



An investigation into the impact of classroom attributes on students' satisfaction and performance between different room types.

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Declaration

I declare that this submission is my own work. Where I have read, consulted, and used the work of others I have acknowledged this in the text.

Signature: *Loise Broderick*

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List of abbreviations

Interactive classrooms -IC's

Tiered lecture halls -TLH's

Flat classrooms FC's

1. Abstract

Third level students all over the world spend a large amount of their time in different classroom environments. Attributes within each room can differ depending on things like room type. These can contribute to students' satisfaction with a space or impact their performance. Within Ireland there is little research in this area specifically regarding third level students. Therefore, the present study aimed to investigate if 1) students' satisfaction with their classrooms attributes differed depending on the room type and 2) if classroom attributes impacted students' performance depending on the room type. A total of 143 students participated, 59 were within the interactive classrooms, 50 within tiered lecture halls and 32 within flat classrooms. Students' satisfaction and impact on performance were measured using two 5-point Likert scales. Results from two separate one-way ANOVAs showed a significant difference for impact of classroom attributes on students' performance based on room type. A Post hoc test revealed the difference between interactive classrooms and flat classrooms. However, students' satisfaction with classroom attributes did not differ significantly between the three-room types. The implications, strengths and limitations of the study were outlined and discussed, along with suggestions for future research.

2. Introduction

2.1 Overview

Third-level students all over the world spend a large amount of time within different room types depending on what they study. Students within higher education institutes usually put emphasis on, and look for quality of education and excellence of the institute. Some specifics include approachable environment, appropriate physical aspects, standard of the education system, assistances that an institute provides and other aspects like course employability (Kanwar & Sanjeeva, 2022). Over the years a vital emphasis has been put on physical infrastructures as students' perceptions and satisfaction can be impacted by them which therefore contributes to becoming successful and effective learners (Usman, 2010). As stated by Bandura (1986), Social Cognitive Theory emphasises that learning is a "multifaceted system", entailing that people's behaviours, characteristics, sociability, and interactions with these variables all impact the ability to learn. Therefore, it's important to examine the specific characteristics that contribute to classroom environments and their impact on students' satisfaction and performance.

The physical learning environment was defined by Taylor and Enggass (2009) as the 'silent curriculum'. This incorporates our inevitability to interact with the spaces around us and how that interaction affects the way we learn either positively or negatively. Although there are many physical classroom attributes that impact students, some often mentioned in research are lighting, noise, temperature, visibility, room layout, furniture, and acoustics (Yang et al., 2013).

2.2 Person environment fit theory

This theory has been widely used within workplaces and education. Over the years adaptations have been raised but the overall idea stays the same. It's defined as the interaction or fit between a person's characteristics and the environment they're in, emphasis is put on that person's influence on their environment but also the environment's impact on them. (Holmback et al., 2008). The P-E fit model is described

as “P” representing students’ actions, performance and understanding, “E” referring to the physical classroom environment; P is always affected by E. This P-E fit model has been used in many studies within different environments and settings including institutes, groups and academics (Pawlowska et al., 2014; Wessel et al., 2008).

2.3 Physical classroom environment, student satisfaction and performance

In the constantly changing world we live in; the physical environment plays a vital role in the experience we have within any setting. However, when it comes to the educational setting, research has shown just how much our surroundings impact us. Like the physical learning environment, the physical classroom environment are defined as a designed area that includes specific spatial characteristics, these can facilitate the learning and teaching within the space. It includes a range of elements such as atmosphere, furniture, resources, lighting, air quality, room size, temperature, ventilation, and technology (Suleman et al., 2014).

Many studies have investigated the impact of some of these specific aspects on students’ performance and satisfaction. Jin and Peng (2022) investigated two room types, one being traditional lecture classrooms vs two, active learning classrooms, within third-level education and their spatial factors impact on student satisfaction. The quantitative study included 316 participants, and separate questionnaires were used and rated using a 5-point Likert scale to measure student satisfaction in each of the two settings. Questions included dividing spatial factors up into four different groups (interaction with instruction, impression of furniture, physical environment, and learning support). Students' gender was seen to have an impact on their satisfaction with the traditional lecture classrooms, therefore gender was used as the control variable in the analysis concerning the traditional lecture classrooms spatial factors and overall satisfaction. It was concluded that all groups had a significant effect on students’ learning experience. The main findings included students being least satisfied with the “learning support” aspect of both classrooms, but satisfied most with “physical environment” aspects of the traditional lecture rooms and “instructional interaction” within active learning rooms. Students were satisfied more with with active learning rooms than with traditional lecture rooms. Overall findings indicated that important

spatial factors did impact students' satisfaction within room types. Limitations of the study put emphasis on the need for more qualitative studies in the area of comparing as it will give a deeper understanding and more detail.

Within a study by Hill and Epps (2010), main conclusions indicated a significant difference in students' satisfaction based on the room type. Similarly, Hao and Florez-Perez (2021) found specific aspects within different classrooms impacting students. Researchers assessed the effect of classroom domains on students' satisfaction and performance in sustainable spaces in universities. Web-based questionnaires were used to collect data and instil a mixed methods analysis of the data. The 173 participants ranged from undergraduate to doctoral students. The spatial factors being assessed were room layout, noise, colour, lighting and temperature. The person-environment fit theory and smart classrooms were discussed throughout. Results concluded that individuals had many different wants for their classroom environment and better design of rooms resulted in higher satisfaction of students. Similarly, students' performance was seen to be better when there was a positive outlook on a room's physical design. Both classroom layout and noise seemed to positively affect the performance and satisfaction of students and notably, temperature affected satisfaction more than lighting. An internet of things device within a classroom has been proposed within the university thanks to students' feedback within the study.

2.4 Classroom attributes; lighting, temperature, air quality and acoustics

Concerning natural lighting, Lam et al. (2019) stated within their Hong Kong universities-based study, that visibility and enough natural light within a room can largely enhance a space, making it more attractive to students which can then lead to raising overall classroom space satisfaction. Similarly, students based in India in a 2020 study by Yarramsetty et al. (2020) expressed a preference for satisfaction with daylight over artificial lighting in educational buildings. Students' moods were impacted by the lighting and flickering of artificial lighting was noted as distracting and a cause of lapse in concentration. Specific to artificial lighting Castilla et al. (2018) conducted a four-year field study on 427 third-level students in Valencia, Spain to investigate and compare the “subjective evaluation of their pre-formed opinions to

lighting”, lights included were fluorescent and LED. The analysis concluded that within the attractive, comfortable and cosy variables, students stated negative satisfaction if the light was fluorescent. Although, positive reflections were expressed in all variables when the light was LED excluding cosy.

Temperature is important specifically the management of indoor temperature effectively within air-conditioned college buildings. This can result in improvements in learning environments. A dissertation study in Saudi Arabia stated temperature affected task accuracy in different ways, depending on the type of task (Mohammed Gaber Ahmed, 2017). Similarly Liu et al. (2021) concluded that university students in China within different room types showed a relationship between optimal temperature that therefore lead to a better impact on performance. Also temperatures that were too high or low were seen to poorly impact performance.

Han et al. (2019) study revealed many aspects of different classrooms that impacted students’ satisfaction, attitudes towards and quality of courses. Results stated things like smells, amenities (like whiteboards, projectors, sound systems), air quality and acoustics impacted students. Choi et al. (2013) investigated 631 students within the University of Minnesota's relationship between indoor environment quality of classrooms and their satisfaction with rooms, courses, and perception of how the indoor environment quality impacts their learning. The study challenged whether all physical aspects impact students, in general results coincide with other studies (Earthman, 2004), stating mostly a positive relationship between some classroom aspects with student satisfaction and learning. Although, it revealed students were satisfied with furniture and lighting within the classrooms, these specific aspects did not impact directly on learning. Suggestions for future research included conducting studies within different types of classrooms with different seating, types of light and furniture.

Noise can sometimes be viewed as unimportant when concerning aspects of classroom environments that impact students. According to Braat-Eggen et al. (2017), a study on the noise levels in open concept study spaces in Netherland universities revealed that out of numerous sounds like, walking, phones ringing and device noises, mumbling voices disturbed students most. Similarly acoustics can cause disruption. A 2015 study accessed informal learning spaces in third-level education and revealed how important

acoustics are to students, specifically reporting was non-speech background noises are unsuitable for learning (Scannell et al., 2015)

2.5 Classroom attributes; Room layout, furniture, visibility

As stated by Cheryan et al. (2014) performance is highly influenced by structural aspects of a space. Colleges and universities classroom layout and furniture can vary depending on the room type. Some traditional lecture hall layouts are commonly lined rows of desks and fixed seating similarly, computer labs are usually designed somewhat the same. When comparing designs of active learning classrooms to traditional lecture halls, combinations of various equipment and layouts can provide flexible and supportive spaces for students. Comfortable long-lasting furniture can change a space from single fixed rows of desks and seating to space that fosters collaborative learning and immersive environment. To show this, Byers et al. (2018) conducted a study on students' perceptions with, and performance within innovative vs traditional learning environments, and how these settings affected learning. Results found that students' performance depended on the type of room. Concerning seating positions, Xi et al. (2017) stated small to medium-sized classrooms were preferred by students over computer-based or collaborative-styled ones. Classroom layout was considered by most students as a contribution to something that impacted their performance. Visibility within a classroom can be described as the field of and distance between pupils and their lecturer or visual aids like a board or projector (Yang et al., 2013). Visibility can be connected to seating position within a classroom as sitting in the front, middle or back can affect what you see. Will et al. (2020) noted that students' seating positions and the further back they sat had a large contribution to their grades declining.

2.6 Classroom attributes; technology

Recent years have seen outstanding technological advancements, as technology is a widely useful instrument for people, groups and institutions as it can expedite actions, enhance efficiency and overall result in the improvement of quality (Alamri, 2019). Some aspects of technology within classroom environments can refer to smart boards or projectors, computers and Wi-Fi. Studies have shown the positive impacts of computer use within school settings, specifically impacting educational performance (Xiao & Sun, 2021). Similarly, an experimental study done by Glass and Kang (2018)

accessed college students' academic performance in two class types; permitted and non-permitted use of technology lectures. They found no difference in scores between each class but long-term effects were seen when it came to performance in exams. Students within a technology-permitted class had worse performance than those in a non-permitted class.

2.7 The present study

This study will investigate if students' satisfaction and impact on performance with classroom attributes differ depending on the classroom they are in, this will contribute to the gap in research within Ireland on this topic. It will involve a quantitative analysis approach with the use of a questionnaire.

2.8 Research questions

RQ1: Is there a difference in students' satisfaction with their classroom attributes depending on the room type?

RQ2: Is there a difference in classroom attributes impacting students' performance depending on the room type?

2.9 Hypotheses

H1: There will be a difference in students' satisfaction with classroom attributes based on the room type (measured as interactive classrooms, tiered lecture hall, flat classroom).

