ENV461H/1103H: The U of T Campus as a Living Lab of Sustainability

Classroom Comfort and Wellbeing

Group-5 Final Paper

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Abstract:

Exploring what physical features of classrooms would affect students' overall comfort and wellbeing in universities continues to be a critical initiative. Physical attributes of classrooms play an essential role in a person being comfortable; unpleasant classroom environments will influence the depth of learning (Astin, 1999) while comfortable classrooms promote a sense of well-being, keep focusing, and limit distractions (Miller, 2008). In attempting to answer the question "To what extent does classroom design affect the students' comfort and wellbeing?", this study takes a statistical approach to assess ambient and spatial attributes that can be found in University of Toronto classrooms. Since university students spend most of their time in the classrooms, classrooms on campus are a good focus to address this problem.

The study was carried out through two sources of data. The first was an online survey, with both multiple choice and open-ended short answer questions conducted across five classrooms at the University of Toronto. The data collected was supported with descriptions of the physical layouts of the classrooms selected, such as type of seating and number of windows. The five classrooms chosen for the study are run by Academic and Campus Events (ACE) as appointed by the client. One hundred surveys were conducted, in order to ask students about their classroom experience and overall satisfaction regarding classroom aspects such as temperature, lighting, note-taking spaces and so on.

By collecting and analyzing the outcomes from the online survey, the purpose of the study is to indicate physical elements of classrooms that conduce or hinder students' wellbeing. The study provides insight for further evaluation of university classrooms with an aim to ensure students receive the greatest benefit from the time spent in academic environments. The study also provides an analysis of the impacts of classroom features to offer potential solutions for creating classroom spaces that can be flexible enough to adapt to

students' diversity and enhance the learning experience for all students, regardless of their backgrounds and educational objectives. The data generated from the study will be handed over to our clients at the Sustainability Office, in order to enhance the pre-existing database which can later be used to classify students' comfort or wellbeing in the relationship with classrooms' physical layouts.

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Background/Literature Review:

Studies have shown that the design and physical characteristics of a building or room undoubtedly has an effect on the comfort and well-being of its' inhabitants. As a result of poor design inhabitants can be negatively affected in a multitude of ways, some of which they may not even be aware of. Building-Related Illnesses (BRI), which includes Sick Building Syndrome (SBS), is an entire index used to describe these negative effects which can span from acute discomfort from unknown causes to clinically defined symptoms, and everything in-between (Stadtner, 2015). These effects can be directly attributed to indoor environmental characteristics within a building or space. Furthermore, and as articulated by JKW Wong et. al. in their study regarding the relationship between building design and comfort in the workplace, it has been concluded that "the building environment affects the well-being, comfort, and productivity of humans in the workplace" (JKW Wong et. al., 2005). In contrast, well-designed buildings that maximize occupant comfort and well-being, bolsters the overall effectiveness and comfort of occupants, while also making for exciting places to work, learn, and live (WBDG, 2016). Additionally, well-designed spaces include a certain degree of support for sense of community by providing connections to the natural environment, and natural light, through windows and open spaces (WBDG, 2016).

In a study conducted by the University of Naples' Faculty of Architecture, researchers rigorously assessed building design methodology based on an ergonomic approach (Attanianese & Duca, 2010). Specifically, they studied human-centered building design processes in order to define a design methodology that supported the creation of working and living spaces that actually fit the needs of inhabitants (Attanianese & Duca, 2010). They concluded that an iterative process for architectural design activities that actively includes "human factor principles", such as users' involvement, variability, diverse considerations, and diverse standards, increases inhabitant productivity, well-being, and comfort (Attanianese

& Duca, 2010). Using these findings, by applying them to building design on the University of Toronto campus, it can be ascertained that incorporating human factor principles into architectural design on campus may in fact improve people's perception and well-being within built environments. Studies like these generally use an analytical and investigative post occupancy evaluation (POE) via semi-structured interviews or place based research methods, with the overall aim being to provide actionable or researchable feedback regarding the function and design of a building (BRE, n/a). Therefore, an identical approach has been employed for this research through a comprehensive questionnaire with a similar aim for our clients at the Sustainability Office.

The breadth of this study covers characteristics of the evaluated buildings that include things such as lighting, temperature, air quality, comfort level of seats, and available amenities. It should be noted, however, that this is a more limited approach as there exists many more categories that constitute inhabitant well-being within academic buildings. Other factors or characteristics that affect occupant well-being and comfort on campus include - safety, overall quality of facilities, levels of participation and inclusiveness, and overall levels of interaction (Muhammad et. al., 2013). Although our research, our conclusions, and our resulting recommendations touch on a few of these additional aspects, these categories represent further options for additional research to be conducted. Supplementary ideographic research could also be conducted to explore the specific relationship between building layout and mental health effects, since mental health issues are a growing dilemma among university campuses which makes it another major point that was not entirely touched on via this study.

The mixed method approach used to conduct this study, which comprised of a questionnaire that included both quantitative (close-ended) and qualitative (open-ended) questions, was influenced and informed by the study conducted by Dr. Guerra-Santin, et. al (Guerra-Santin et. al., 2016). The researchers also used a similar mixed method approach in

order to determine occupant behaviour and building performance, in their study. Their approach integrated information on occupants' behaviour, which was the qualitative aspect, and attitudes regarding indoor conditions, which was the quantitative aspect (Guerra-Santin et. al., 2016). As a result, their findings were much more broad, and furthered their depth of understanding more than what would be possible had they been using a single method approach. For these reasons, a similar approach was taken for this study. We then analyzed the data gathered by this method via comprehensive comparisons and pattern discovery in order to establish relevant conclusions and recommendations.

While discussing our method, however, it should be noted that studies related to multidimensional POE tools highlight some of the shortcomings of our approach (Candido et. al., 2016). Although the main aim of POE tools has remained the same (Candido et. al., 2016), over the course of a few years POE tools have been iterated on, improved, and adapted. Furthermore, using a multivariate data analysis methodology would likely increase the accuracy and effectiveness of our recommendations and conclusions, given that a multivariate approach is the most adequate way to analyze data obtained from a mixed method approach (Pripp, 2012). Despite these inherent issues, our client finds that feedback ascertained from this study has the potential to be helpful in influencing areas for further research and points of discovery.

Methodology:

Five buildings from different departments on campus, operated by ACE, were selected as our objects to conduct the research. The selected buildings are the Bahen Centre for Information Technology (BA1130), Convocation Hall (CH), the Earth Sciences Centre (ES1050), Galbraith Building and the George Ignatieff Theatre (GI). In order to study the relationship between the classroom physical environment and the students' comfort and

wellbeing, two sources of data were conducted in the research, including a survey questionnaire and the physical layouts of the selected classrooms.

