Active learning spaces foster development of communication skills in senior undergraduate science students

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The main objective of this study was to evaluate the efficacy of an active learning space (ALS) in supporting student development of effective communication as a transferable skill. A fourth-year medical science course was taught in two different settings, an ALS and a fixed-row classroom, by the same instructor. Participants preferred the ALS for supporting communication skill development, despite it having no quantifiable effect on their communication apprehension. The ALS had a significantly higher impact than the fixed-row classroom on groupwork/collaboration and student-student interactions. This study highlights the importance of the physical classroom space for fostering students' development of communication and collaborative skills.

Introduction

Active learning has become an increasingly important mode of instruction at institutions of higher education. Compared to didactic lecturing, active learning allows students to engage in discussions and problem-solving to create a more collaborative classroom environment (Freeman et al., 2014). A collaborative learning setting allows students to communicate with each other in a way that is challenging in a didactic classroom. Communication is an important skill for students to have and is considered a prerequisite for many other learning processes that take place during active learning (Adedokun et al., 2017; Schulz, 2008). Communication can be defined in many ways as it encompasses many different scenarios, both verbal and non-verbal. For the purposes of this study, the focus is on effective verbal communication, although non-verbal communication such as eye contact and body language is not negligible (Henshaw et al., 2011). One such definition, which relates to the context of this study, is that an effective communicator collaborates well with others and also possesses strong interpersonal skills such as personal, social, and civic responsibility (Dede, 2010). The two main forms of verbal communication students most often employ in an active learning setting are interpersonal communication and group discussion (Shanahan, 2013).

Effective communication is an important attribute both inside and outside academia; however, evidence suggests that the relative communication ability of many university graduates is severely lacking (Chadha, 2006; Drew, 1998; Hill et al., 2020; Schulz, 2008; Shanahan, 2013). It can be difficult to measure or quantify an individual's communication ability. One such way to quantify an individual's communication ability is by investigating their communication apprehensions. Communication apprehension is defined as an "individual's level of fear or anxiety associated with either real or anticipated communication with another person or persons" (McCroskey, 1977). Communication apprehension acts as a barrier to effective communication, regardless of students' underlying communication skills (Shanahan, 2013). Allowing students to practice their oral communication in a supportive classroom environment, such as an active learning space, is one way to help alleviate communication apprehension (Shanahan, 2013).

The physical infrastructure of classrooms has been relatively slow to change despite advancements in active learning. Some academic institutions have developed variations of active learning spaces (ALS); the underlying goal is to enhance active learning and collaboration among students and reduce emphasis on the instructor (Park & Choi, 2014; Stalp & Hill, 2019). These spaces can be high or low tech and often incorporate movable furniture in order to meet the pedagogical goals of the instructor (Neill & Etheridge, 2008; Nicol et al., 2018). Previous studies have shown that students perceive ALS as more engaging than traditional lecture spaces (Adedokun et al., 2017; Brooks, 2011; Neill & Etheridge, 2008). However, much of the available literature comparing traditional classrooms to ALS relies on a quasi-experimental design in which two groups of students take the same course in a different style of classroom (Brooks, 2011; Clinton & Wilson, 2019; Whiteside et al., 2010; Wilson & Randall, 2012). Unfortunately, many of these studies do not expose the students to both classroom environments and consequently, it is difficult to compare

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student perceptions of each space. The following study makes use of a cross-over design in order to obtain more accurate student perceptions of different learning spaces.

The design and utilization of ALS is a newly developing field and there is much that needs investigating regarding how a learning space might foster the development of communication. Can active learning strategies and communication development take place effectively in a traditional classroom? The current study was the first to investigate the impact of the physical learning space on the students' perception of the development of effective communication. More specifically, the aims were (1) to investigate if the physical learning space influences student perceptions of their development of effective communication and (2) to investigate whether the physical classroom affects the quality of peer-to-peer interactions.

Methodology

Participants

Students were recruited from a fourth-year undergraduate medical science course focused on inflammation in diseases. There were 33 students enrolled in the course and all consented to participate in submitting Likert surveys. Not all students were present during data collection, so the n value changed with each Likert survey. There were 14 females and 19 males. The mean age of students was 21.42 ± 1.62 years. Twenty-two students had prior active learning experience and 17 students had experience learning in an ALS outside of the current course (supplementary table 1). The current course was a flipped-style course in which students were required to complete online learning modules before coming to class. During class, students engaged in different active learning activities specifically designed by the instructor, to build upon their baseline knowledge acquired from the modules.

Study Design

The current study used both quantitative and qualitative measures of data collection to compare interactions and communication as well as rich descriptions of students' experience in an ALS and a traditional fixed-row classroom. Quantitative data were collected first in the form of Likert surveys and classroom observation; qualitative data were then collected in the form of a short answer survey to give students the opportunity to expand on their experiences during the course. Students were taught in two different settings, a fixed row classroom (Figure 1a) and an ALS (Figure 1b), by the same instructor. Students started in the fixed-row classroom and at the midpoint of the term moved into the ALS.

Measures

This section will include a description of the various quantitative and qualitative data measures. See Table 1 for a summary of data collection.

Classroom Observation: Students were observed using the Classroom Observation Protocol for Undergraduate STEM (COPUS) which is a previously validated periodic-interval observation instrument used to characterize and quantify the activities of both the instructor and the students in the classroom (Smith et al., 2013). COPUS allows observers to measure the frequency of 12 pre-determined instructor behaviours and 13 pre-determined student behaviours every 2 minutes during class time, where multiple activities can be coded during one 2-minute interval (Smith et al., 2013). The researchers wanted to determine if the instructor and students behaved any differently in each learning space and used COPUS as a method to measure classroom behaviours. Classroom observation took place for three consecutive classes in the fixed-row classroom and three consecutive

Figures 1a and 1b. Classroom Environments.
1a) The fixed row classroom had desks arranged in rows with a projector screen, whiteboards, and instructor located at the front of the room; 1b) The active learning space had the instructor located in the center of the room with groups of students (pods) set up around the periphery of the room, each group of students has its own projector screen and interactive whiteboard.

classes in the ALS. The researcher observed but did not participate in the class.