H2: There will be a difference on classroom attributes impact on students' performance based on the room type (measured as interactive classrooms, tiered lecture hall, flat classroom).

3. Method section

3.1 Design

The current study involved a quantitative research design. The quantitative data employed a 3x1 factorial, between groups design. The independent variable is room type with three levels: interactive classrooms, tiered lecture halls and flat classrooms. The first dependant variable is students' satisfaction (with the classrooms attributes) and the second is impact on students' performance (based on the classroom attributes). These were scored using the Impact of classroom attributes on student satisfaction and performance survey designed by Yang et al. (2013).

3.2 Participants

Participants within this study were all undergraduate students attending Dun Laoghaire Institute Of Art Design + Technology (IADT), (N=143). There were 80 participants who identified as females, 54 males, 7 others and 2 who preferred not to say. Participants were recruited through purposive sampling as specific classroom types were chosen to provide surveys to e.g. students in traditional lecture classrooms. In terms of groups, within the interactive classrooms there were (N= 59), tiered lecture halls (N= 50) and flat classrooms (N=34). Participants were treated in keeping with the ethical standards of the Psychological Society of Ireland (PSI) and the Department of Technology and Psychology Ethics Committee (DTPEC) within IADT approved the study (Appendix A). Table 1 shows genders n values, mean, standard deviation and figure 1 shows the percentage of participants gender in the study.

Table 1

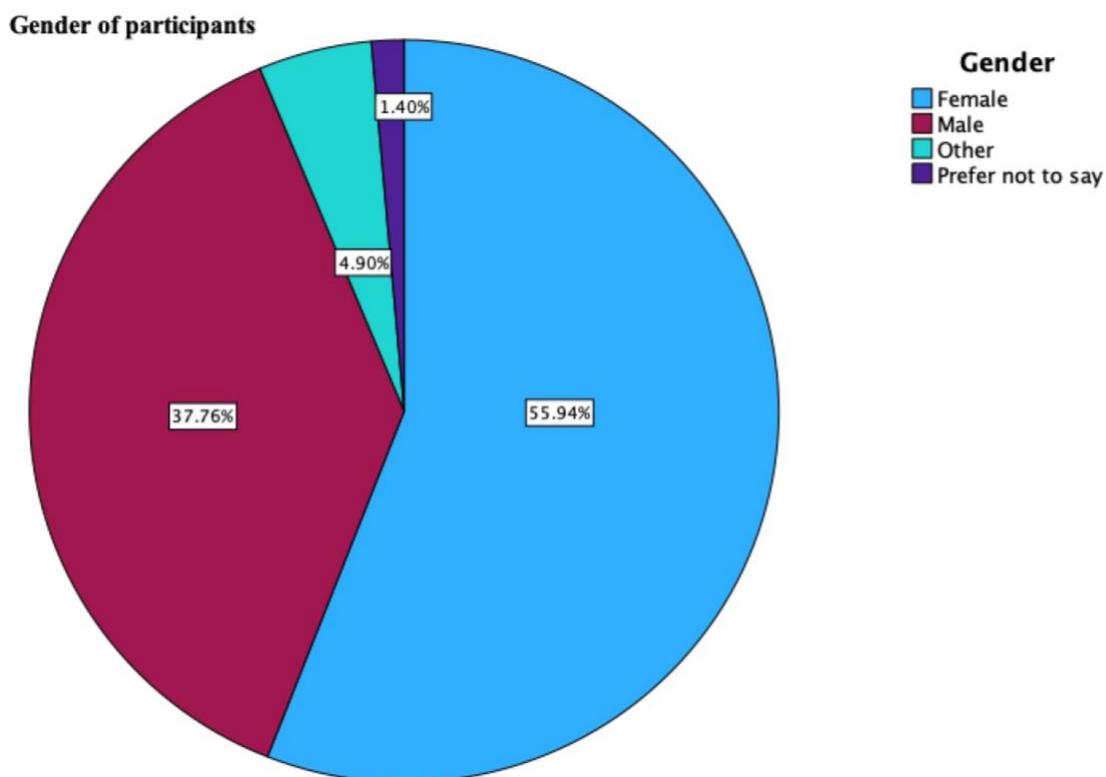
The n values, mean and standard deviation for gender

Descriptive Statistics

	N	Mean	Std. Deviation
Gender	143	1.5175	.65921
Valid N	143		

Figure 1

A pie chart displaying the percentage of participants gender.



3.3 Materials

Firstly, participants were provided with a QR code to the online survey which was carried using Microsoft Forms. Secondly, an information sheet was provided to inform participants about the purpose and their roles within the study (Appendix B). A consent form was used to ensure informed consent was secured to participants before the collection of data (Appendix C). A demographic form was included to gather information regarding students' gender and the room type they were in to ensure they were within participation criteria (Appendix D). Lastly, a debrief form was provided to thank participants for providing their data and restate the study's purpose. It also included contact details of the researcher and their supervisor if participants wish to withdraw from the study or have any questions (Appendix E).

Yang et al. (2013) survey 'The Impact of classroom attributes on student satisfaction and performance' was used (see Appendix F). The Impact of classroom attributes on student satisfaction and performance survey includes two separate 5-point Likert scales. The Likert scale requires students to rate their satisfaction with 10 classroom attributes (satisfaction vote) from "1-very dissatisfied" to "5-very satisfied", these 10 attributes are listed as follows; temperature, air quality, artificial lighting, daylight, acoustics, visibility, furniture, room layout, hardware and software. The Likert scale requires students to rate the impact of these same 10 attributes on their performance (impact vote), ranging from "1-no impact" to "5-large impact". Cronbach alpha coefficient for the satisfaction vote is stated as $\alpha = .82$ and for impact vote $\alpha = .75$ (Yang et al., 2013). Within the current study the reliability for satisfaction votes were $\alpha = .703$ and for impact votes $\alpha = .777$ (Appendix G).

3.4 Pilot study

A pilot study was carried out (N=4). This was done to recognise any possible errors within the study. The pilot study was a success, participants had no suggestions therefore there were no required changes.

3.5 Procedure

As a quasi-experimental design was used, students within each chosen classroom i.e. interactive classrooms, tiered lecture halls and flat classrooms were recruited to voluntarily partake in the study through Microsoft forms while they were in the class setting. The information sheet included the aims and purpose of the study, that participants were not obliged to take part if they did not want to and that they could withdraw from the study at any point. Once read, students were brought onto the consent form page, if consent was given and students were over 18, they were provided with a demographic form which required them to include their gender, a unique code for identification purposes and the room type they were seated in. Participants then completed the Impact of classroom attributes on student satisfaction and performance survey. Once finished, this was followed by a question to confirm consent and ensure they still wanted to submit their responses. Participants were then debriefed which included contact details of the researcher and thanked for their participation in the study.

4. Results

4.1 Overview of results

Two 5-point Likert scales were used to measure satisfaction and impact on performance (Yang et al., 2013). Statistical analysis was carried out using IBM SPSS Statistics (version 29). The alpha level for the analysis was .05. Two one-way between-groups analysis of variance (ANOVA) were conducted.

The independent variable for this study was:

- (i) Room type (Interactive classrooms, Tiered lecture hall, Flat classroom)

The dependant variables for this study were:

- (i) Students' satisfaction
- (ii) Impact on students' performance

Participants were divided into three groups based on room types (Interactive classroom, Tiered lecture hall, Flat classroom). Inferential statistics were used to investigate if there was a difference in students' satisfaction based on room type and impact on performance. Tables 2, 3 and 4 below describe each classroom attribute within each of the three classroom types.

Table 2*Specifications of the classroom attributes within the interactive classrooms.*

Room type	Temperature	Air quality	Artificial lighting	Daylight	Acoustics	Visibility	Furniture	Room layout	Hardware	Software
Interactive classrooms	Heating systems are present (radiators) and openable windows in most rooms.	Openable windows and CO2 monitors are present in all rooms.	Illumination is present from ceiling lights in all rooms.	A mix of large and/or smaller windows are present within all rooms.	Speakers are connected to lecturers computers, allowing sound to travel around each room.	Desks, computers and/or other classroom equipment have potential to restrict visibility in some rooms.	Fixed desk rows, individual desks and wheeled chairs are present between rooms.	Lecturers teaching space is positioned towards the top or side of each room. Desks are fixed and mostly front facing, seats are moveable in all rooms.	One or multiple projectors can be seen on walls and/or at the top of some rooms. Computers are also fixed to desks within some rooms.	Wifi connection is available for many devices. Many essential programs and software are installed on computers.

Table 3*Specifications of the classroom attributes within the tiered lecture halls.*

Room type	Temperature	Air quality	Artificial lighting	Daylight	Acoustics	Visibility	Furniture	Room layout	Hardware	Software
Tiered lecture halls	Small openable windows are present in all rooms.	Openable windows and CO2 monitors are present in all rooms.	Illumination is present from ceiling lights in all rooms.	Small high windows are the only source of daylight present within all rooms.	Speakers are connected to lecturers computers, allowing sound to travel around each room.	No presence of obvious objects that potentially could restrict visibility within all rooms.	Fixed tiered desks and chairs are present in all rooms.	Lecturers teaching space is positioned towards the top of each room. A fixed seating arrangement is present in all rooms.	One projector can be seen at the top of the room.	Wifi connection is available for many devices. No student accessible computers are present.

Table 4*Specifications of the classroom attributes within the flat classrooms.*

Room type	Temperature	Air quality	Artificial lighting	Daylight	Acoustics	Visibility	Furniture	Room layout	Hardware	Software
Flat classrooms	Heating systems are present (radiators) and openable windows in all rooms.	Openable windows and CO2 monitors are present in all rooms.	Illumination is present from ceiling lights in all rooms.	Large windows at the back of room are present.	Speakers are connected to lecturers computers, allowing sound to travel around each room.	No presence of obvious objects that potentially could restrict visibility within all rooms.	Desks are in rows and chairs are standard without wheels in all rooms.	Lecturers teaching space is positioned towards the top of each room. Desks are rowed, facing the front and movable in all rooms.	One projector can be seen at the top of the room.	Wifi connection is available for many devices. No student accessible computers are present.

4.2 Analysis 1- DV1 Satisfaction

4.2.1 Descriptive statistics

143 participants were included in the study, 59 were included within the Interactive classrooms, 50 within the Tiered classrooms and 34 within the Flat classrooms. The distribution of participants between each group is shown in table 5. The means and standard deviations for satisfaction within the three-room types are presented in table 6 below.

