important. Given the expense of developing active learning classrooms, it is critical to assess student experiences and attitudes related to learning spaces. This study indicates that students perceive active learning classrooms as better suited for collaborative learning than traditional lecture classrooms. Moreover, students in active learning classrooms indicated that collaborative learning was more enjoyable and useful than did their peers in traditional lecture classrooms. Given these findings, active learning classrooms may help encourage positive attitudes towards collaborative learning.

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Table 1

Examples and frequency of themes by condition for responses to what aspects of their learning space are helpful for learning

Theme	ALC Count	Example	TLC Count	Example
Rounded tables work well for group work	12	“The round tables are helpful to allow group discussions and having many whiteboards allows many different groups to have their concepts throughout the room.”	1	“This class would be better taught in [X] Hall where there are white boards around the room plus round tables that encourage discussion.”
Whiteboard space supports summarizing material.	18	"The class is nice and big with whiteboards everywhere, so it’s easy to break into our groups to do the drawings, etc."	11	"I like separating in three different areas on the white board."
Visibility of material supports learning	5	"It is helpful having all the space to write on the boards and the seating is nice because you can look all around the class."	3	"I like how everybody faces the front because it forces you to pay attention to what's being presented.”
Ample space and good layout facilitate learning.	6	"The room is big, so it is nice having room to sit and interact. The round tables are also nice for discussing with the other students sitting, but sometimes the round tables can be bad if your back is facing the front and having to turn around to see something on the board."	7	"Large space allows all the group members to have discussions."

Note. ALC is Active Learning Classroom and TLC is Traditional Lecture Classroom

Table 2

Examples and frequency of themes by condition for responses to what aspects of their learning space are not helpful for learning

Theme	ALC Count	Example	TLC Count	Example
Tables were wrong for group size	2	"Groups were a little large for table sizes."	5	"It was a little bit difficult to have a group discussion while seated because the chairs and desks are faced in front, and when there are more than two people sitting in the group, it becomes really hard to talk to each other."
Classroom layout impacted my learning.	6	"As nice as it was having boards around the classroom so everyone could do group work, the bends in the classroom wouldn't allow you to see some of the other groups work if you were sitting in certain spots. It would require you to move around or crane your neck to be able to see."	10	"The table set up doesn't promote groupwork because everybody is facing forward and the chairs are not mobile."
Facing the front of the classroom was difficult.	5	"It can be hard sometimes to take notes and things if the table is not right in front of you when the instructor is talking, you have to turn your chair around to face the front, but then nothing to write on."	0	
Uncomfortable or inadequate seating	4	"The seats are uncomfortable. And, depending on the position of the tables, it can be hard to move	9	"The chairs and tables are fixed, not very useful for group work."

		around the room sometimes. During group work, it was hard to find an appropriate outlet to plug my laptop into at the tables I sat at."		
Nothing/no answer	8	"Not one thing at all."	5	“None.”

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Table 3

Examples and frequency of themes by condition for responses to what would you like to change about your classroom space

Theme	ALC Count	Example	TLC Count	Example
Table size or layout.	3	"I can't stand not having a desk in front of me when I'm looking to the front of the classroom so having rows would be nice but then it makes moving for group work a little more tough."	7	"More space between each desk rows, and more flexible chairs, so that people can turn around easier to have group discussions."
Improved projector or whiteboard visibility.	4	"A bigger screen and maybe a different location of it or have dual screens so it is easy to see from any place in the room. "	5	"Make more whiteboards so that the groups can spread out and we can have more people writing on the board from one group"
Improved seating options	0	"It can be hard sometimes to take notes and things if the table is not right in front of you when the instructor is talking, you have to turn your chair around to face the front, but then nothing to write on."	5	"Have the chairs and desks moveable so you can interact with your group more. "
Nothing/no answer	17	Nothing, the classroom works well	4	“None.”

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Table 4

Examples and frequency of themes by condition for responses to "What is interesting or enjoyable about group work in this course in AVIT 428?"