Primary data was collected from the survey questionnaire which consists of both quantitative questions (via Likert scale) and qualitative questions (via open-ended responses). Based on the clients' suggestions and the results of group discussion, we designed a questionnaire with a mix of 14 multiple choice questions and short answer questions, asking students about multiple factors that may attribute to their wellbeing. These questions covered areas including amenities, acoustics, accessibility, cleanliness, lighting, seating, air quality, and work surface. Moreover, each physical factor listed in the survey forms an independent variable. 20 students from each site were surveyed and a total of 100 responses were collected for data analysis. Given that the surveys were conducted during different times of the day, it is possible that it had an influence on the conditions of a classroom such as natural light levels, temperature, and air quality. Time stamps were recorded to keep the data more concise and precise while conducting the survey. Participants were asked to complete the questionnaire as they were leaving the classroom, to increase the accuracy of the data as a result of fresh insights on how they just experienced the class they exited.

In addition to collecting data from the questionnaire, group members observed a general layout and conditions of each of the classrooms to help with data analysis. To minimize subjectivity, information about some physical conditions, including classroom size, furniture type, number of seats, and number of windows was observed and used as a secondary tool to compare and support the survey results of five chosen classrooms.

The survey results were analyzed individually at each site and comparisons were made to provide students' preferences among these five classrooms. Furthermore, potential changes and improvements of classrooms based on our survey results were evaluated and

proposed to our clients at the Sustainability Office. Finally, Excel was used to help with data conditioning and analysis by organizing survey results and providing charts and tables.

Main Finding:

Certain aspects of classroom design are believed to hinder students' comfort and wellbeing; thus, it can also be anticipated that these aspects affect students' productivity. Generally, the physical parameters of a classroom factors into if students feel either positively or negatively towards built environments. As a rule of thumb, the higher the classroom standards are, the higher the students' comfort and overall productivity will be. This study was conducted in order to establish the effects, and patterns of the physical parameters present in five of the selected classrooms.

Seating arrangement seemed to have a substantial impact on the students' comfort in classrooms. That said, there is no well-established seating layout that can potentially fulfill all situations since seating is multi-component dependent (e.g., room size, number of students, etc.). The majority of respondents (i.e. > 60%) felt that the seats are poorly set in both Convocation Hall and Earth Sciences. The chairs in theatre style classrooms, such as GI and CH, are rigid allowing for limited flexibility when operating at maximum capacity. This arrangement is also disadvantageous given that it constrains students to a very limited space. On the other hand, the overall response to seating in Behan Center was quite positive. This indicates that students feel more comfortable with movable seats that are arranged in a multi-layered manner. This could be attributed to the fact that students can have a higher degree of freedom to move the chairs while still being able to view the stage. The results collected from the Galbraith building were split in half, with half of the respondents being satisfied with the seating and the other half unsatisfied. This could be due to the fact that the classroom in GB is on a single level, meaning students who sit in the middle or at the back of the class can potentially have troubles seeing the front.

Proper note-taking space or desk size is another essential factor in hindering students' comfort. There is a variety of writing-surface configurations including continuous tables, individual tables, and folding arm tables. Approximately two-thirds of the participants felt that the note-taking space in the classrooms of Earth Sciences and George Ignatieff is not satisfactory. Based on these findings it can be inferred that students do not prefer folding arm tables. This could be due to several reasons such as small surface size, and limited accommodation for left handed students. In response to the question of note-taking space in Convocation Hall, the majority (i.e., > 80%) of those surveyed were vehemently unsatisfied. Convocation Hall was not designed for use as a conventional classroom; thus, designated note-taking space was omitted. Large portion of the respondents indicated that the note-taking space in Galbraith and Bahen Center met their expectations since the configuration of writing-surfaces in these classrooms are individual or continuous tables allowing for adequate space for laptops, notebooks, water bottles etc.

Many schools are putting emphasis on renovating their classrooms to address various issues related to amenities. These amenities include electric outlets, coat racks, and internet connection due to their direct correlation to student needs. One conventional way to improve the current classroom infrastructure is to enable outlets and data plugs to be a part of the furniture currently in use. The majority of those who responded felt that Convocation Hall and Earth Sciences offers less amenities which may be due to the dated design of the buildings. On the contrary, students are more satisfied with the design of classrooms in Bahen Center since it is relatively more contemporary, with electrical outlets already being integrated into the furniture.

Acoustics and excessive noise can have an adverse impact on the students' comfort during lecturing time. The majority of students commented that the noise level in all surveyed classrooms is acceptable, i.e., neutral or satisfactory. Similar responses have been obtained in

cleanliness of classrooms, where most of the students were satisfied. Classroom temperature is an important factor that has a significant influence on students' engagement and productivity. Temperature is controllable by the students to a certain extent, as they can dress accordingly. Temperature also has a tolerable range of 22° to 28°. Most students have found that temperature is ideal in all classrooms except for rooms in the Galbraith Building where the temperature was found to be too hot.

When asked "which classroom is the most favourite/least favourite on campus?" Bahen Center was found to be the favourite classroom for 20 participants. On the other hand, Convocation Hall was chosen as the least favourite classroom by 24 participants. It should be noted, however, that out of the 20 aforementioned responses for Bahen and the 24 aforementioned responses for Convocation Hall, a whopping 45% of these responses were from participants that had just come out of the buildings when surveyed. This could be an indication of a bias in these responses, as a result. To avoid repetition, the main reasons have been discussed above since these classrooms have been determined in this study.

Limitations:

There were several factors that limited the effectiveness of our research. Not only was our initial sample size small (100) when considering that thousands of students are on campus daily, but our efforts were spread across 5 different classrooms in 5 different buildings. This meant that the sample size per site was limited to only 20 students per classroom. With a sample size this small we were not able to get a diverse set of responses, as most of the responses were collected within 1 or 2 classes. Therefore, the data may not accurately represent the broader consensus. Simply increasing the sample size will allow us to diversify the data; different majors (architecture students vs computer science students),

ages (first year vs final year), and a times of day can significantly change the perception of a classroom.

We also limited our study to a single form of research supported by the physical characteristics of the classroom. Most of the data was collected after class while the students were leaving. That said, in order to gather the data before the class dispersed completely the surveys needed to be handed out promptly, which limited the surveyor - respondent interactions resulting in most of the data being rather formal. As we were unable to ask each and every surveyee what they meant by 'neutral' (no opinion vs torn between options), the 'neutral' portion of our survey is ambiguous and left up to interpretation. People also did not feel obligated to go in depth with their responses in the open ended portions of our survey. This is evident in the when asking respondents what their favourite and least favourite classrooms on campus are. Rather than specifically naming a classroom within a building, the respondents generally responded with the building itself, rendering the data inconclusive.

Conclusion:

Physical conditions of a classroom can impact students in profound ways. Elements within learning spaces should be ergonomically designed to provide support and comfort. Our study, based on a relatively small sample size and limited research methods, suggests further research should be carried out in this field to fully validate the findings. However, our study has allowed us to conduct a basic understanding of the classroom designs, their effects on students and areas to target in order to improve the conditions that can hinder student wellbeing. Our research indicates that factors such as seating should be configured in a way that allows movement and flexibility when navigating in and around the space. Amenities in older buildings should be upgraded in order to meet contemporary standards. For example, charging devices are needed now more than ever because of the dependence on technologies,

such as tablets and laptops, for note-taking, lecture slides, etc. Moreover, larger class sizes and overcrowded classrooms are consistently related to increased levels of dissatisfaction in students. This is due to the design philosophy that looks to maximize capacity over optimizing student comfort. Alternatively, smaller classrooms with ample space for students are more conducive to student learning and productivity. Although improving these elements comes at a financial cost, the benefits of such improvements may be worth the initial fiscal expenditure given that student comfort would be significantly improved. Universities, thus, should focus more on the impacts of classroom designs and develop a cost-benefit perspective on efforts to improve classroom physical conditions in the long run.