Table 5*Summary of the distribution of participants between each room type.*

Room type	N
Interactive classrooms	59
Tiered lecture halls	50
Flat classrooms	34
Total	143

Table 6*Summary of rounded mean and standard deviation scores for satisfaction within each room type. (Labelled SatDV1)*

SatDV1		
Room type	Mean	Std. Deviation
Interactive classrooms	3.79	.70
Tiered lecture halls	3.59	.51
Flat classrooms	3.52	.55
Total	3.66	.61

The following figures 2, 3 and 4 summarise students' satisfaction with each classroom attribute in the three-room types from the Likert scale votes. Regarding the use of percentages for more detail, the tables 7, 8 and 9 below include the percent of students' satisfaction votes with each classroom attribute between the three classroom types.

Figure 2

A horizontal stacked bar chart displaying students' satisfaction votes with each classroom attribute within Interactive classrooms.

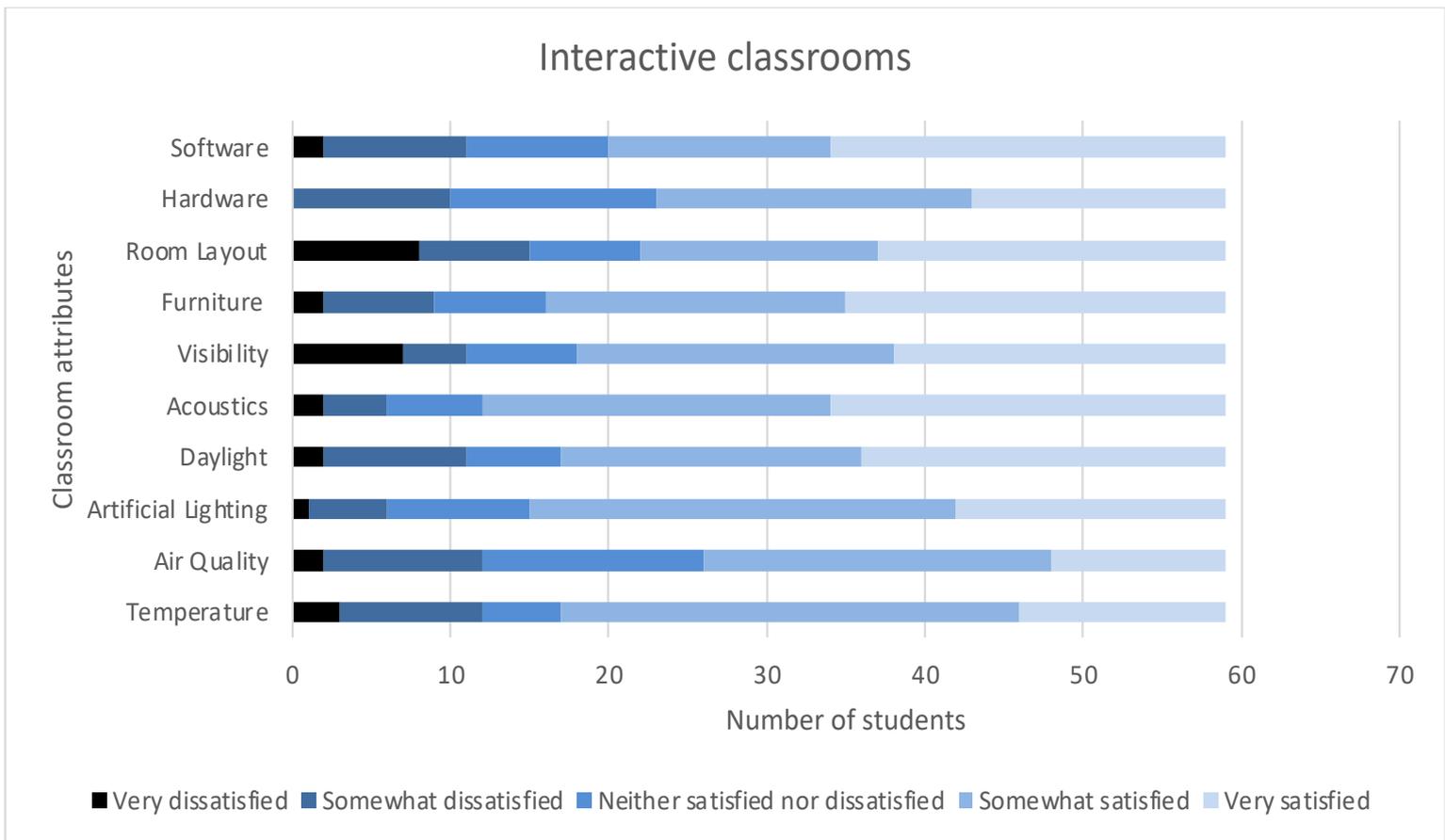


Figure 3

A horizontal stacked bar chart displaying students' satisfaction votes with each classroom attribute within Tiered lecture halls.

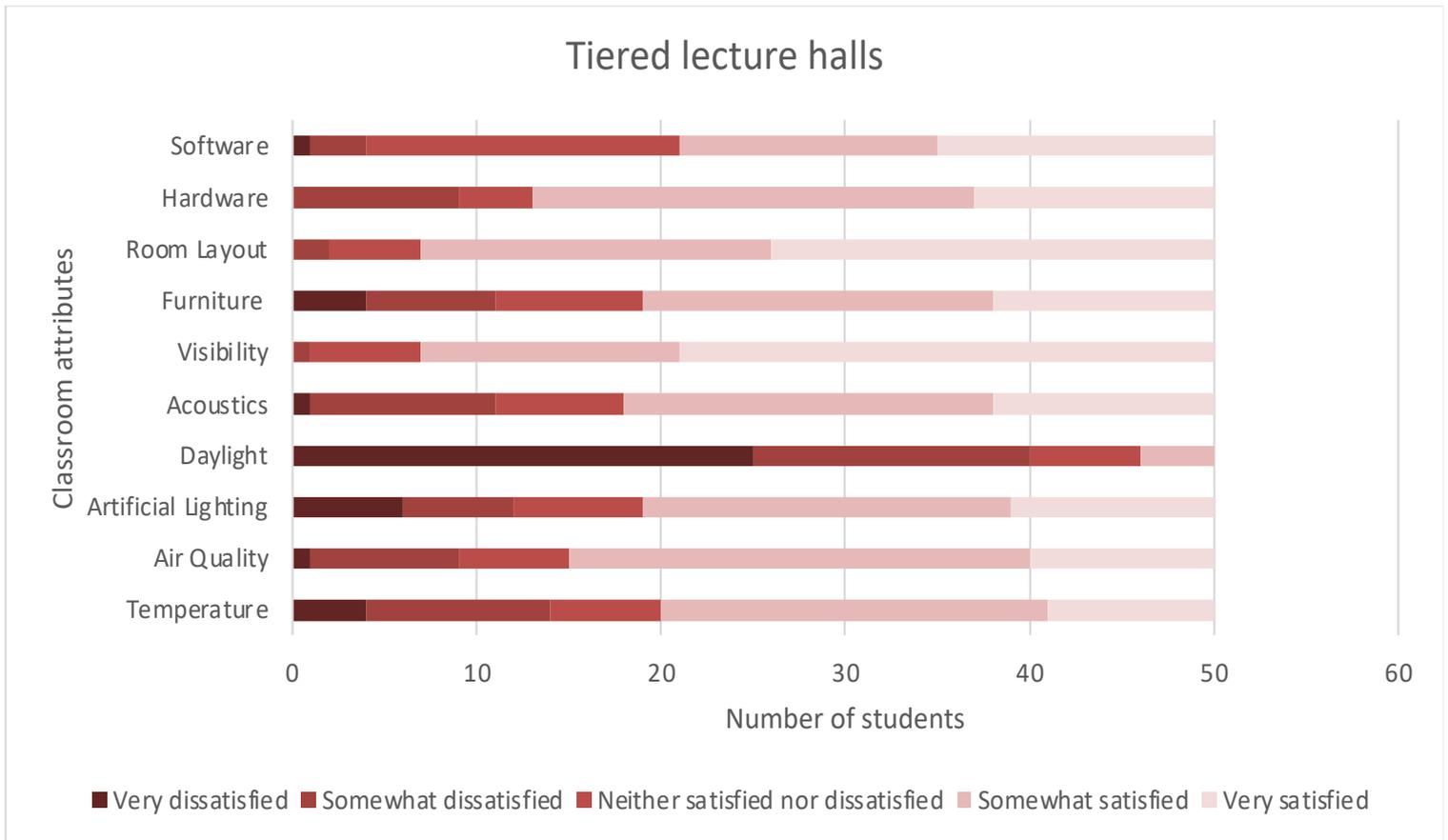


Figure 4

A horizontal stacked bar chart displaying students' satisfaction votes with each classroom attribute within Flat classrooms.

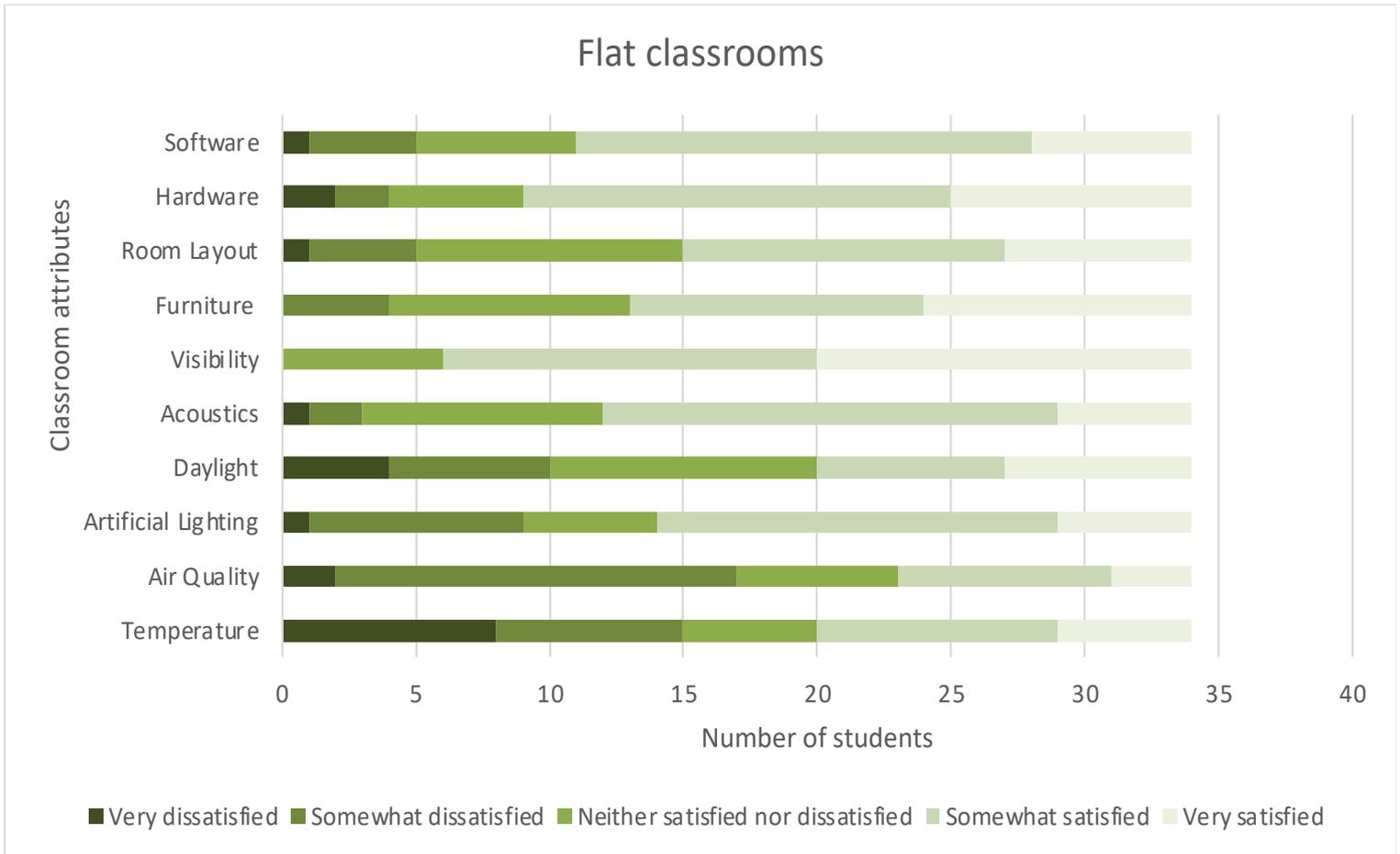


Table 7*Votes for satisfaction per classroom attribute in percentiles in Interactive classrooms.*