Theme	ALC Count	Example	TLC Count	Example
Getting to interact with peers	13	"I got to know some people in my class that I otherwise would not have met. I usually sit in the back and don't say anything to anyone so I don't know a lot of people in my classes."	3	"Becoming much more social with classmates"
Hearing others' ideas	7	"I think it is interesting to hear what every person in my group got from the lesson and what they found to be important."	4	"Different people remember different things from the lessons."
The task itself	5	"Hearing about the different airplanes"	4	"Comparing and contrasting the different aircraft."
Group work helps with learning	8	"I can ask my team members questions about systems that I don't understand, and usually someone offers a good explanation."	12	"Having ability to discuss material to avoid confusion."
Nothing/not applicable	1	"I very much dislike the group work in this class."	5	"I feel as though most of the learning was done at home on my own time, and the time spent in unstructured groups with no organization or direction wasn't enjoyable."

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Table 5

Examples and frequency of themes by condition for responses to the question "What do you find personally relevant or useful for your career about in-class group work in AVIT 428?"

Theme	ALC Count	Example	TLC Count	Example
Teamwork skills are important for career	10	"In aviation working within a crew is a vital part of being a professional. Building interpersonal skills and the ability to discuss ideas and systems with others I believe will help me to be a better crew member."	5	"We're all about to have a career of working alongside other people as a team, so the group work is very relevant to our careers."
Learning how to work with others	3	"I would consider myself a less sociable person so getting to work in a group setting has made me feel more comfortable sharing ideas with my classmates whereas I would normally shy away from such things."	7	"Learning how to work with other people who have varying levels of knowledge about the topic being discussed."
Knowledge learned in tasks is important	10	"For my career, its personally relevant to know that there are different configurations and system types, but they often perform similar functions across multiple aircraft. The important thing is to know the differences."	6	"The topics we are learning in the class are very relevant and are going to be helpful in the near future."
Industry training involves group work	2	"Discussing systems in a class setting is very similar to airline new hire FO (first officer) training."	1	"It is important to know what ground school in airlines will be like."
Opportunity to develop public speaking skills	1	"I get to practice public speaking which I don't in other classes."	3	"Standing up and presenting in front of the class. It got everyone comfortable talking in front of everyone and

				prepared us for the accident presentations later in the semester. It improved everyone's public speaking skills I think."
Talking with others helps with comprehension	3	"The material shared always has different experiences from classmates' stories and you learn many different ways of how to get things down in a different way."	2	"Collaboration is required to effectively get all material across."
Being held responsible for knowing material	1	"Being held responsible to help the group out."	1	"Completing homework is necessary because you'll let down the group if you're chosen as a presenter and don't know what you're talking about."
None/no answer	1	"N/A"	2	"I honestly don't find what we do in class as group work relevant or useful to our career."

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Table 6

Examples and frequency of themes by condition for responses to the question "What are the costs or downsides of in-class group work in AVIT 428?"

	ALC Count	Example	TLC Count	Example
Social loafing/unengaged group members	9	"People that don't care as much as you do. They drag you down and then you have to put in extra work to make up for their slack."	9	"Some downsides are that there are usually at least one or two people not contributing."
Prefer lecture	0		2	"Lectures would be much more helpful in this class."
Confusion about tasks and individual roles	5	"Slightly difficult to delegate a task to everyone. Often leaves members standing by and not being involved in the process."	4	"Fairly unstructured, lets people either do too much for the group or too little, leaves little for people not socially engaged within the group to do."
Too much time/inefficient	7	"it can take awhile and can lead to not much getting done."	5	"It does take more time to run a group work since you have to listen to different peoples' opinions."
Information may not be relevant to the exam	0		5	"Because it's not professor-led, it's hard to know what's important and will be covered on an exam."
Difficult for shy people	0		2	"As a shy person it takes more for me to ask questions."

Repetitive	4	“Often the group work in this class could get quite monotonous and repetitive. It felt like we would do the same routine for every class.”	1	“It can get long and very repetitive.”
Students can confuse each other/share inaccurate information	3	“Because we are all students, there are times when the information discussed will be wrong. Sometimes there will be a concept which we all don't have a 100% correct understanding of, and if everyone believes it, incorrect information could be retained.”	0	

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