Likert Surveys: Participants completed a total of 6 Likert Surveys throughout the term with a 0.16% grade increase for each Likert survey submitted. This totaled to a 1% grade increase applied at the end of the term by the manager of the students' respective programs. All students consented to participate in completing Likert surveys; however, not all students were present during survey handout and collection and were unable to receive the full compensation. The researchers chose previously validated Likert surveys to easily quantify students' communication apprehension, as well as their attitudes towards each classroom setting. This helped increase the validity of students' perceptions.

Likert Survey 1 (Communication): This survey investigated communication apprehension among students in various verbal communication situations ranging from interpersonal communication, group discussion, public speaking, and meetings. Statements from the Personal Report of Communication Apprehension (PRCA) (McCroskey, 1978) were selected to determine students' level of communication apprehension. Students were asked to agree or disagree with 15 statements outlining different verbal communication scenarios on a 5-point Likert scale. This survey was distributed to students at 3 different time points: the first day of class to measure their baseline communication apprehension, at the midpoint of the semester before they switched classrooms, and finally at the end of the semester after they had been exposed to each classroom.

Likert Survey 2 (Classroom Impact): This survey was modified from Adedokun et al. (Adedokun et al., 2017) to investigate how students would rate the impact each classroom had on different aspects of classroom learning, motivation and climate. More specifically, the researchers wanted to compare how the physical learning space impacted groupwork, individual learning, student-student interactions, instructor-student interactions, interest in attending class, physical comfort, motivation to learn, and overall learning. This survey was distributed twice: at the midpoint of the semester before they switched classrooms, and at the end of the semester after they had been exposed to each classroom.

Likert Survey 3 (Classroom Preference): This survey was modified from Adedokun et al (Adedokun et al., 2017) to investigate student preference for each classroom. Students were given a scale in which they could quantify their preference for different aspects of each classroom. This allowed the researchers to evaluate how the two classroom environments compared, and for students to quantify their preferences. This survey was distributed on the last day of

classes, after students were exposed to each classroom setting.

Short Answer Online Survey: This survey was conducted independently from the Likert survey data collection so as not to interfere with the candidness of student responses as it would relate to the grade increase incentive. Once classes had ended and all Likert survey data was collected, all students that were enrolled in the course were provided with a letter of information and invited to complete a short answer online survey through their course website. This survey collected qualitative data and gave students the opportunity to expand on their experiences and explain their perceptions of each learning space, in addition to reflecting upon their perceived communication development. Students were incentivized to complete the online survey by being entered into a gift card draw. Students who completed the short answer survey were not compensated with any additional grade increase so as not to affect the candidness of their response. Nine students completed the survey, and the winner was awarded the gift card after the survey closed. Student responses were kept anonymous and short answer responses were not linked back to the Likert survey data.

Data Analysis

All statistical analyses were performed using IBM© SPSS© Statistics Version 26. Means and standard deviations are reported for Likert surveys 1 and 2 and response percentages are reported for Likert survey 3. To examine mean differences between time points of Likert survey 1 a repeated measures ANOVA was performed. To examine mean differences between the time points of Likert survey 2 a paired sample t-test was performed.

Results

This section will include a description of the various quantitative and qualitative data results.

Classroom Observation (COPUS)

To determine the prevalence of instructor and student behaviours in each classroom setting the researchers added up how often each behaviour was coded by the observer over three consecutive classes and divided by the total number of codes for those three classes. The breakdown of instructor and student activities were relatively consistent between the two classroom settings with some minor differences (Figure 2).