Interactive classrooms					
	Very dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Very satisfied
Temperature	5.1%	15.3%	8.5%	49.2%	22.0%
Air Quality	3.4%	16.9%	23.7%	37.3%	18.6%
Artificial Lighting	1.7%	8.5%	15.3%	45.8%	28.8%
Daylight	3.4%	15.3%	10.2%	32.2%	39.0%
Acoustics	3.4%	6.8%	10.2%	37.3%	42.4%
Visibility	11.9%	6.8%	11.9%	33.9%	35.6%
Furniture	3.4%	11.9%	11.9%	32.2%	40.7%
Room Layout	13.6%	11.9%	11.9%	25.4%	37.3%
Hardware	0.0%	16.9%	22.0%	33.9%	27.1%
Software	3.4%	15.3%	15.3%	23.7%	42.4%

Table 8*Votes for satisfaction per classroom attribute in percentiles in Tiered lecture halls.*

Tiered lecture halls					
	Very dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Very satisfied
Temperature	8.0%	20.0%	12.0%	42.0%	18.0%
Air Quality	2.0%	16.0%	12.0%	50.0%	20.0%
Artificial Lighting	12.0%	12.0%	14.0%	40.0%	22.0%
Daylight	50.0%	30.0%	12.0%	8.0%	0.0%
Acoustics	2.0%	20.0%	14.0%	40.0%	24.0%
Visibility	0.0%	2.0%	12.0%	28.0%	58.0%
Furniture	8.0%	14.0%	16.0%	38.0%	24.0%
Room Layout	0.0%	4.0%	10.0%	38.0%	48.0%
Hardware	0.0%	18.0%	8.0%	48.0%	26.0%
Software	2.0%	6.0%	34.0%	28.0%	30.0%

Table 9

Votes for satisfaction per classroom attribute in percentiles in Flat classrooms.

Flat classrooms					
	Very dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Very satisfied
Temperature	23.5%	20.6%	14.7%	26.5%	14.7%
Air Quality	5.9%	44.1%	17.6%	23.5%	8.8%
Artificial Lighting	2.9%	23.5%	14.7%	44.1%	14.7%
Daylight	11.8%	17.6%	29.4%	20.6%	20.6%
Acoustics	2.9%	5.9%	26.5%	50.0%	14.7%
Visibility	0.0%	0.0%	17.6%	41.2%	41.2%
Furniture	0.0%	11.8%	26.5%	32.4%	29.4%
Room Layout	2.9%	11.8%	29.4%	35.3%	20.6%
Hardware	5.9%	5.9%	14.7%	47.1%	26.5%
Software	2.9%	11.8%	17.6%	50.0%	17.6%

4.2.2 Inferential statistics

A one-way between-groups analysis of variance (ANOVA) was conducted to explore students' satisfaction with three different classroom types (Interactive classrooms, Tiered lecture halls, Flat classrooms). Assumption tests were preliminarily conducted for the one-way between-groups ANOVA. Levene's test for homogeneity of variance was not violated for the first analysis (see Appendix H). The SPSS output for ANOVA can be seen in Appendix I. There was no significant difference seen in students' satisfaction between the three-room types: $F(2, 140) = 2.760, p = .67$. Power = .527.

4.3 Analysis 2- DV2 Classroom attributes impact on performance

4.3.1 Descriptive statistics

The total of participants in each group of room type were the same as analysis one, shown in table 10. The mean and standard deviation for classroom attributes impact on performance within the three-room types are presented in table 11 below.

Table 10

Summary of the distribution of participants in between room types.

Room type	N
Interactive classrooms	59
Tiered lecture halls	50
Flat classrooms	34
Total	143

Table 11

Summary of rounded mean and standard deviation scores for impact on performance within each room type. (Labelled ImpDV2)

Room type	Mean	Std. Deviation
Interactive classrooms	3.86	.65
Tiered lecture halls	3.74	.55

Flat classrooms	3.46	.70
Total	3.72	.64

The following figures 5, 6 and 7 summarise classroom attributes impact on student performance within in the three-room types from the Likert scale votes. Regarding the use of percentages for more detail, the following tables 12, 13 and 14 include the percent of classrooms attributes impact on students' performance votes between the three classroom types.

Figure 5

A horizontal stacked bar chart displaying students' votes for each classroom attributes impact on performance within Interactive classrooms.

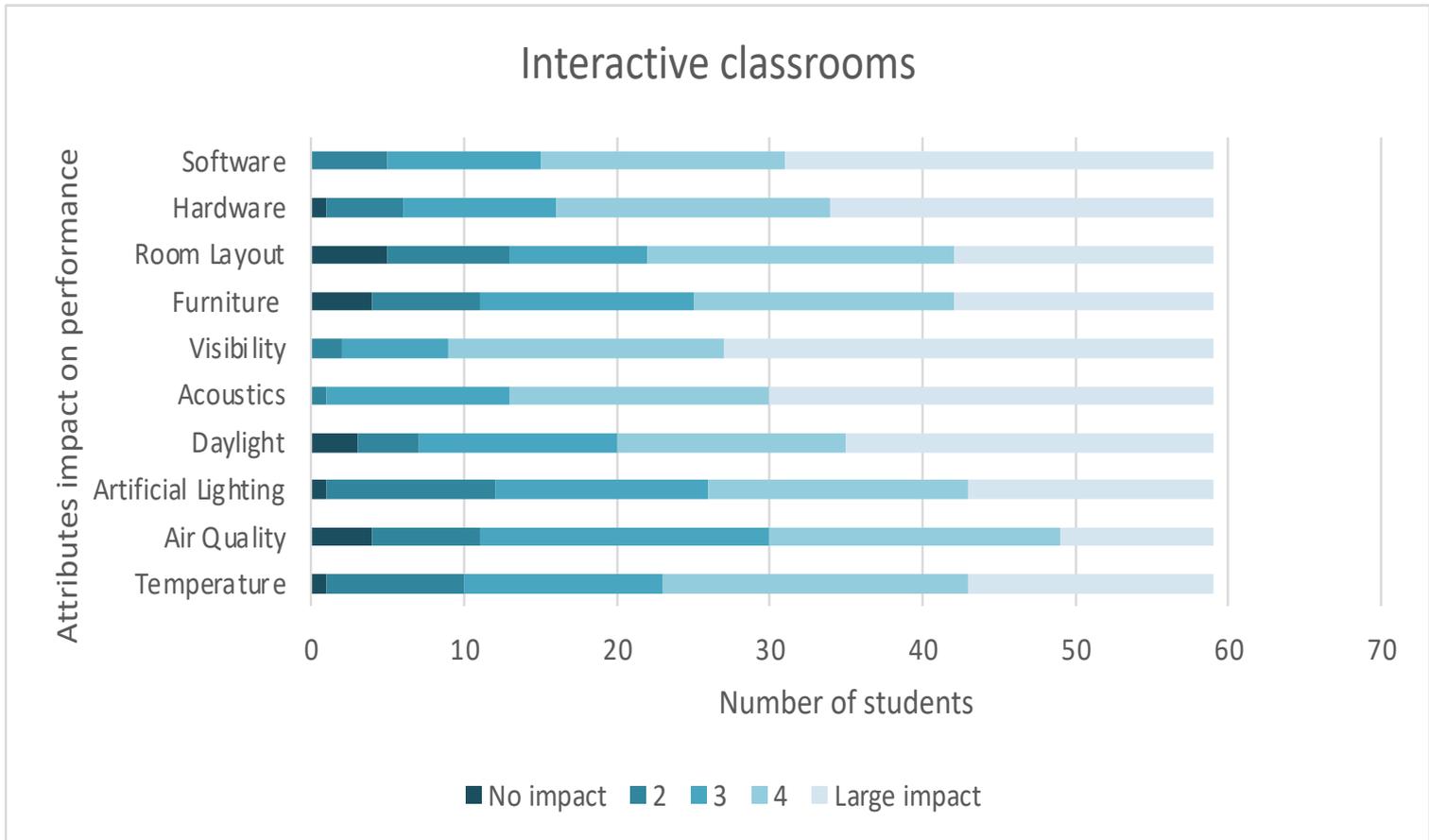


Figure 6

A horizontal stacked bar chart displaying students' votes for each classroom attributes impact on performance within Tiered lecture halls