Recommendation for Future Study:

The largest challenge our group faced when conducting the surveys was the limited man power at our disposal. With only 5 people conducting surveys, individual time constraints and clashing schedules, as well as the lecture schedules in within the chosen classrooms affected both sample size and the number classrooms we were able to cover on campus.

Our topic, which related to defining the physical aspects of classrooms affecting student wellbeing, was a broad area of study and the questions curated only managed to scratch the surface. Our questions were more specifically at the “what” of the problem without delving too deep into the “why”. In the future, it would certainly be helpful to further develop the question set so that they are able to help us gain more than a surface-level understanding. This can also help eliminate the biases that may be present in the data collected. For example, simply asking students what their favourite classroom on campus is a reflection of a certain bias given that students asked at a particular location may only be familiar (due to their fields of study) with a certain set of buildings. By refining the question

into asking which classroom out of a given set of options students prefer, we can help not only evaluate which classroom is favored but establish which classrooms the students are familiar with and which they are not.

As mentioned above, our research was limited to just conducting a survey and despite our survey providing both qualitative (open ended questions) and quantitative (likert scale) data we didn't aim to incorporate other forms of data collection (observational, behavioral mapping etc.) in our research. Supportive data can be important in understanding and explaining points discovered through our survey. If a student responds that a classroom is too hot there can be a multitude of explanations for why they felt that way. These explanations could include things such as sitting too close to the heating vents, or whether or not the room was operating at maximum capacity. Without supporting data it can be difficult to deduce the reasoning behind the responses gathered.