In both the fixed-row classroom and the ALS, students were most often coded doing "Other group work" (Figure 2a). As this was a flipped course, there were many active learning activities that took place, all of which were coded using "Other group work". This included activities such as
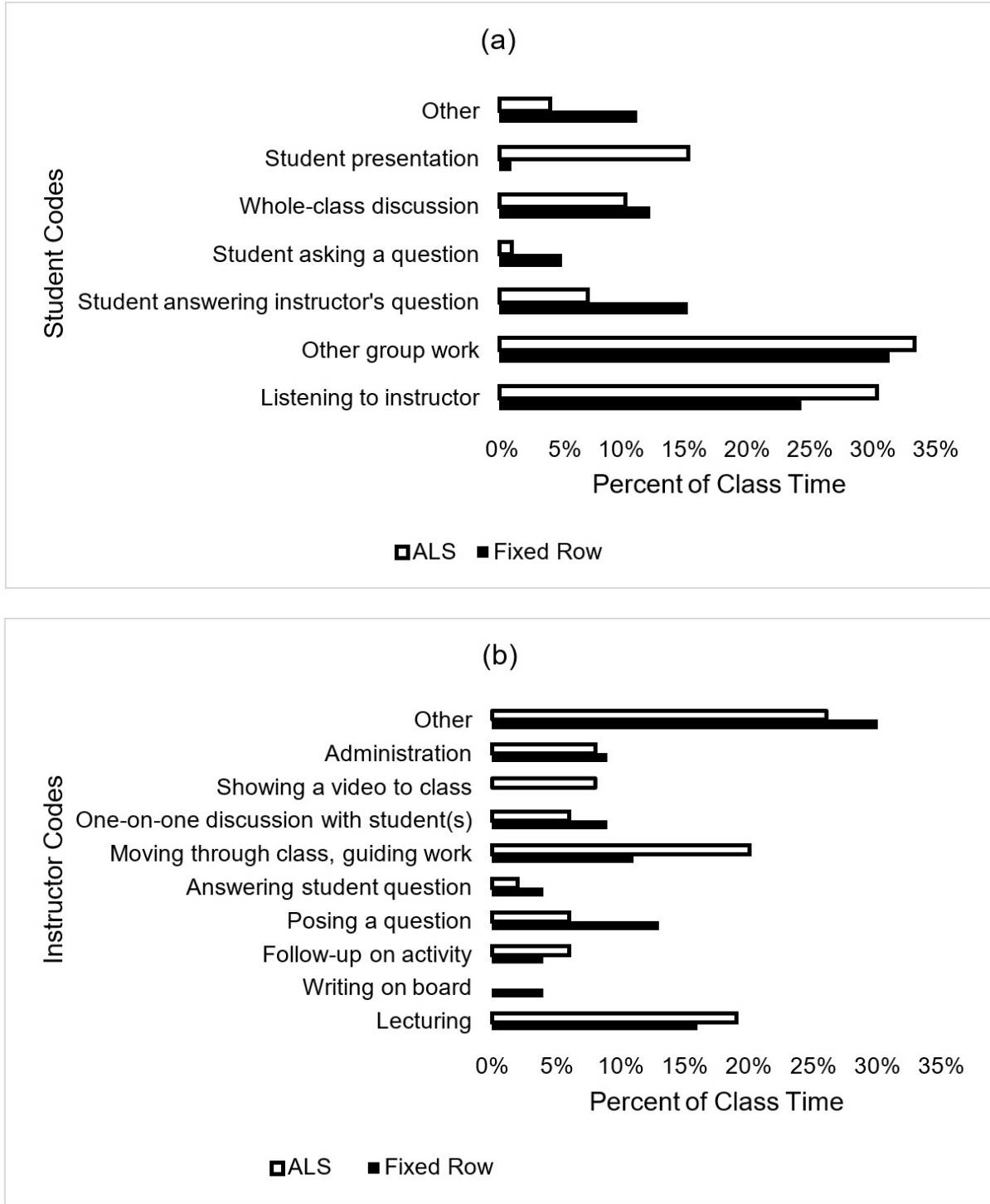
Figure 2. Classroom observation conducted using the COPUS instrument over a period of three classes taught in a fixed-row classroom (black) and three consecutive classes taught in an active learning space (ALS) (white).
2a) The percentage of class time students were coded over three ALS class periods and three fixed row class periods.
2b) The percentage of class time instructor activities were coded over three ALS class periods and three fixed row class periods.

think-pair-share, working on a case study, defining terms with a group, and different forms of group discussion. (Figure 2a). In both classroom settings, the instructor was most often coded doing "Other" (Figure 2b). The instructor's "Other" activities often involved explaining or facilitating an active learning activity. The instructor spent time writing on the white board in the fixed row classroom but did not in the ALS, alternatively the instructor showed videos in the ALS but did not in the fixed row (Figure 2b). The instructor spent more time moving through the room and guiding student work in the ALS compared to fixed row (Figure 2b). Most other instructor and student activities were similar between the two classrooms (Figure 2b).

Likert Survey 1: Communication

Students were asked to indicate the degree to which different communication statements applied to them on a scale of (1) strongly agree to (5) strongly disagree. Student mean responses and standard deviations are reported in Table 2. Students' mean responses to negative communication statements were most often between (3) undecided and (4) disagree, indicating students most often disagreed with negative communication statements. Student mean responses to positive communication statements were between (2) agree and (3) undecided. As the statements in the communication survey were both positive and negative, student responses were re-coded in SPSS to analyze the means of all statements. Negative statement responses were re-coded to reflect positive responses. Parametric and non-parametric tests were run in SPSS with no significance found. Differences in gender, previous exposure to active learning and previous exposure to ALS were examined and there was no statistically significant difference.

Likert Survey 2: Impact Survey

Students were asked to rate the impact each classroom had on their learning and overall perception of the classroom climate on a scale of (1) no impact to (5) very significant impact. Student mean responses and standard deviations are reported in Table 3. A paired t-test was performed in SPSS and significance was found ($p<0.05$) between the ALS and the fixed row classrooms for "group work/collaboration" and "student-student interactions". "Group work/collaboration" had the highest impact rating in the ALS while the lowest impact rating was "individual learning".

Likert Survey 3: Preference Survey

Students were asked to indicate their preferred classroom for classroom learning and engagement. Students indicated the strength of their preference on the scale provided. A strong

Table 1. Scheduled data collection.
The first survey 1 was handed out in the first class, while survey 3 was handed out and collected on the last day of class. The short answer survey was administered online, after the class had ended.