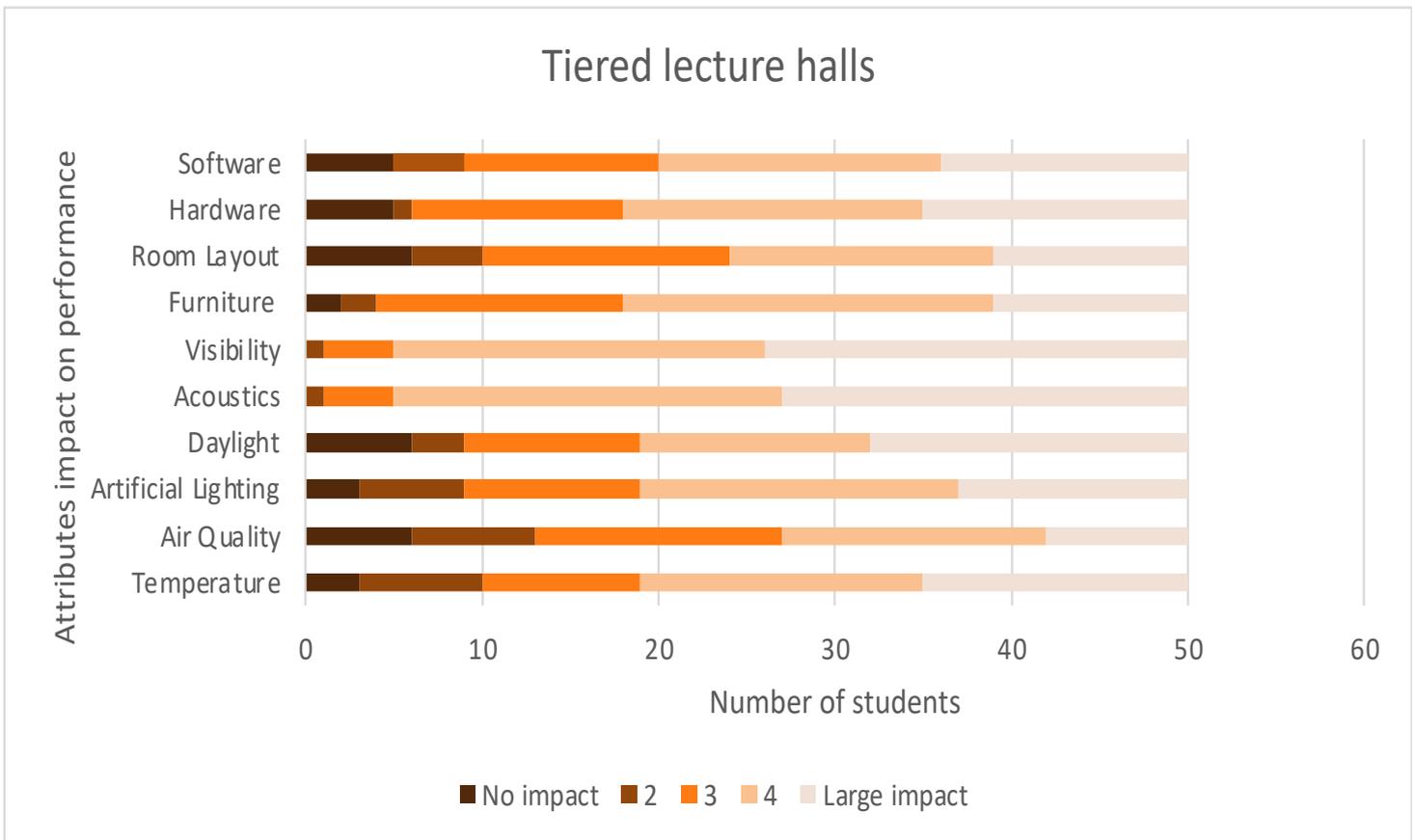


Figure 7

A horizontal stacked bar chart displaying students' votes for each classroom attributes impact on performance within Flat classrooms.

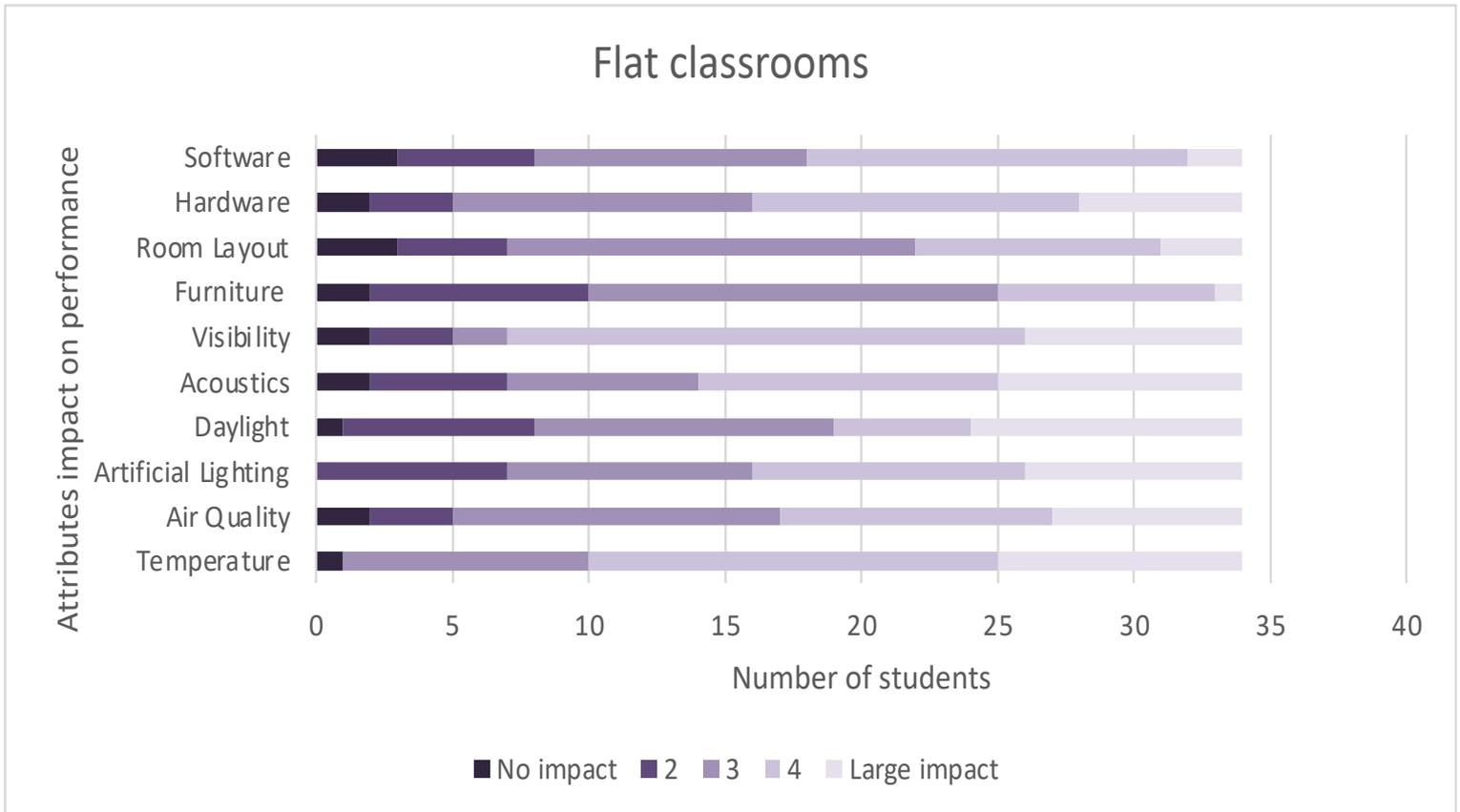


Table 12

Votes for classroom attributes impact on performance in percentiles in Interactive classrooms.

Interactive classrooms					
	No impact	2	3	4	Large impact
Temperature	1.70%	15.30%	22.00%	33.90%	27.10%
Air Quality	6.80%	11.90%	32.20%	32.20%	16.90%
Artificial Lighting	1.70%	18.60%	23.70%	28.80%	27.10%
Daylight	5.10%	6.80%	22.00%	25.40%	40.70%
Acoustics	0.00%	1.70%	20.30%	28.80%	49.20%
Visibility	0.00%	3.40%	11.90%	30.50%	54.20%
Furniture	6.80%	11.90%	23.70%	28.80%	28.80%
Room Layout	8.50%	13.60%	15.30%	33.90%	28.80%
Hardware	1.70%	8.50%	16.90%	30.50%	42.40%
Software	0.00%	8.50%	16.90%	27.10%	47.50%

Table 13

Votes for classroom attributes impact on performance in percentiles in Tiered lecture halls.

Tiered lecture halls					
	No impact	2	3	4	Large impact
Temperature	6.0%	14.0%	18.0%	32.0%	30.0%
Air Quality	12.0%	14.0%	28.0%	30.0%	16.0%
Artificial Lighting	6.0%	12.0%	20.0%	36.0%	26.0%

Daylight	12.0%	6.0%	20.0%	26.0%	36.0%
Acoustics	0.0%	2.0%	8.0%	44.0%	46.0%
Visibility	0.0%	2.0%	8.0%	42.0%	48.0%
Furniture	4.0%	4.0%	28.0%	42.0%	22.0%
Room Layout	12.0%	8.0%	28.0%	30.0%	22.0%
Hardware	10.0%	2.0%	24.0%	34.0%	30.0%
Software	10.0%	8.0%	22.0%	32.0%	28.0%

Table 14

Votes for classroom attributes impact on performance in percentiles in Flat classrooms.

Flat classrooms					
	No impact	2	3	4	Large impact
Temperature	2.90%	0.00%	26.50%	44.10%	26.50%
Air Quality	5.90%	8.80%	35.30%	29.40%	20.60%
Artificial Lighting	0.00%	20.60%	26.50%	29.40%	23.50%
Daylight	2.90%	20.60%	32.40%	14.70%	29.40%
Acoustics	5.90%	14.70%	20.60%	32.40%	26.50%
Visibility	5.90%	8.80%	5.90%	55.90%	23.50%
Furniture	5.90%	23.50%	44.10%	23.50%	2.90%
Room Layout	8.80%	11.80%	44.10%	26.50%	8.80%
Hardware	5.90%	8.80%	32.40%	35.30%	17.60%
Software	8.80%	14.70%	29.40%	41.20%	5.90%

4.3.2 Inferential statistics

A one-way between-groups analysis of variance (ANOVA) was conducted to explore the impact of classroom attributes on students' performance between three different classroom types (Interactive classrooms, Tiered lecture halls, Flat classrooms). Assumption tests were preliminarily conducted for the one-way between-groups ANOVA. Levene's test for homogeneity of variance was not violated for the first analysis (see Appendix J). The SPSS output for ANOVA can be seen in Appendix K. There was a significant difference for impact of classroom attributes on students' performance between the three-room types: $F(2, 140) = 4.315, p = .015$. The effect size was small ($\eta = .058$).

Post hoc analysis was carried out using Bonferroni. These results showed a significant difference in the impact on performance between the interactive classrooms and flat classrooms ($p = .015, 95\% \text{ C.I.} = [.0685, .7241]$). Means and Standard deviations are shown in Table 15 below. Figure 8 displays the mean differences. Students within the two other room types did not differ significantly.