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Appendix A: Graphical Data

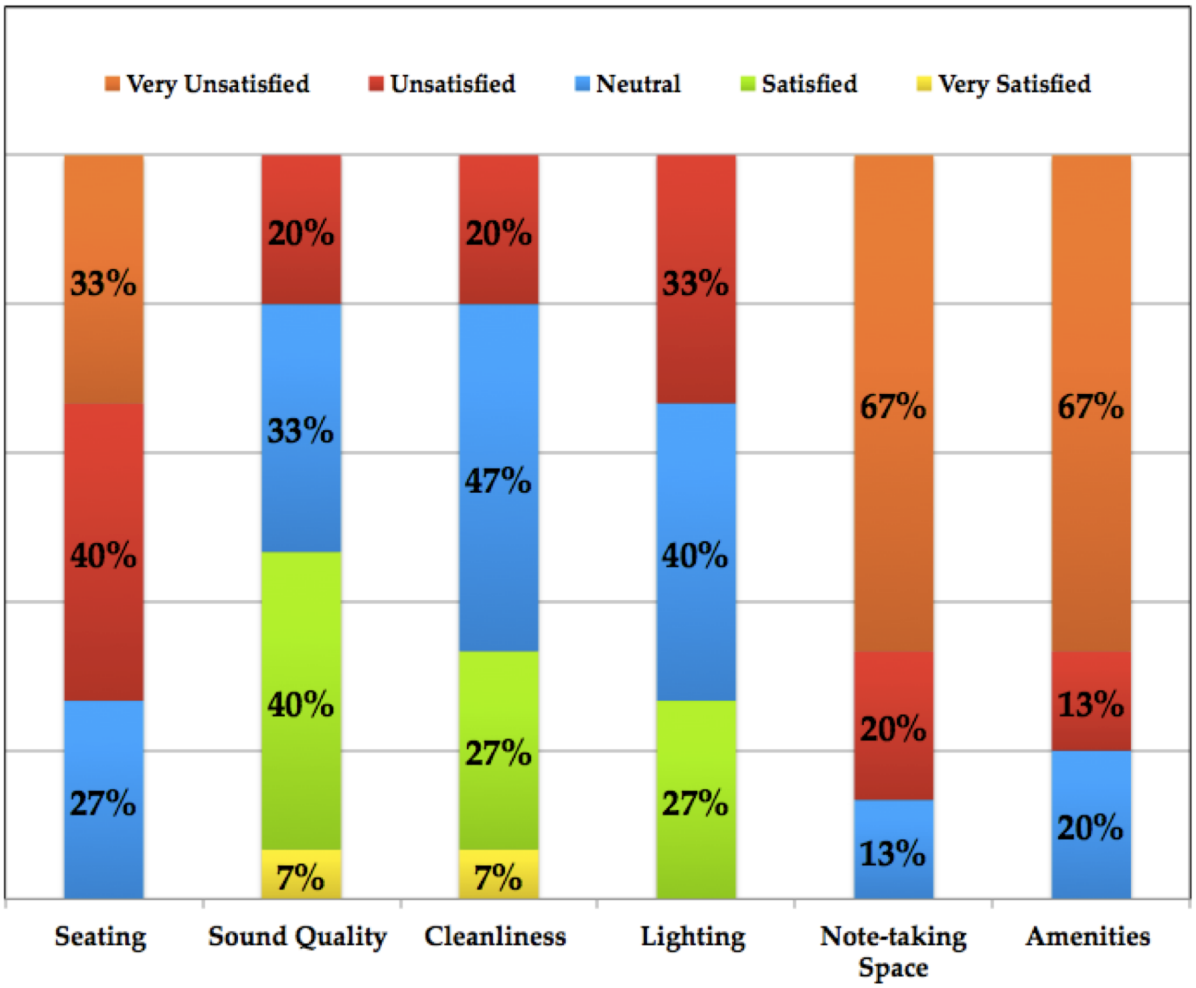


Figure 1: Data from Convocation Hall

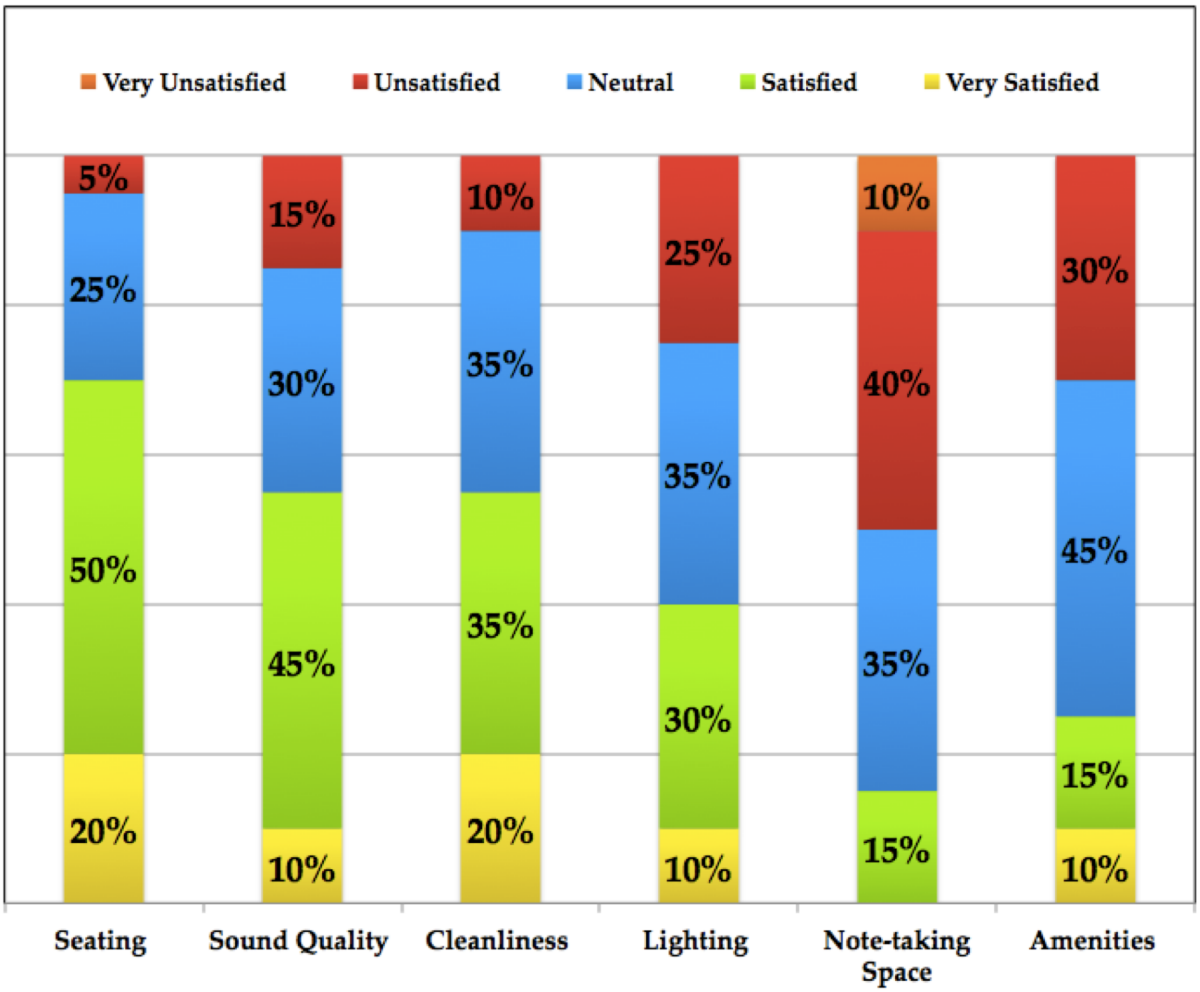


Figure 2: Data from George Ignatieff Theatre