Classroom Setting	Quantitative Data Collection
Fixed Row	Survey 1 (Communication)
Fixed Row	COPUS
Fixed Row	COPUS
Fixed Row	COPUS Survey 1 (Communication) Survey 2 (Classroom Impact)
Midpoint of Term: students switched classroom settings	
ALS	COPUS
ALS	COPUS
ALS	COPUS
ALS	Survey 1 (Communication) Survey 2 (Classroom Impact)
ALS	Survey 3 (Classroom Preference)
Students were sent a link to fill out the online short answer survey	

preference for the fixed row classroom was equal to -3, 0 indicated no preference, and a strong preference for the ALS was equal to +3. The numerical values assigned to each classroom were hidden on the scale with which the participants were provided so as not to bias their responses. Percentages of student responses for each item were calculated (Figure 3). Thirty-one students completed this survey. Overall, students had a strong preference for the ALS when ranking the classrooms based on "opportunities for student-student interactions" (Figure 3b) and "group work/collaborative learning" (Figure 3d) with over half of the students indicating they had a strong preference for the ALS. In terms of "group work/collaborative learning", no students indicated a preference for the fixed row classroom, nor did any indicate there was no preference (Figure 3d). In terms of "opportunities for student-student interactions", only 3% (n=1) of students indicated no preference, while no students indicated any preference for the fixed-row (Figure

Table 2. Mean responses and standard deviations to Survey 1: Communication.
Participants rated the survey items on a 5-point Likert scale; (1) Strongly Agree, (2) Agree, (3) Undecided, (4) Disagree, (5) Strongly Disagree. No significant differences were found among the three time points.

	Statement	First Class n=31	Post Fixed Row n=29	Post ALS n=29
	I always avoid speaking in public if possible.	3.84 ± 1.04	3.61 ± 1.13	3.73 ± 1.23
	I am tense and nervous while participating in group discussion.	3.74 ± 0.93	3.75 ± 1.00	3.66 ± 0.90
	I am fearful and tense all the while I am speaking before a group of people.	3.68 ± 1.08	3.75 ± 1.00	3.70 ± 1.06
	When communicating my posture feels strained and unnatural.	3.42 ± 1.08	3.54 ± 0.96	3.43 ± 1.14
	While participating in a conversation with a new acquaintance I feel nervous.	3.35 ± 1.17	3.39 ± 1.03	3.55 ± 1.15
	Conversing with people who hold positions of authority (instructors) causes me to be fearful and tense.	3.32 ± 1.08	3.14 ± 1.08	3.40 ± 1.22
Negative	My thoughts become confused and jumbled when I speak before an audience [the class].	3.16 ± 1.19	3.21 ± 1.23	3.43 ± 1.22
	I feel self-conscious when I am called upon to answer a question or give an opinion in class.	2.98 ± 1.14	2.93 ± 1.12	3.07 ± 1.26
	I have no fear facing an audience [classroom].	3.42 ± 1.12	3.25 ± 1.08	2.97 ± 1.15
	I find the prospect of speaking mildly pleasant.	3.00 ± 0.85	2.43 ± 0.92	2.43 ± 0.90
	I look forward to an opportunity to speak in public [front of the class].	2.97 ± 1.11	2.86 ± 1.11	2.77 ± 1.25
	I feel I am more fluent when talking to people than most other people are.	2.71 ± 0.90	2.61 ± 0.92	2.80 ± 1.19
Positive	Although I am nervous just before getting up [speaking], I soon forget my fears and enjoy the experience.	2.39 ± 0.95	2.36 ± 0.99	2.77 ± 1.10
	I look forward to expressing my opinion at meetings [in classroom or group discussions].	2.35 ± 0.91	2.43 ± 0.92	2.37 ± 0.96

Table 3. Mean responses and standard deviations of the impact of each classroom on overall learning and student motivation.

Participants rated the survey items on a 5-point Likert scale; (1) No Impact to (5) Very Significant Impact. Significance was found between the 2 classrooms for the item group work/collaboration, and student-student interactions, as indicated by an asterisk ($p<0.05$). There were no significant differences found between the other items.

	Fixed Row n=28	ALS n=28	p-value
Group Work/Collaboration*	3.32 ± 1.16	4.36 ± 1.06	0.001116*
Student-Student Interactions*	3.61 ± 1.07	4.25 ± 1.00	0.008245*
Individual Learning	3.11 ±1.13	3.46 ± 0.96	0.076526
Interest in Attending Class	3.14 ± 1.48	3.63 ± 1.31	0.196801
Physical Comfort	3.36 ± 1.10	3.75 ± 1.11	0.196989
Overall Learning	3.54 ± 1.23	3.89 ± 1.10	0.231754
Motivation to Learn	3.39 ± 1.23	3.68 ± 1.12	0.341103
Instructor-Student Interactions	3.57 ± 1.26	3.54 ± 1.26	0.895608

3b). In terms of "opportunities for instructor-student interactions", the students were more divided, but there was still a strong skew towards a preference for the ALS (Figure 3a). "Personal work" showed the most variation in student responses (Figure 3c).

Short Answer Survey

This survey prompted students to expand upon their learning experiences in both classrooms. Nine students completed the survey, and their responses were kept anonymous. As a result, these responses were not linked to the Likert survey responses.

Discussion

Effective Communication

The primary purpose of the current study was to evaluate the efficacy of an ALS in supporting student development of effective communication When evaluating the quantitative data from the communication survey the researchers did not find any statistically significant differences in communication among the three time points; however, based on qualitative data, the ALS did positively influence student perceptions of communication. Importantly, all nine students recognized that their communication skills improved as a result of learning in the ALS. Some students

attributed their improvement to the ease of group discussion in the ALS. For example, "The combination of the [ALS] and the style of class made me a more confident communicator." This was further supported by the preference survey, in which all student respondents (n=31) indicated their preference for the ALS regarding group work and collaboration (Figure 3d). This is consistent with other findings that suggest students perceive group discussions as an effective way to develop communication skills (Clinton & Kelly, 2017). Participants in Clinton and Kelly's study believed that group discussions were useful as an opportunity to develop communication skills, in addition to an opportunity to interact with others and gain their perspectives (Clinton & Kelly, 2017). Based on these findings, the current study suggests that the ALS does positively influence student perceptions of their development of effective communication.