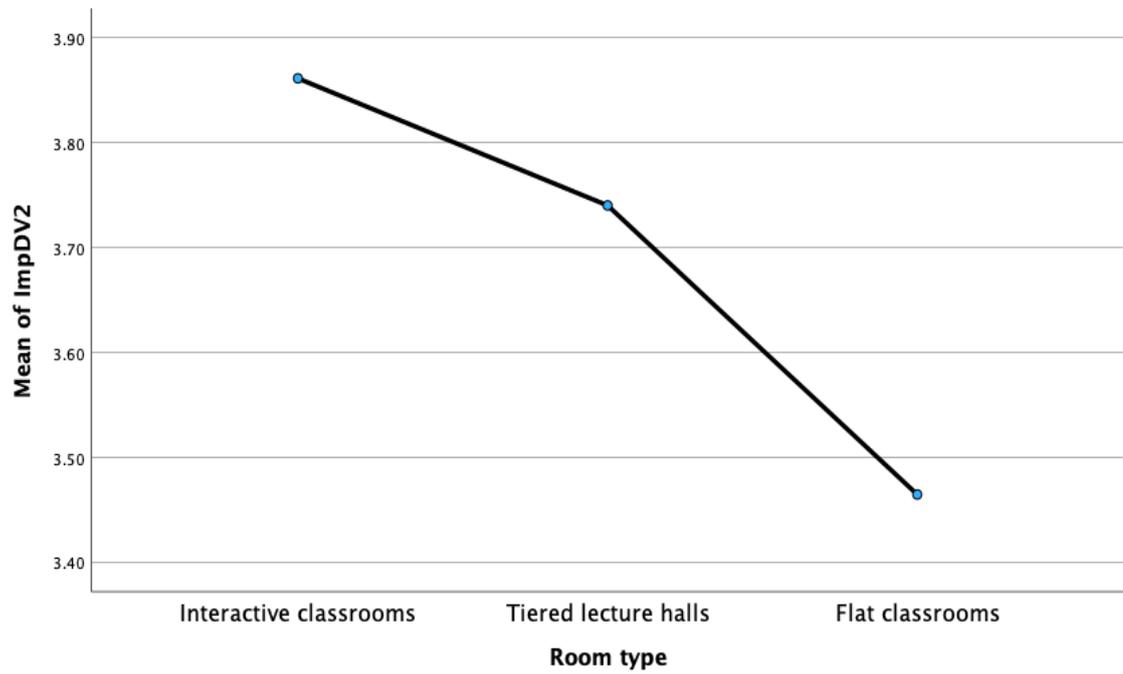
Table 15

Mean and standard deviation for classroom attributes impact on performance.

	N	Mean	Std. Deviation
Interactive classrooms	59	3.8610	.64967
Tiered lecture halls	50	3.7400	.54884
Flat classrooms	34	3.4647	.69669
Total	143	3.7245	.64275

Figure 8

Means plot showing differences of impact on performance for the three-room types.



Results will be discussed in the next section.

5. Discussion

5.1 Overview of findings

The purpose of the present study aimed to investigate 1) if there was a difference in students' satisfaction with their classroom attributes depending on the room type and 2) if there was difference in classroom attributes impacting students' performance depending on the room type. Three room types were involved: Interactive classrooms (IC's), tiered lecture halls (TLH's) and flat classrooms (FC's). Findings suggested that satisfaction with classroom attributes did not differ significantly depending on room type. Descriptive statistics indicated that students were overall somewhat satisfied with each room type this was shown through means tables and figures. Although, classrooms attributes impacting students' performance saw a significant difference based on room type, specifically IC's, and FC's.

Hypothesis one stated there would be a difference in students' satisfaction with classrooms attributes based on the room type. This hypothesis was not supported. The present study's findings do not coincide with previous research. Jin and Peng (2022) looked at students' satisfaction with many elements in different room types. Specifically concluding with physical environment aspects, students were most satisfied with the traditional lecture rooms over the active learning classrooms. This study used a mixed methods approach to data collection, a survey and interview process. This may contribute to the difference in findings with the current study as more detail and aspects were investigated. Similarly, within a study by Hill and Epps (2010), lecturers taught classes within two room types. A significant difference in students satisfaction based on the room type was found. Large differences between each of the two classrooms features and attributes were exclusively mentioned. Considering the current study had some presence, absence or contrast of different attributes in each room type (e.g. rooms had similar windows, furniture, and lighting), may have contributed to the lack of statistical significance. Although it is important to mention

these presence, absence or contrast of different attributes in each room type have potential to hinder significance but they also may contribute to significance in findings too. Hence, an additional open ended question at end of a survey like Yang et al. (2013) may confirm, deny or allow students to comment on these potentials. Hill and Epps (2010) also stated that each room type had an approximately equal size of participants. This may also explain difference in findings from the present study as group sizes between the three room types did differ and may have impacted this.

Hypothesis two stated that there would be a difference, in classrooms attributes impact on students' performance, based on room type. This hypothesis was supported. A statistical significance was seen between IC's and FC's. An explanation for this difference and in contrast to analysis 1 may be the presence, absence or contrast of certain aspects within each attribute, between rooms. For example most IC's had a variety of technology access, variety of different furniture types and potential visibility restrictions. On the other hand FC's had no student accessible computers, standard furniture types and no presence of obvious visibility restrictions. Comparing two room types impact on performance, a study with similar findings by Xi et al. (2017), investigated university students' seating choices in different classrooms and how the classrooms impacted their academic performance. They concluded that students were most satisfied with medium sized rooms over any other room type. Attributes within rooms also had an impact on the students' performance overall. This coincides with the significant difference in room type impacting students' performance in the present study. Another similar study by Byers et al. (2018) that looked at students' perceptions with and performance within innovative vs traditional learning environments, and how these settings affected learning. Conclusions saw differences in students' performance based on the classroom type. Students' performance was impacted and bettered when learning in innovative learning environments vs their peers in traditional ones.

5.2 Strengths of the present study

This study provided a unique insight to students' outlooks and opinions of the classroom settings they learn in daily. Very little research has been explored or reported around college classroom environments within Ireland. Therefore, as these individuals

spend the most time in these settings and work on enriching their learning, getting their outlook is crucial in research. It adds an exclusive and personal perspective. Secondly the study consisted of a relatively large sample size of 143 participants. This provided a better representation across many students on campus in different courses. Thirdly, attending each class to gather data strengthened the study, it provided an opportunity to introduce and explain the research to students, allowing for more understanding. Lastly, the study's topic may have provided students with new information and thoughts about their learning spaces. Introducing them to ideas they may not have considered before. Providing them a space to give their opinions and on a topic that is not often spoken about in college settings.

5.3 Limitations of the present study

Firstly, the removal of predefined conditions data was notably a limitation. This was done as a second analysis would have been required. Within the timeframe and expertise at undergraduate level, this was not possible. Secondly although the sample size was a great representation of many students on campus, the group size for one of the original levels in 'room type' variable was too low. Originally 'design studio' variable had only 17 participants, this led to combining with the 'computer labs' variable to create a new variable 'IC's'. This was possible as attributes in both rooms were quite similar. Comparing means of such unequal group sizes would have been unfair and could have skewed results. Finally, outliers within the data set were removed, similarly to the changing variables this was not ideal, but as they were significantly impacting the analysis assumptions there was no other viable option.

5.4 Theoretical and practical implications

Theoretical implications

A theoretical implication included how this research may align with principals in the 'Person environment fit theory', defined as the fit between someone's characteristics or actions with the environment they are in. Emphasising individuals influence on their environment and the environment's impact on them (Holmback et al., 2008). Students'

satisfaction with classrooms attributes may not have differed between room types but overall, their satisfaction levels were presented through descriptives as positive, coinciding with the idea of a good fit between a students' opinions and the learning space. Similarly with classrooms impact on students' performance differing depending on the room type could be linked to 'Social Cognitive Theory'. This can be briefly described as an individual's performance being reciprocally connected and influenced by their own characteristics and their environment (Bandura, 1986). Students' performance being impacted by their classroom type indicates that the connection between a student and a certain environment can make a difference and effect how they learn.

Practical implications

Based on the results of this study; the higher education registrar's office, faculty and students can be made aware of students' perspectives of the physical environments they learn in daily. This may lead or contribute to prioritising students' experience and the potential addition of students' input when designing, creating, or changing learning spaces. Ireland particularly lacks exploration of this topic in third level education settings. Many similar studies explored satisfaction and impact on performance in different countries like Jin and Peng (2022) study on students' satisfaction with two different classroom types in China and Byers et al. (2018) based in Australia and looked at two types of classrooms impact on students' performance and attitudes. The need for these perspectives on educational settings in college and universities in Ireland is needed.

5.5 Future research

Future research studies should undertake a mixed method design, this may contribute to more detail of areas within classrooms that the surveys do not cover. Hao and Florez-Perez. (2021) collected data from students using both surveys and interviews. This added more detail and gave people an opportunity to express their deeper opinions. Additionally including more demographic variables like gender, year of study,

academic level or course type may add perspective to see if they contribute to individuals outlook on a classroom environment. For instance, Jin and Peng (2022) included multiple variables within their study like academic level, gender, and discipline of study, this allowed them to report findings relating to the impact of each variable on students' satisfaction. Finally, looking into this area of research and the topic of satisfaction and impact on performance specifically for students with additional needs. Their perspectives may add more insight if differences in environments are needed for neurodivergent people within third level educational spaces.

5.6 Conclusion

To conclude, the present study contributed to research around students' satisfaction with their classroom attributes and overall learning environment depending on the room type. Additionally with classroom attributes impacting students' performance depending on the room type. Findings suggested that students' satisfaction did not differ significantly based on the room type. Although, classrooms attributes did impact students' performance significantly based on the room type, specifically IC's, and FC's. Further research is needed to explore this topic and area. With additional variables and use of different methodology, a more extensive quantity of information and detail could be gained and contributed to the field.

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7. Appendices

Appendix A: Ethical approval email

From: Grainne Kirwan <Grainne.Kirwan@iadt.ie>

Sent: Thursday 7 December 2023 16:36

To: Irene Connolly <Irene.Connolly@iadt.ie>

Subject: Exploring the impact of different IADT classrooms physical environment on students: a study measuring student satisfaction, classroom effect on performance and academic motivation.

Dear Irene

Thank you for forwarding the ethics application from Laoise Broderick

The amber route project entitled "Exploring the impact of different IADT classrooms physical environment on students: a study measuring student satisfaction, classroom effect on performance and academic motivation." has been approved by the Psychology Ethics Committee and the student may proceed with data collection whenever you deem them to be ready.

Best wishes
Grainne

Dr. Gráinne Kirwan CPsychol (BPS)

Lecturer in Psychology
Programme co-chair BSc (Hons) Applied Psychology
Chair Psychology Ethics Committee IADT
Member of IADT Governing Body
Member of Psychological Society of Ireland Council

Department of Technology and Psychology
IADT
Kill Avenue, Dun Laoghaire, Co. Dublin, Rep. of Ireland, A96 KH79

Appendix B: Information sheet

Information sheet

Title of project: The impact of different classroom environments on students' satisfaction and performance.