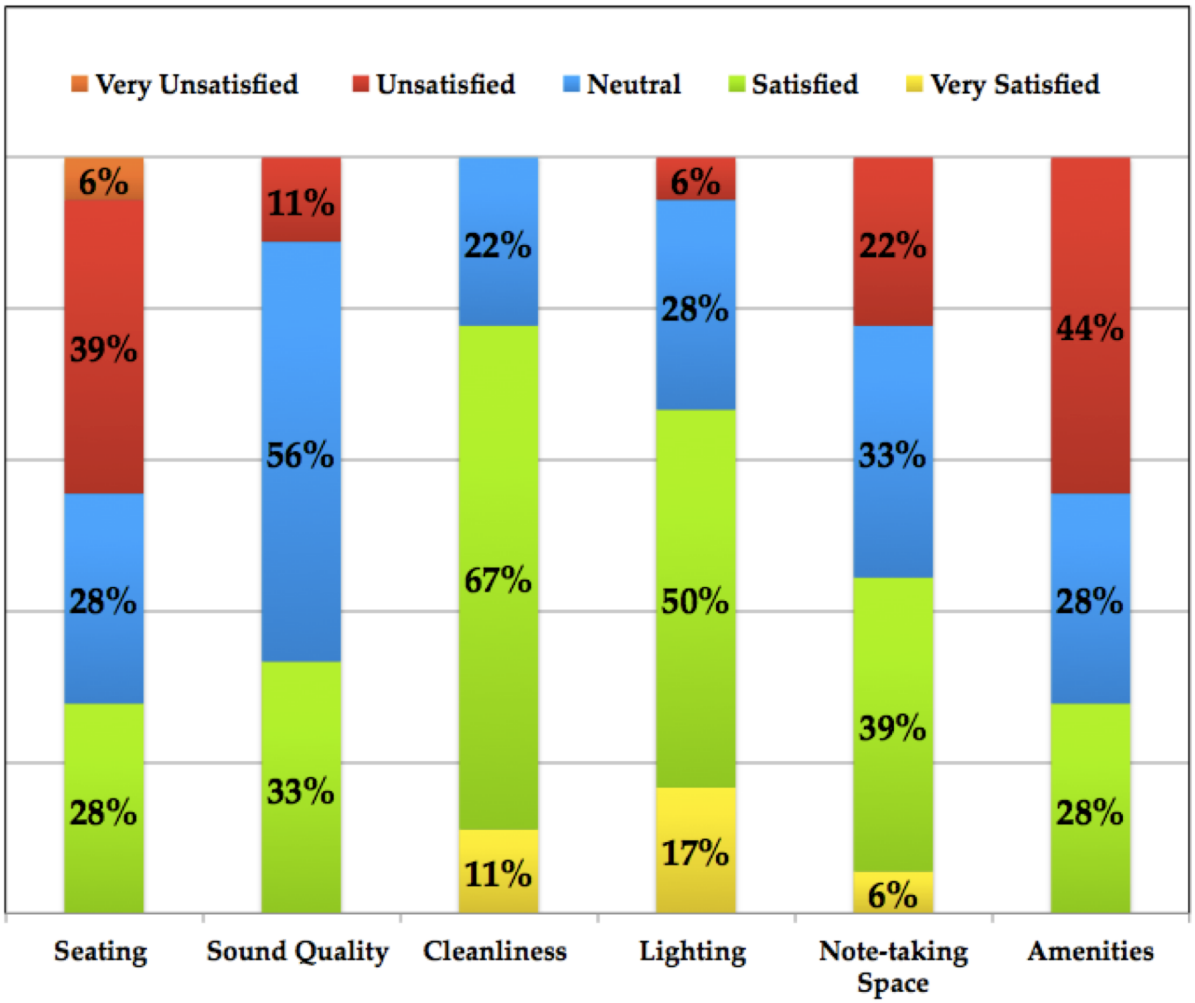


Figure 3: Data from Gabraith Building

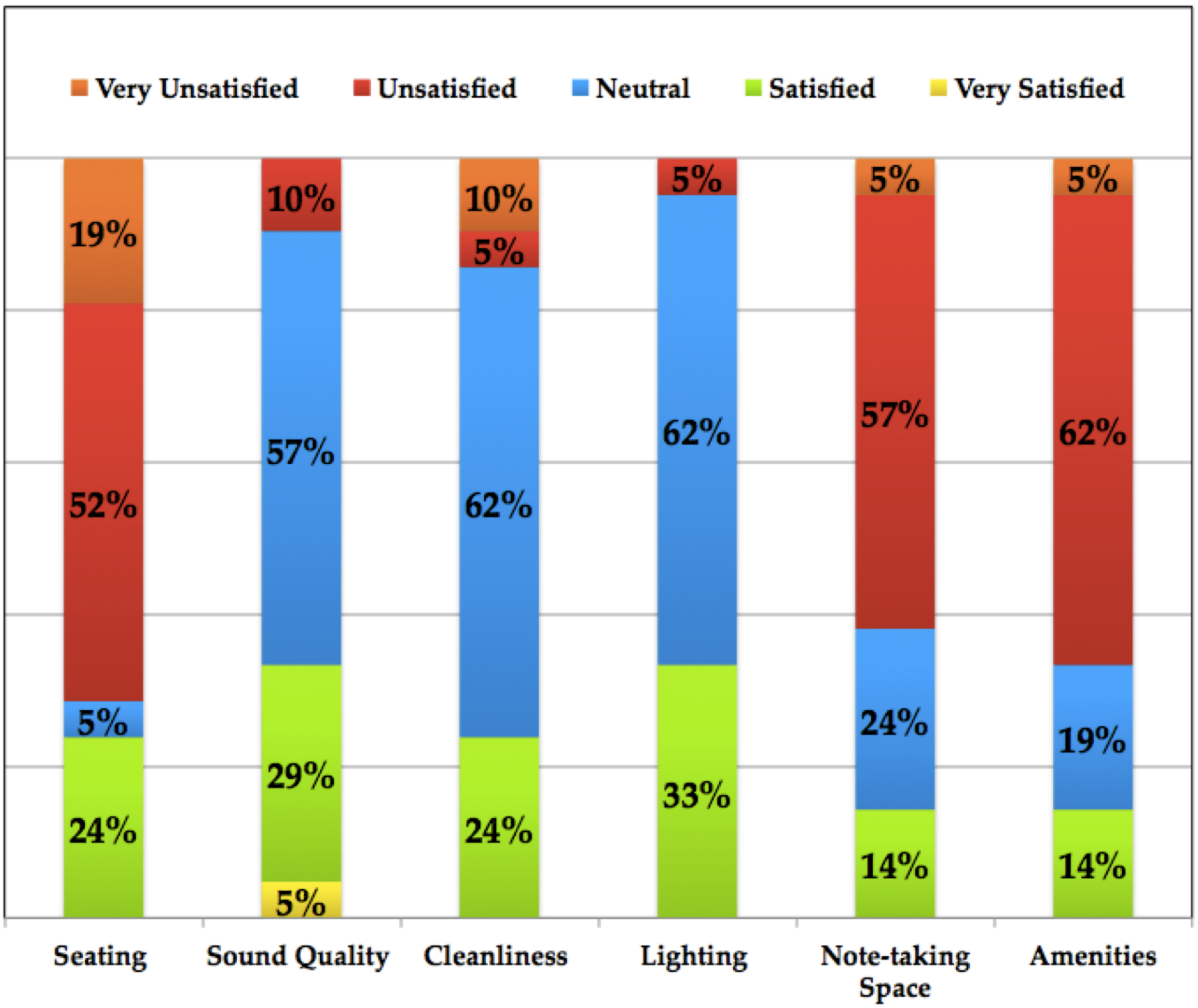


Figure 4: Data from Earth Sciences Centre

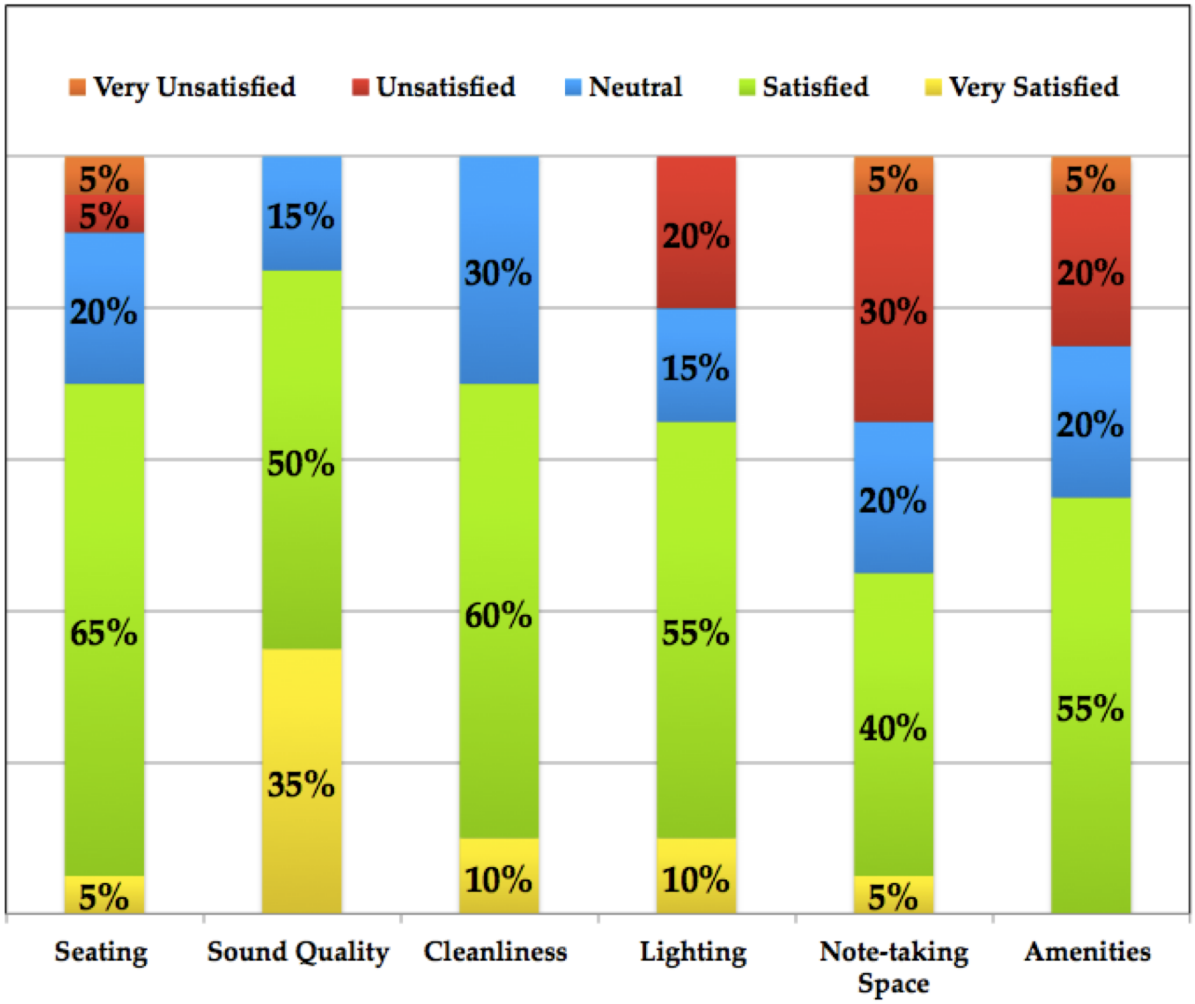
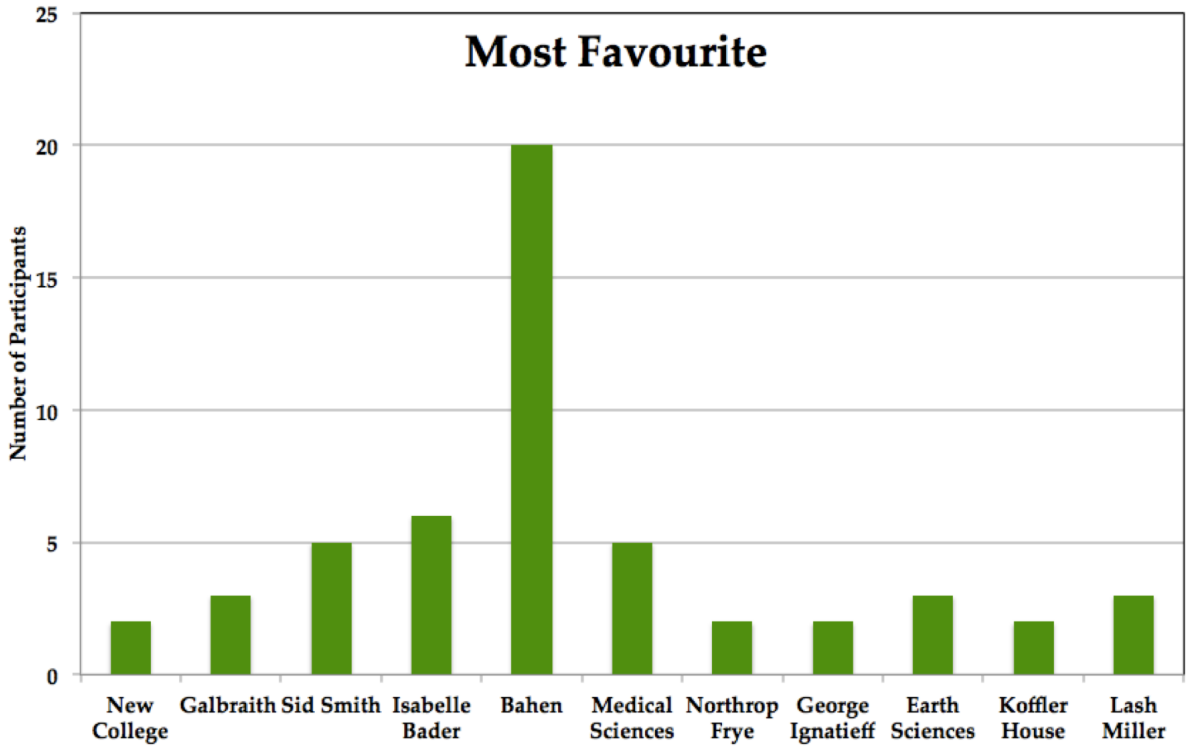