Work by Shanahan and colleagues suggests that techniques to properly alleviate communication apprehension should be applied over a relatively long period of time in a supportive and safe environment (Shanahan, 2013). Students had nine class sessions throughout the term, which may not be sufficient time to evaluate any quantitative changes in their communication apprehension. In addition, a study of undergraduate and graduate business and accounting students found the majority of students' communication apprehension is in a

Table 4. Emerging themes from student responses to the qualitative short answer survey. Nine students submitted responses out of 33 enrolled in the course.		
Emerging Themes	Example Comments	
	ALS	Fixed Row
Group Work & Collaboration	Positive - I found learning in ALS to be significantly more engaging and a better experience overall. It is much easier to do group work, as the set-up is conducive to discussion and the sharing of ideas. - ALS is much more interactive and allows for better group discussion - It was easy to collaborate with peers and do activities in groups with the whiteboards	Negative - …group work felt more nerve racking because everyone was in the same area, there were no "independent" spaces/pods - There's far less opportunity for collaboration and discussion in the fixed-row classrooms. I felt limited in terms of my contribution and perhaps, as a result, limited in my learning. The fixed row classrooms are better for didactic teaching style in my opinion, but far worse for discussions
Physical Space & Technology	Positive - The ALS was much brighter which contributed to my overall alertness in the class. It also had more comfortable seating, an interesting layout that encouraged collaboration, and smart boards for student use. - Well I really do enjoy the individual projectors and the ability to work on our own section of the classroom. - I have been encouraged to participate more in the ALS classroom as the smaller intimate pods make it easier participate in	Positive - the fixed row classroom was less awkward and more comfortable than the ALS classroom Negative - [the Fixed Row] was very dark, outdated, and uncomfortable. - The structure of fixed row classrooms make it harder to form groups and interact with others. If the desks in the row classrooms were grouped together instead, I believe that it would result in similar benefits as the ALS classroom but at a lower cost.
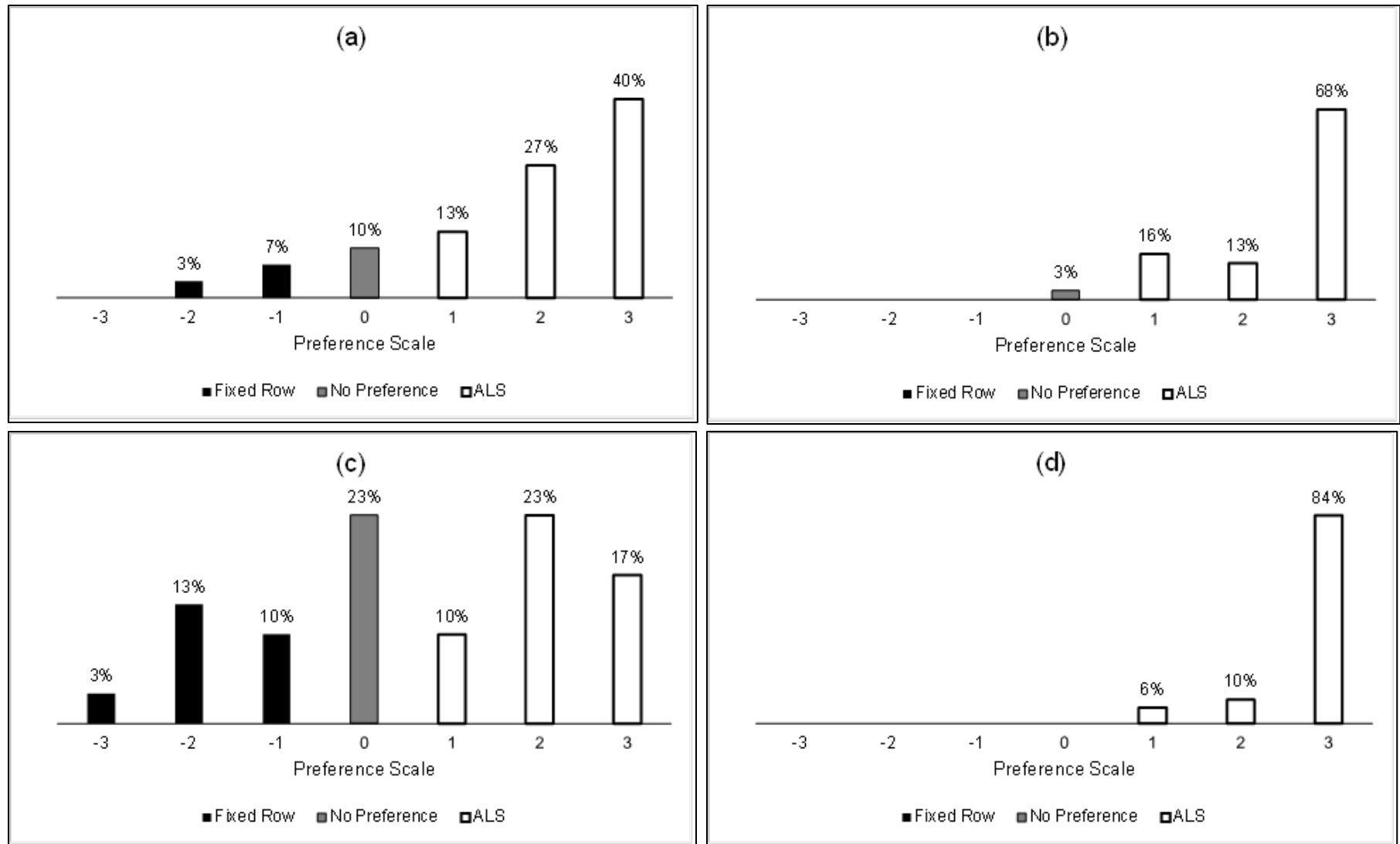
Figures 3a, 3b, 3c, and 3d. Student response percentages to Survey 3: Preference Survey. Students were able to quantify their preference for either the fixed row classroom (black) or the ALS (white).