You are being invited to take part in the research 'The impact of different classroom environments on students' satisfaction and performance'. This project is being undertaken by Laoise Broderick for our major research project as part of the BSc (Hons) in Applied Psychology, IADT. Before you decide whether you wish to take part, it is important for you to understand why this research is being done and what it will involve. Please take time to read this information carefully and discuss it with someone you trust. If there is anything that is unclear or if you would like more information please ask, our contact details are at the end of this information sheet. Thank you for reading this.

What is the purpose of the project?

Third-level students all over the world spend a large amount of time within different types of classroom environments. Many of these have different ambient, spatial and technological attributes. For example; the lighting, layout and hardware within a room may be different. Each person can perceive and experience these aspects in various ways. Therefore, this project aims to examine if these specific attributes, within four different classroom types, will affect student's satisfaction and have an impact on their performance. Results may lead to new knowledge surrounding optimal learning environments within third level education settings. Information will be collected from undergraduate IADT students using a questionnaire.

Who is being invited to take part?

This study is for IADT students who are over the age of 18. Specially students who are in any of the four named classroom types; A flat classroom, a tiered lecture hall, a computer lab room or a design studio.

What is involved?

If you choose to participate, you will be asked a demographic question about the gender you identify as and the classroom you are taking the study in, followed by 5-point Likert scales. The first questionnaire asks you to rate your satisfaction with different attributes in the classroom, this involves using a 5-point Likert scale, 1=Very dissatisfied and 5=Very Satisfied. The second asks you to rate how these attributes impact your performance, also using a 5-point Likert scale, 1=No impact and 5=Large impact. Thirdly, you will be asked to indicate one listed predefined condition which is present and best describes the attributes in the classroom. The questionnaire will take 4-6 minutes to fill out.

Do I have to take part?

You are free to decide whether you wish to take part or not. If you do decide to take part, you will be asked to sign a consent form that lets us know you have read this information sheet and understand what is involved in the research. You are free to withdraw from this study at any time and without giving reasons. Choosing to take part or not to take part in the study will not impact your grades, assessments or future studies.

What are the disadvantages and risks (if any) of taking part?

The questionnaire used within the study addresses students satisfaction with classroom attributes and how these may impact their performance. There may be questions included that you would prefer not to answer. You may decide not to respond to these questions if you do not wish to.

What are the possible benefits of taking part?

We cannot promise the study will help you, but the information provided to us from the study will help to increase the understanding of students satisfaction with the different IADT classroom types and if aspects within the rooms impact student's performance.

How will my information be used?

Your responses to the questionnaire will be combined with all other participants data and statistically analysed. No individual data will be identifiable in the final report. The results of this analysis will be reported in the thesis for the BSc (Hons) in Applied Psychology in the Dun Laoghaire Institute of Art, Design & Technology. This can be requested through the library at IADT, or by emailing the researcher or supervisor at N00201890@student.iadt.ie or irene.connolly@iadt.ie. This study may also be published in an academic journal article and may be written about for blog posts or media articles and these can be requested from the researcher.

How will my data be protected?

Participants confidentiality will be safeguarded during and after the study. GDPR regulations will be followed by the researcher. Data collected will be anonymised and information that can be used to identify an individual will not be collected. Before beginning the study you will be asked to create a unique code that will be used to identify your data if you wish to have it removed after completing and submitting your responses. Under the EU General Data Protection Regulation (GDPR) the legal basis for collecting data for scholarly research is that of public interest. The regulations regarding the protection of your data will be followed. Only data which is needed for analysis will be collected. By giving your consent to take part in the study you are consenting to the use of your data as detailed in this information sheet.

The data will be retained by the researcher for at least one year, and may be retained for up to 7 years if the results of the study are published in certain capacities (e.g. in a journal article). There is also a possibility that the fully anonymised dataset may be submitted to a journal and made available to other researchers and academics worldwide for verification purposes, but if this occurs it will be ensured that you are not identifiable from the data.

As the supervisor on this project, I, Irene Connolly, am responsible for ensuring that all datasets will be stored in accordance with GDPR regulations and those which are not submitted to a journal will be fully deleted on or before January 2031.

Data collected from the questionnaires will be accessible to the researcher, their supervisor and the statistics lecturer only. Data will be stored securely on a password protected computer. If a data breach was to occur, the data protection officer in IADT will be informed immediately. Data will be coded in accordance with each participants unique self-generated code. You will find contact information for IADT's Data Protection Officer, Mr Bernard Mullarkey, and more information on your rights concerning your data at <https://iadt.ie/about/your-rights-entitlements/gdpr/>

Who has reviewed the study?

This study has been approved by the IADT Psychology Ethics Committee.

What if you have any questions or there is a problem?

If you have a concern about any aspect of this study, you may wish to speak to the researcher(s) who will do their best to answer your questions. You should contact Laoise Broderick at N00201890@student.iadt.ie or their supervisor Irene Connolly at irene.connolly@iadt.ie.

Thank you for taking time to read the information sheet and to anyone who chooses to participate in the study.

Date

24/01/24

Appendix C: Consent form

Consent form

Title of Project: The impact of different classroom environments on students' satisfaction and performance.

Name of Researcher/s: Laoise Broderick

Please tick boxes below

1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. *

Yes

No

2. I understand that my participation is voluntary and that I am free to withdraw at any time. *

Yes

No

3. I understand that data collected about me during this study will not be identifiable when the research is published. *

Yes

No

4. I am over 18 years of age *

Yes

No

5. I agree to take part in this study. *

Yes

No

Appendix D: Demographic form

Demographic information form

Please provide us with an anonymised code which we can use to identify your data if you later wish to have it removed from our dataset. Please do so by answering the following two questions.

6. What are the second letters of your first and last name? (For example, if your name is Jane Smith, these letters would be 'AM'). What are the last three digits of your telephone number?

*

Enter your answer

7. Gender I identify as *

- Male
- Female
- Other
- Prefer not to say

8. What room are you completing this survey in? A flat classroom, a tiered lecture hall, a computer lab room or a design studio?

*

Enter your answer

Appendix E: Debrief form

Debrief

Thank you for taking part in this study. The aim was to examine if specific attributes, within four different classroom types, will affect student's satisfaction and have an impact on their performance.

Withdrawal information

If you have any questions about this study, or if you would like to withdraw your data from the study, please contact the researcher or supervisor at N00201890@student.iadt.ie or irene.connolly@iadt.ie. In your email let them know your unique ID code for example what are the second letters of your first and last name? (For example, if your name is Jane Smith, these letters would be 'AM'). What are the last three digits of your telephone number? If you submit a request for data removal, all data collected from you will be securely deleted. You will be able to remove your data from the study until February 19th 2024 when the data will be combined and analysed. Data removal will not be possible after that date. Please keep a copy of this information in case you wish to remove your data after leaving this screen.

Data protection

Your data will be treated according to GDPR regulations. You will find contact information for IADT's Data Protection Officer, Mr Bernard Mullarkey, and more information on your rights concerning your data at <https://iadt.ie/about/your-rights-entitlements/gdpr/>.

Thank you again for taking the time to participate in this research.

If you have any questions about this study, please contact the researcher or supervisor at N00201890@student.iadt.ie or irene.connolly@iadt.ie.

Appendix F: The Impact of classroom attributes on student satisfaction and performance survey

Student Satisfaction with Classroom Attributes

Using the scale below, in regard to the current classroom you are seated in, please indicate your satisfaction level with each of the different classroom attributes listed.

9. *

	1. Very Dissatisfied	2. Somewhat dissatisfied	3. Neither satisfied nor dissatisfied	4. Somewhat satisfied	5. Very Satisfied
Rate your satisfaction with the Temperature in this classroom:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rate your satisfaction with the Air Quality in this classroom:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rate your satisfaction with the Artificial Lighting in this classroom:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rate your satisfaction with the Daylight in this classroom:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rate your satisfaction with the Acoustics (the audio contact with instructor and the ability to hear the presenter, etc) in this classroom:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rate your satisfaction with the Visibility (ability to see the blackboard, whiteboard, projector, visual aids, etc) in this classroom:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rate your satisfaction with the Furniture in this classroom:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rate your satisfaction with the Room Layout in this classroom:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rate your satisfaction with the Hardware (projector, computer, clicker, smart board, etc) in this classroom:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rate your satisfaction with the Software (software installed on classroom computers, and the internet) in this classroom:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Impact of Classroom Attributes on Students Performance

Using the scale below, in regard to the current classroom you are seated in, please indicate the level of impact each of the different classroom attributes listed have on your performance.

10. *

	1. No Impact	2.	3	4.	5. Large Impact
Rate the degree to which you believe the Temperature in this classroom impacts your performance	<input type="radio"/>				
Rate the degree to which you believe the Air Quality in this classroom impacts your performance:	<input type="radio"/>				
Rate the degree to which you believe the Artificial Lighting in this classroom impacts your performance:	<input type="radio"/>				
Rate the degree to which you believe the Daylight in this classroom impacts your performance:	<input type="radio"/>				
Rate the degree to which you believe the Acoustics (the audio contact with instructor and the ability to hear the presenter, etc) in this classroom impacts your performance:	<input type="radio"/>				
Rate the degree to which you believe the Visibility (ability to see the blackboard, whiteboard, projector, visual aids, etc) in this classroom impacts your performance:	<input type="radio"/>				
Rate the degree to which you believe the Furniture in this classroom impacts your performance:	<input type="radio"/>				
Rate the degree to which you believe the Room Layout in this classroom impacts your performance:	<input type="radio"/>				
Rate the degree to which you believe the Hardware (projector, computer, clicker, smart board, etc) in this classroom impacts your performance:	<input type="radio"/>				
Rate the degree to which you believe the Software (software installed on classroom computers, and the internet) in this classroom impacts your performance:	<input type="radio"/>				

Predefined conditions (removed before analysis began)

Predefined Conditions For Classroom Attributes

Please tick **one** box for each question below to indicate which predefined condition is present, and best describes the attributes in the current classroom you are seated in.