Figure 5: Data from Bahen Centre for Information Technology



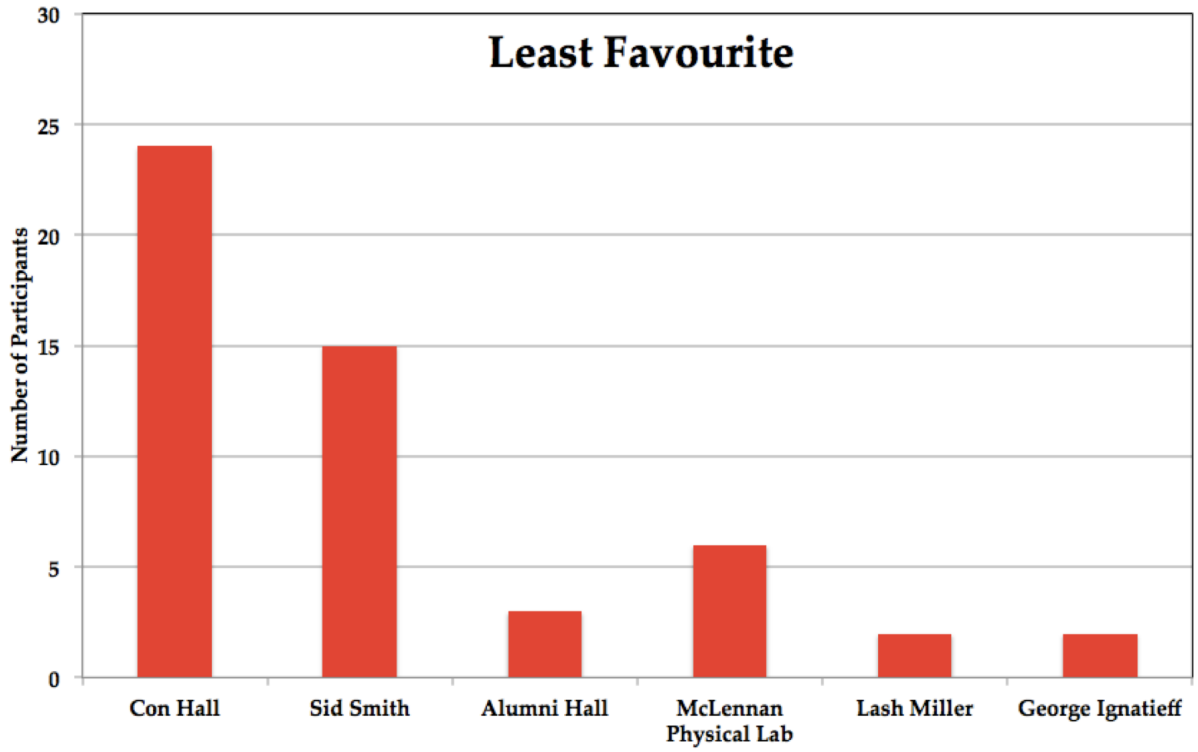
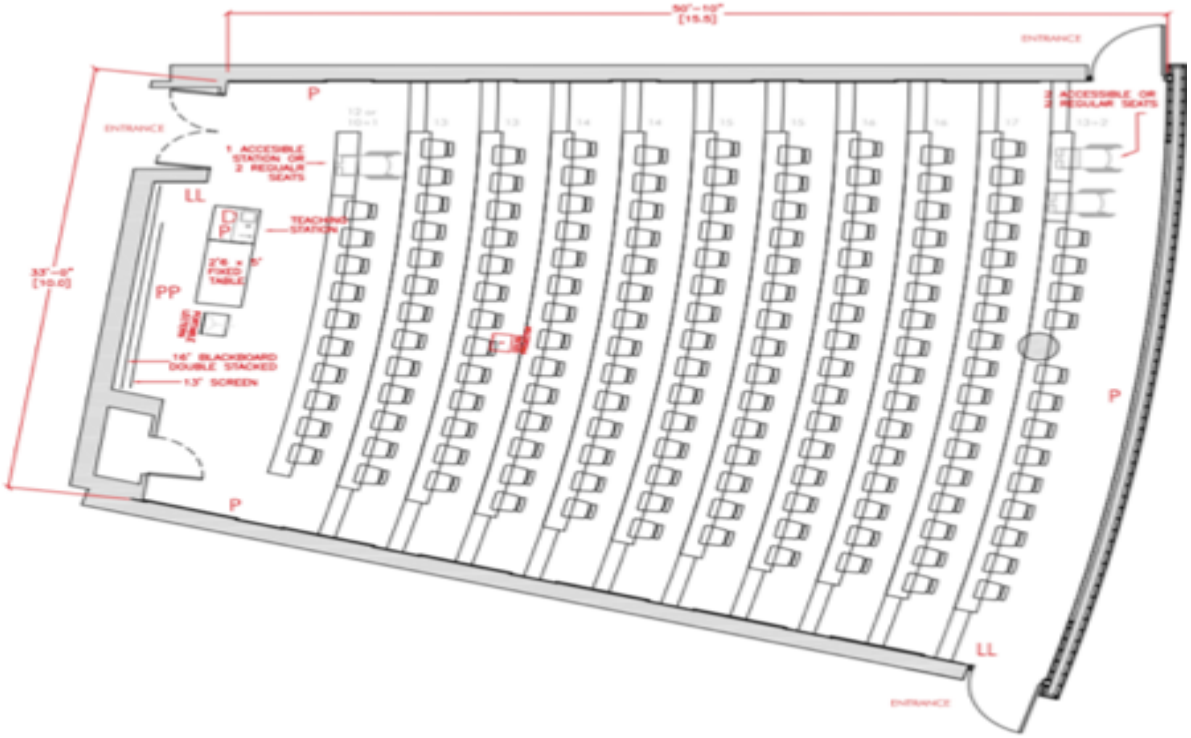