3a) shows student response percentage for opportunities for instructor-student interactions; 3b) opportunities for student-student interactions; 3c) personal work; 3d) group work/collaborative learning;
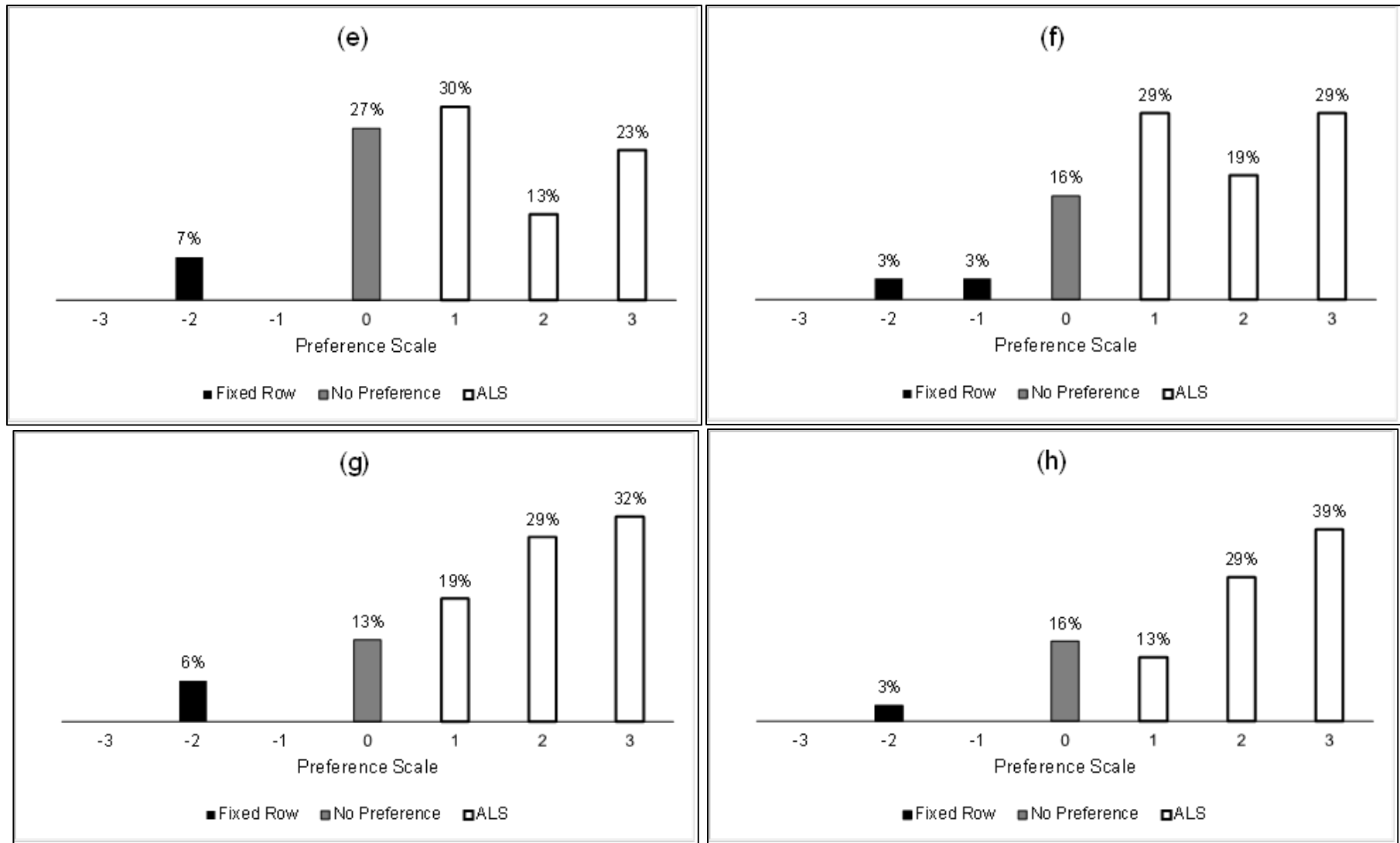
Figures 3e, 3f, 3g, and 3h. Student response percentages to Survey 3: Preference Survey. Students were able to quantify their preference for either the fixed row classroom (black) or the ALS (white).

3e) student motivation; 3f) interest in attending class; 3g) overall classroom learning; 3h) physical comfort.

public speaking context (Shanahan, 2013). Since students in the current study did not explicitly have work related to traditional public speaking, apprehensions in public speaking contexts may not be addressed or alleviated. Data from the qualitative survey suggested that some students felt that they had strong communication skills, which is consistent with the quantitative survey data. Although students may have felt confident in their own communication abilities, they recognized that "… [the ALS] may have helped someone else who is maybe not as comfortable with talking to people they don't know well." In the future, it may be beneficial to measure communication apprehensions at different time points in a student's university career, especially in their early years.