11. Which factor would you use to describe the Temperature in the classroom? *

- Heat from sun
- Heat from classroom equipment
- Cold air from windows
- Cold air from AC unit or vent
- Cold air from door or outside room source
- Noticeably different temperature than other classrooms or hallways
- No discomfort

12. Which factor would you use to describe the Air Quality in the classroom? *

- Comfortable
- Dirty air (polluted)
- Humid air (warm)
- Dry air (dehydrated)
- Odorous air (foul smelling)
- Drafty air
- Stuffy air (unventilated)

13. Which factor would you use to describe the Artificial Lighting in the classroom? *

- Adequate illumination
- Too bright
- Too dark
- Too much glare
- Lack of control
- Undesirable colour
- Shadows
- Flickering

14. Which factor would you use to describe the Daylight in the classroom? *

- Adequate illumination
- Too bright
- Too dark
- Too much sunlight
- Insufficient sunlight/windows
- Lack of control
- Shadows
- NA

15. Which factor would you use to describe the acoustics (the audio contact with instructor and the ability to hear the presenter, etc) in the classroom? *

- Sound from air vent/ AC
- Sound from electronic equipment
- Sound from talking inside the classroom
- Sound from talking outside the classroom
- None

16. Which factor would you use to describe the visibility (your ability to see the blackboard, whiteboard, projector, visual aids, etc) in the classroom? *

- Far from the front of the classroom
- Sight block by equipment
- Sight block by other students
- Slope of classroom
- None

17. Which factor would you use to describe the furniture in the classroom? *

Level of comfort with furniture

Furniture mobility

Number of chairs and desks

18. Which factor would you use to describe the Room layout in the classroom? *

Layout for interaction and collaboration with others

Sufficiency of space for moving around classroom

Layout of workspaces for course tasks

Appendix G: Reliability, Cronbach alpha coefficient for The impact of classroom attributes on student satisfaction and performance survey

Satisfaction

Reliability

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	143	100.0
	Excluded ^a	0	.0
	Total	143	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.703	10

Impact on performance

Reliability

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	143	100.0
	Excluded ^a	0	.0
	Total	143	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.777	10

6.8 Appendix H: Assumption tests (Analysis 1 satisfaction)

Levene's test for homogeneity of variance

Tests of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
SatDV1	Based on Mean	2.101	2	140	.126
	Based on Median	2.079	2	140	.129
	Based on Median and with adjusted df	2.079	2	128.124	.129
	Based on trimmed mean	2.111	2	140	.125

Shapiro-Wilk test for normality

Tests of Normality

Room type		Kolmogorov-Smirnov ^a			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
SatDV1	Interactive classrooms	.085	59	.200*	.971	59	.165
	Tiered lecture halls	.140	50	.016	.954	50	.050
	Flat classrooms	.135	34	.119	.978	34	.694

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Appendix I: ANOVA (Analysis 1 satisfaction)

Oneway

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Interactive classrooms	59	3.7949	.69690	.09073	3.6133	3.9765	2.00	5.00
Tiered lecture halls	50	3.5900	.50880	.07196	3.4454	3.7346	2.50	4.40
Flat classrooms	34	3.5176	.55184	.09464	3.3251	3.7102	2.10	4.70
Total	143	3.6573	.61041	.05105	3.5564	3.7582	2.00	5.00

ANOVA

SatDV1

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.007	2	1.003	2.760	.067
Within Groups	50.903	140	.364		
Total	52.910	142			

ANOVA Effect Sizes^{a,b}

		Point Estimate	95% Confidence Interval	
			Lower	Upper
SatDV1	Eta-squared	.038	.000	.108
	Epsilon-squared	.024	-.014	.095
	Omega-squared Fixed-effect	.024	-.014	.095
	Omega-squared Random-effect	.012	-.007	.050

a. Eta-squared and Epsilon-squared are estimated based on the fixed-effect model.

b. Negative but less biased estimates are retained, not rounded to zero.

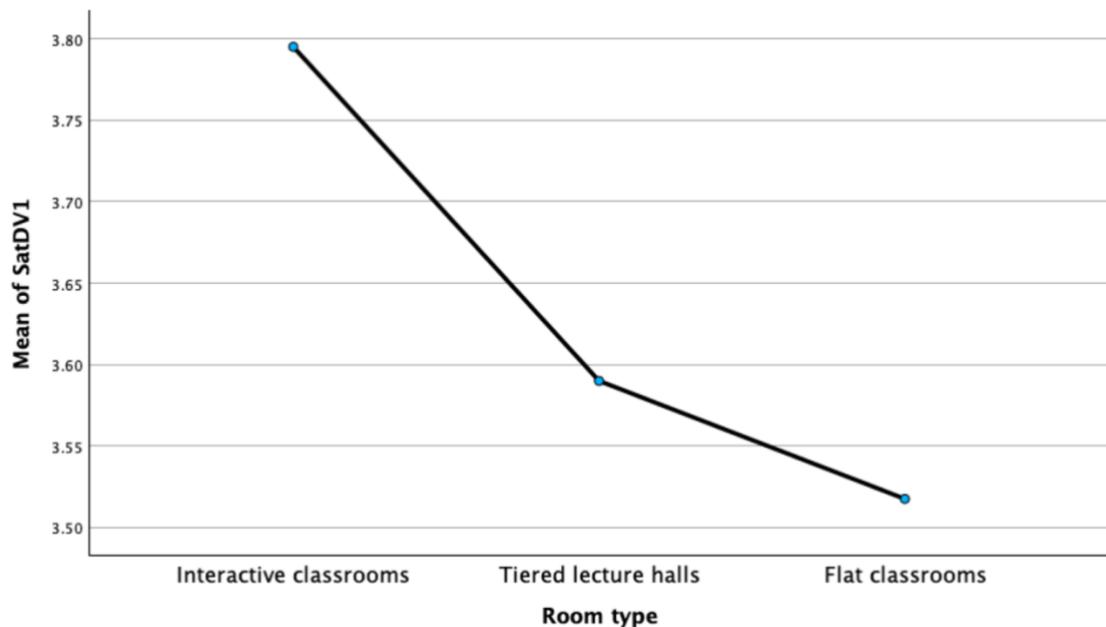
Post Hoc Tests

Multiple Comparisons

Dependent Variable: SatDV1

	(I) Room type	(J) Room type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	Interactive classrooms	Tiered lecture halls	.20492	.11591	.184	-.0697	.4795
		Flat classrooms	.27727	.12983	.086	-.0303	.5848
	Tiered lecture halls	Interactive classrooms	-.20492	.11591	.184	-.4795	.0697
		Flat classrooms	.07235	.13404	.852	-.2452	.3899
	Flat classrooms	Interactive classrooms	-.27727	.12983	.086	-.5848	.0303
		Tiered lecture halls	-.07235	.13404	.852	-.3899	.2452
Bonferroni	Interactive classrooms	Tiered lecture halls	.20492	.11591	.238	-.0759	.4858
		Flat classrooms	.27727	.12983	.103	-.0373	.5919
	Tiered lecture halls	Interactive classrooms	-.20492	.11591	.238	-.4858	.0759
		Flat classrooms	.07235	.13404	1.000	-.2524	.3971
	Flat classrooms	Interactive classrooms	-.27727	.12983	.103	-.5919	.0373
		Tiered lecture halls	-.07235	.13404	1.000	-.3971	.2524
Tamhane	Interactive classrooms	Tiered lecture halls	.20492	.11580	.221	-.0761	.4859
		Flat classrooms	.27727	.13110	.108	-.0423	.5968
	Tiered lecture halls	Interactive classrooms	-.20492	.11580	.221	-.4859	.0761
		Flat classrooms	.07235	.11889	.906	-.2188	.3635
	Flat classrooms	Interactive classrooms	-.27727	.13110	.108	-.5968	.0423
		Tiered lecture halls	-.07235	.11889	.906	-.3635	.2188

Means Plots



Power Analysis – One-way ANOVA

Power Analysis Table

	Power ^b	N ^c	Test Assumptions		Sig.
			Std. Dev.	Effect Size ^d	
Overall Test ^a	.526	143	.61041	.240	.05

- a. Test the null hypothesis that population mean is the same for all groups.
- b. Based on noncentral F-distribution.
- c. Total sample size across groups.
- d. Effect size measured by the root-mean-square standardized effect.

Appendix J: Assumption tests (Analysis 2 impact on performance)

Levene's test for homogeneity of variance

Tests of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
ImpDV2	Based on Mean	.532	2	140	.589
	Based on Median	.543	2	140	.582
	Based on Median and with adjusted df	.543	2	129.628	.582
	Based on trimmed mean	.522	2	140	.595

Shapiro-Wilk test for normality

Tests of Normality

Room type		Kolmogorov-Smirnov ^a			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
ImpDV2	Interactive classrooms	.124	59	.025	.975	59	.267
	Tiered lecture halls	.102	50	.200*	.959	50	.080
	Flat classrooms	.091	34	.200*	.978	34	.717

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Appendix K: ANOVA (Analysis 2 impact on performance)

Oneway

Descriptives

ImpDV2

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Interactive classrooms	59	3.8610	.64967	.08458	3.6917	4.0303	2.20	5.00
Tiered lecture halls	50	3.7400	.54884	.07762	3.5840	3.8960	2.70	4.60
Flat classrooms	34	3.4647	.69669	.11948	3.2216	3.7078	1.80	4.90
Total	143	3.7245	.64275	.05375	3.6182	3.8307	1.80	5.00

ANOVA

ImpDV2

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.406	2	1.703	4.315	.015
Within Groups	55.258	140	.395		
Total	58.664	142			

ANOVA Effect Sizes^{a,b}

		Point Estimate	95% Confidence Interval	
			Lower	Upper
ImpDV2	Eta-squared	.058	.002	.138
	Epsilon-squared	.045	-.012	.126
	Omega-squared Fixed-effect	.044	-.012	.125
	Omega-squared Random-effect	.023	-.006	.067

- a. Eta-squared and Epsilon-squared are estimated based on the fixed-effect model.
- b. Negative but less biased estimates are retained, not rounded to zero.

Post Hoc Tests

Multiple Comparisons

Dependent Variable: ImpDV2

		(I) Room type	(J) Room type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Tukey HSD	Interactive classrooms	Tiered lecture halls		.12102	.12076	.577	-.1651	.4071
		Flat classrooms		.39631*	.13527	.011	.0759	.7168
	Tiered lecture halls	Interactive classrooms		-.12102	.12076	.577	-.4071	.1651
		Flat classrooms		.27529	.13965	.123	-.0555	.6061
	Flat classrooms	Interactive classrooms		-.39631*	.13527	.011	-.7168	-.0759
		Tiered lecture halls		-.27529	.13965	.123	-.6061	.0555
Bonferroni	Interactive classrooms	Tiered lecture halls		.12102	.12076	.954	-.1716	.4136
		Flat classrooms		.39631*	.13527	.012	.0685	.7241
	Tiered lecture halls	Interactive classrooms		-.12102	.12076	.954	-.4136	.1716
		Flat classrooms		.27529	.13965	.152	-.0631	.6137
	Flat classrooms	Interactive classrooms		-.39631*	.13527	.012	-.7241	-.0685
		Tiered lecture halls		-.27529	.13965	.152	-.6137	.0631
Tamhane	Interactive classrooms	Tiered lecture halls		.12102	.11480	.648	-.1574	.3995
		Flat classrooms		.39631*	.14639	.026	.0375	.7551
	Tiered lecture halls	Interactive classrooms		-.12102	.11480	.648	-.3995	.1574
		Flat classrooms		.27529	.14248	.164	-.0747	.6253
	Flat classrooms	Interactive classrooms		-.39631*	.14639	.026	-.7551	-.0375
		Tiered lecture halls		-.27529	.14248	.164	-.6253	.0747

*. The mean difference is significant at the 0.05 level.

Means Plots