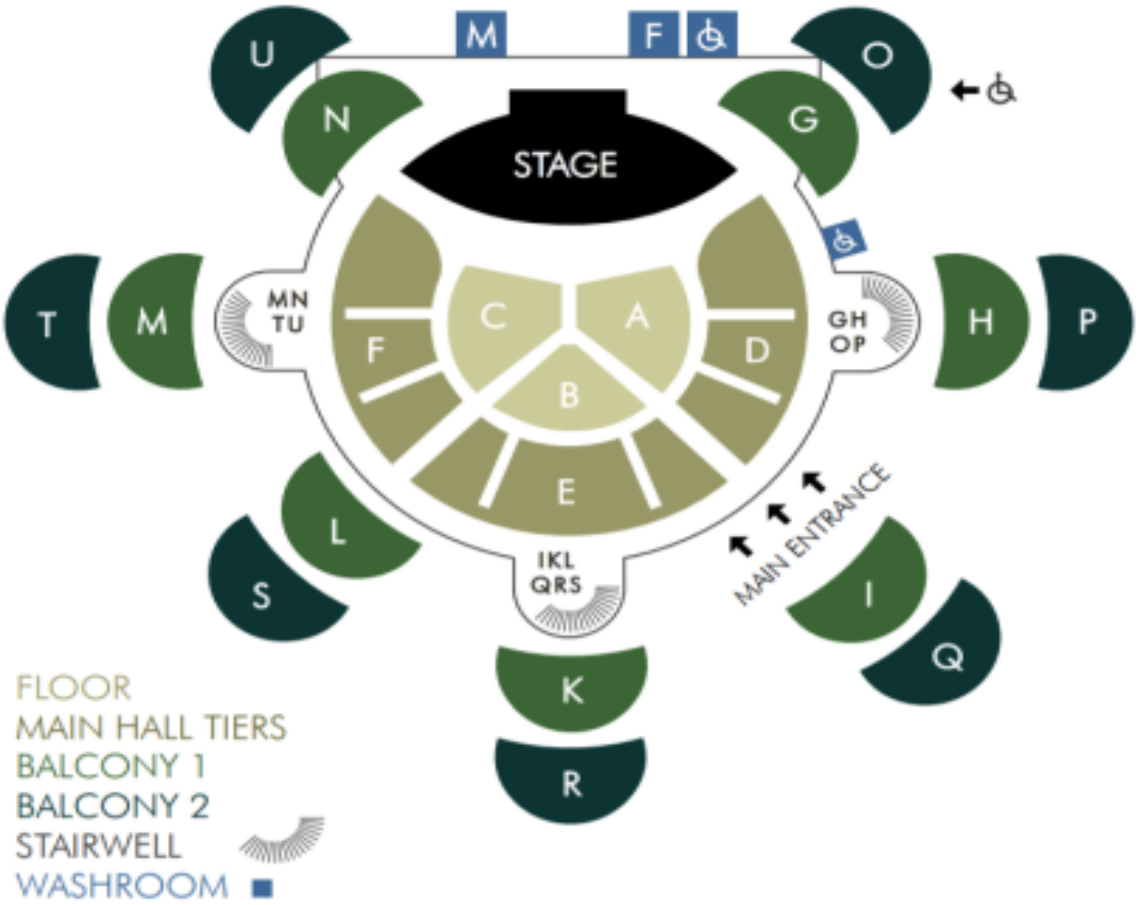
Figure 6: Data the Most and Least Favourite Classrooms.