Learning Spaces

Based on the observational results, the instructor successfully implemented similar learning activities in both physical classrooms. This is important as the fact that the activities are closely related in both environments decreases the possibility that the duration of learning activity type is a confounding variable between the two classroom environments. The instructor and students were most often coded participating in active learning activities, followed closely by didactic lecturing. The slight differences in coding percentages between the different classroom settings can likely be attributed to different content covered in each class and active learning activities specifically designed for such content. Some other differences in coding are likely because of the difference in classrooms. The instructor spent more time moving through the class in the ALS because the ALS had a lot more open space while the fixed row classroom had little space between the desks and presented a slight barrier for the instructor to check-in with every group. In addition, the lack of space in the fixed row classroom made it difficult for students to comfortably get into groups to perform different active learning activities which likely negatively impacted their ability to communicate. Similar findings have been reported in work from Vercellotti and colleagues, in that the instructor struggled to interact with student groups in a fixed row classroom and students put very little effort into facing each other in the fixed row classroom for group activities (Vercellotti, 2018). COPUS may be better suited for large enrollment classes taking place in a lecture hall, as many of the training videos presented on the official COPUS website seemed to target large enrollment classes. The current study, with 31 participants, would certainly not be considered a large enrollment class (Smith et al., 2013); however, COPUS was still a useful and previously validated instrument that allowed the researchers to easily determine the primary activities carried out in each classroom environment.

The design of the ALS allows for easy and effective collaboration amongst students which in turn creates an environment in which students are given the opportunity to collaborate and engage with more knowledgeable peers (Doolittle, 1995; Harland, 2010; Vygotsky, 1980). When asked how the ALS may have impacted their learning, one participant responded with, "It has made me more likely to ask other people for their thoughts or their help when I do not understand a concept." Another commented that "it was also easier for me to hear and engage with what my peers were saying, making it easier for me to recognize them as an important resource for my learning. In other words, I started considering more what can I learn from their unique perspective on our discussion topic." Importantly, the students were able to recognize that the design of ALS allows for easier interaction with peers which can directly lead to asking a more knowledgeable peer for help on a challenging subject. From a communication perspective, it is important for students to be able to communicate the content in which they are struggling to understand, whether that be seeking help from their instructor or their peers. Participants in this study were able to recognize the valuable resource in their student peers because of the ease of group discussion in the ALS. This is further supported by work done by Vercellotti, who found that students actively learning in both a traditional classroom and an interactive classroom reported that interactions with their peers in class supported their learning and were very useful. Students commented that working through concepts with a focus on their own learning and knowing that a fellow peer may be able to help them was calming and helped their learning (Vercellotti, 2018). In addition, students in the present study that believed they had strong communication skills were able to recognize that some of their peers may not be as confident; they suggested that the design of the ALS is useful for those individuals that need help developing their communication skills. Based on these findings, the second aim was met as the ALS positively affected the quality of student-student interactions.

It is important to recognize that not all students preferred the ALS to the fixed row classroom; although all students recognized that the ALS was more effective at facilitating group work and collaborative activities. One student that responded to the short answer survey thought that the centralized instructor in the ALS had a negative impact on their learning. For example, "I ended up participating less in [the ALS] class [discussion] as I am more comfortable with facing forward and seeing the [instructor] who I am talking towards." This may be why some participants preferred the fixed row classroom in the preference survey (Figure 3a and 3h). The design of the ALS puts the instructor at the center of the room with groups of students around the periphery

(Figure 1b). The instructor moved around the room when addressing the entire class; however, students may have felt alienated when the instructor was not facing their direction. In addition, the projector screens are located on the walls, which makes it difficult for students to focus on both the instructor and the screen simultaneously.

Overall, this work further supports the implementation and use of ALS. It was clear through quantitative student responses to the preference survey that the ALS was better suited and preferred for group work, collaboration, and student-student interactions, although there was some division on other items. When students were asked to rate the impact of each classroom, "groupwork/collaboration" and "student-student interactions" had a significant difference between the two classroom settings. This is consistent with results from the other surveys and adds to our narrative that an ALS is more suitable for developing communication skills than a traditional fixed-row classroom. This is consistent with other findings that indicate students perceive ALS to enhance student engagement and allow for easier interactions with peers (Adedokun et al., 2017; Neill & Etheridge, 2008; Whiteside et al., 2010). One participant commented that "The classrooms were able to achieve similar outcomes; however, the [ALS] classroom made those outcomes easier to achieve and were more effective." Although active learning was successfully performed in the fixed row, students felt that active learning outcomes, and effective communication were easier to achieve in the ALS.

Limitations

There were several limitations to the current study. The n value was small, and not all students were able to complete every Likert survey which further impacted the n value. the current study was carried out over a short time frame. A longer time frame may be needed to see substantial change in students' skills, particularly in the senior years of their undergraduate degree. Finally, this study was carried out using undergraduate students from one course that had limited program enrollment, which may limit the generalizability of the findings.

Conclusions and Future Directions

Based on the results of the current study; (1) The physical learning space influenced student perceptions of their development of effective communication as students perceived an improvement in their communication skills after learning in the ALS; (2) the physical classroom affected the quality of peer-to-peer interactions, students preferred the ALS to the fixed row, especially in terms of collaboration and groupwork. This study highlights the importance of investigating student perceptions of a learning space in

order to create the best environment for each learning context. This study further supports increasing the adoption of ALS by higher education institutions.