Appendix B: Classroom Physical Layout

BAHEN CENTRE FOR INFORMATION TECHNOLOGY

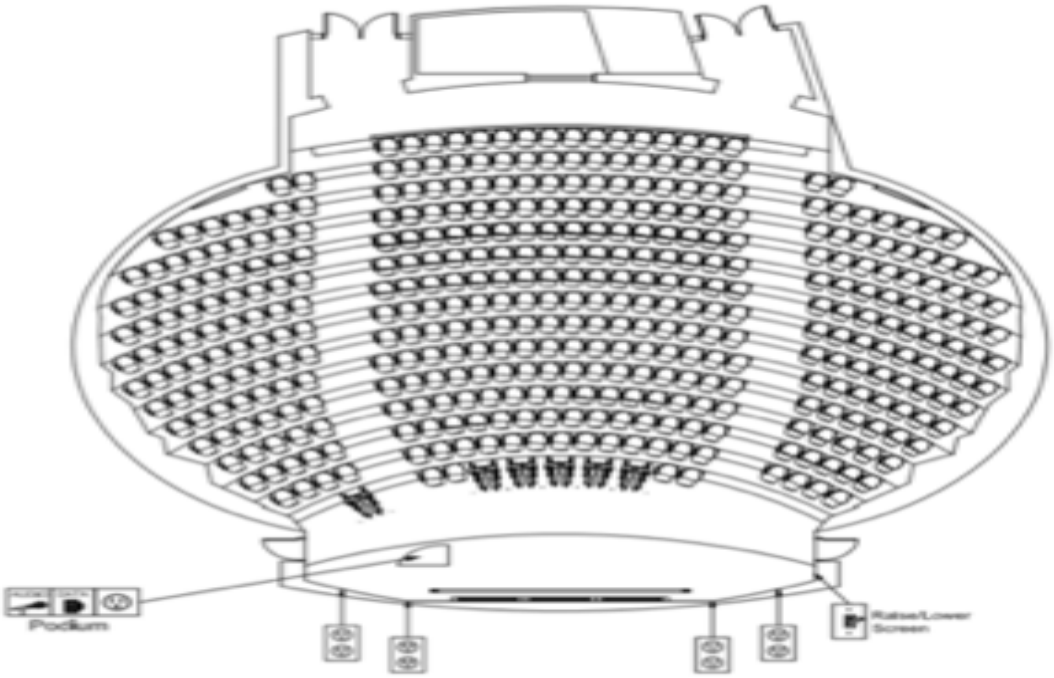


CONVOCATION HALL

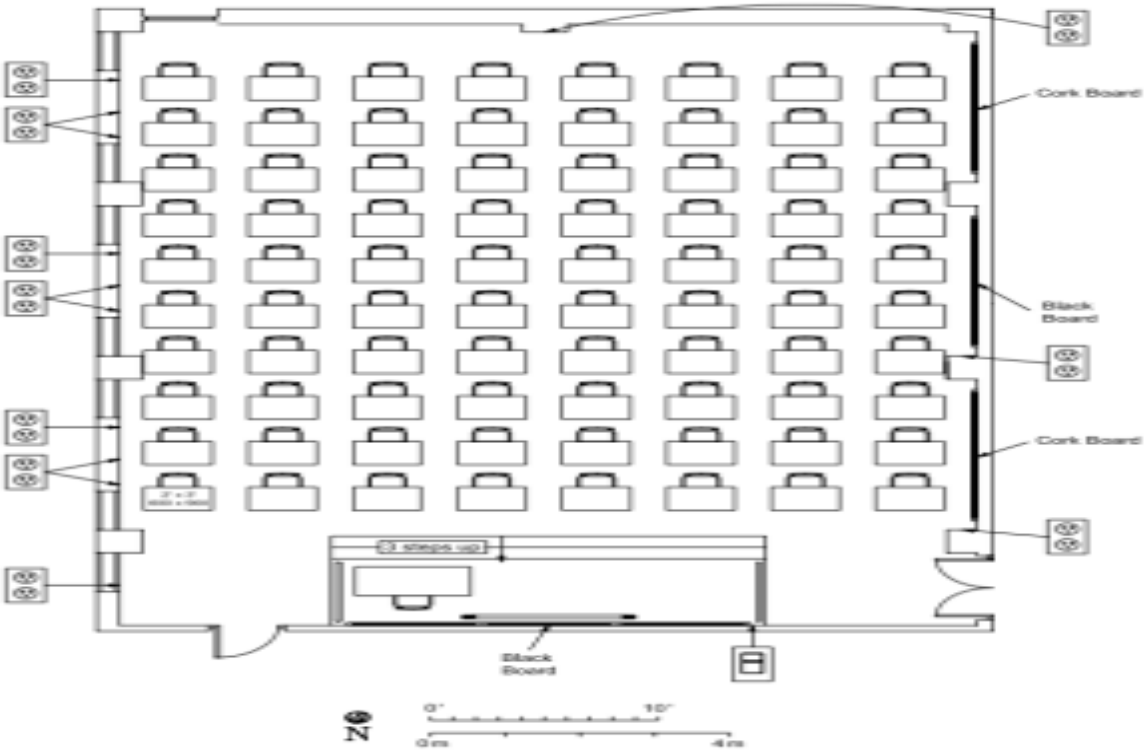


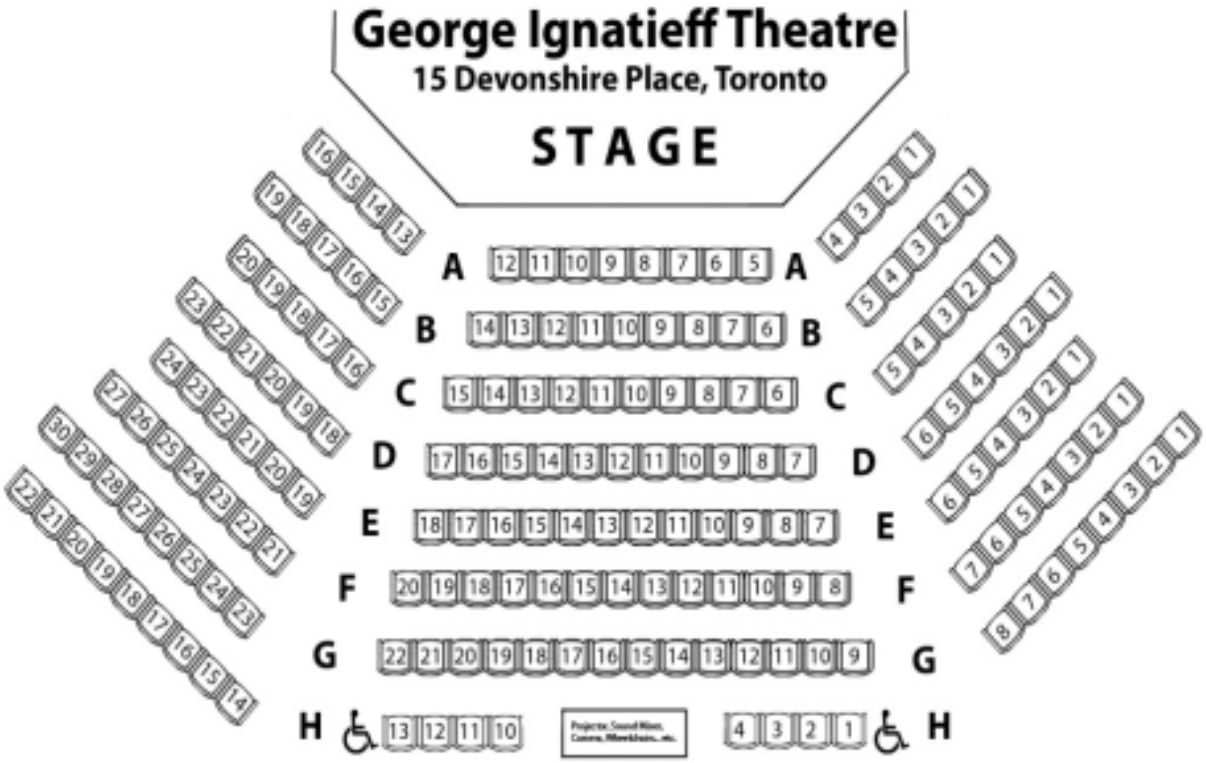
EARTH SCIENCES CENTRE

ES 1050



GALBRAITH BUILDING
GB 405


Cork Board
Black Board
Cork Board
Black Board
0'
10'
0 m
4 m


George Ignatieff Theatre
15 Devonshire Place, Toronto
STAGE
A
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