Declaration of Conflict of Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

Adedokun, O. A., Carleton Parker, L., Henke, J. N., & Burgess, W. D. (2017). Student Perceptions of a 21st Century Learning Space. *Journal of Learning Spaces*, *6*(1), 1–13. https://files.eric.ed.gov/fulltext/EJ1152589.pdf

Brooks, D. C. (2011). Space matters: The impact of formal learning environments on student learning. *British Journal of Educational Technology*, *42*(5), 719–726. https://doi.org/10.1111/j.1467-8535.2010.01098.x

Chadha, D. (2006). A curriculum model for transferable skills development. *Engineering Education*, *1*(1),19–24. https://doi.org/10.11120/ened.2006.01010019

Clinton, V., & Kelly, A. E. (2017). Student attitudes toward group discussions. *Active Learning in Higher Education*, *00*(0), 1–11. https://doi.org/10.1177/1469787417740277

Clinton, V., & Wilson, N. (2019). More than chalkboards: classroom spaces and collaborative learning attitudes. *Learning Environments Research*, 1–20. https://doi.org/10.1007/s10984-019-09287-w

Dede, C. (2010). 21st Century Skills: Rethinking How Students Learn - Google Books. In J. Bellanca & R. Brandt (Eds.), *21st Century Skills: Rethinking How Students Learn*. Solution Tree Press. https://books.google.ca/books?hl=en&lr=&id=aGYXBwA AQBAJ&oi=fnd&pg=PT79&dq=Comparing+frameworks+ for+21st+century+skills.+21st+century+skills:+Rethinking

+how+students+learn,+20,+51-76.)&ots=wbf0A07ZYO&sig=vzmJ7Ws2XwktoydxwrpUVwQHc6g#v=onepage&q&f=false

Doolittle, P. E. (1995). *Understanding Cooperative Learning Through Vygotsky's Zone of Proximal Development*.

Drew, S. (1998). Students' Perceptions of their Learning Outcomes. *Teaching in Higher Education*, *3*(2), 197–217. https://doi.org/10.1080/1356215980030206

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *PNAS*, *111*(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

Harland, T. (2010). Vygotsky's Zone of Proximal Development and Problem-based Learning: Linking a theoretical concept with practice through action research. *Teaching in Higher Education*, *8*(2), 263–272. https://doi.org/10.1080/1356251032000052483

Henshaw, R. G., Edwards, P. M., & Bagley, E. J. (2011). Use of swivel desks and aisle space to promote interaction in mid-sized college classrooms. *Journal of Learning Spaces*, *1*(1). http://libjournal.uncg.edu/jls/article/view/277/170

Hill, M. A., Overton, T., Kitson, R. R., Thompson, C. D., Brookes, R. H., Coppo, P., & Bayley, L. (2020). "They help us realise what we're actually gaining": The impact on undergraduates and teaching staff of displaying transferable skills badges. *Active Learning in Higher Education*. https://doi.org/10.1177/1469787419898023

McCroskey, J. C. (1977). Oral communication apprehension: a summary of recent theory and research. *Human Communication Research*, *4*(1), 78–96.

McCroskey, J. C. (1978). Validity of the PRCA as an index of oral communication apprehension. *Communication Monographs*, *45*, 192–203.

Neill, S., & Etheridge, R. (2008). Flexible Learning Spaces: The Integration of Pedagogy, Physical Design, and Instructional Technology. *Marketing Education Review*, *18*(1), 47–53. https://doi.org/10.1080/10528008.2008.11489024

Nicol, A. A., Owens, S. M., SCL Le Coze, S., MacIntyre, A., & Eastwood, C. (2018). Comparison of high-technology active learning and low-technology active learning classrooms. *Active Learning in Higher Education*, *19*(3), 253–265. https://doi.org/10.1177/1469787417731176

Park, E. L., & Choi, B. K. (2014). *Transformation of classroom spaces: traditional versus active learning classroom in colleges*. *68*, 749–771. https://doi.org/10.1007/s10734-014-9742-0

Schulz, B. (2008). The Importance of Soft Skills: Education beyond academic knowledge. In *NAWA Journal of Language and Communication*.

Shanahan, D. (2013). High Oral Communication Apprehensives: How Can Students be Helped to Reduce Their Fear of Public Speaking? *Irish Journal of Academic Practice*, *2*(1). https://doi.org/10.21427/D72F09

Smith, M. K., Jones, F. H. M., Gilbert, S. L., & Wieman, C. E. (2013). The Classroom Observation Protocol for Undergraduate STEM (COPUS): A New Instrument to Characterize University STEM Classroom Practices. *Life Sciences Education*, *12*, 618–627. https://doi.org/10.1187/cbe.13-08-0154

Stalp, M. C., & Hill, S. E. (2019). The Expectations of Adulting: Developing Soft Skills through Active Learning Classrooms. *Journal of Learning Spaces*, *8*(2), 25–40. http://libjournal.uncg.edu/jls/article/view/1753/1363

Vercellotti, M. Lou. (2018). Do interactive learning spaces increase student achievement? A comparison of classroom context. *Active Learning in Higher Education*, *19*(3), 197–210. https://doi.org/10.1177/1469787417735606

Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes.* Harvard University Press.

Wass, R., Harland, T., & Mercer, A. (2011). Scaffolding critical thinking in the zone of proximal development. *Higher Education Research & Development*, *30*(3), 317–328. https://journals.scholarsportal.info/pdf/07294360/v30i0003/317_sctitzopd.xml

Whiteside, A., Brooks, D. C., & Walker, J. D. (2010, September). *Making the Case for Space: Three Years of Empirical Research on Learning Environments*. Educause Review Online. https://doi.org/10.1111/j.1467-8535.2010.01098.x

Wilson, G., & Randall, M. (2012). The implementation and evaluation of a new learning space: a pilot study. *Research in Learning Technology*, *20*. https://doi.org/10.3402/rlt.v20i0/14431

Appendix

Supplementary Table 1. Demographic breakdown of student responses to Likert surveys	n
Gender	
Female	14
Male	19
Mean Age	21.42 ± 1.62 years
Program of Study	
IMS	29
IMS/HBA	4
Year of Study	
Fourth Year	24
Fifth Year	8
Unknown	1
Active Learning Experience	
Yes	22
No	7
Unknown	4
ALS Experience	
Yes	17
No	14
Unknown	2