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What do engineering students want in an academic library space?

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Abstract

Prior to embarking on a major renovation of the University of Florida's (UF) science and engineering library in 2022, the library asked their patrons, including engineering students, what they wanted in an academic library space. How do engineering students use their academic library and what do they envision as an ideal space? The library teamed with the Department of Interior Design in the UF College of Design, Construction and Planning to collaborate on a study of the top two floors of the library that were slated for renovation. The goal was to develop floor plans that facilitate innovative research, creative thinking and problem-solving. The study methodology included an observational study, online survey of patrons, and focus groups. Because engineering students make up a large percentage of the library's patrons, their input was sought and incorporated in the design of the floor plans. Of the 335 responses to the survey, 25% (84 respondents) were engineering students. The results showed that 39% of the engineering students spend more than 8 hours per week in the library and during that time, they spend 77% in frequent or very frequent individual study while 42% said they use the library very frequently or frequently for group study. As for aesthetics, students want a space with clean lines, lots of power outlets, and some control over ambient features such as noise, lighting, and furniture use. They also are looking for a natural feel, with plants and neutral tones. Students want to have privacy when they work but they want to feel the comfort and energy of having others around them. This paper discusses the analysis and interpretation of the online survey results. The study methodology can be used by other engineering libraries who wish to perform an analysis of their own space usage and student design preferences.

Background

The University of Florida (UF) is an R1 public university with an enrollment of about 41,000 undergraduate students and 16,000 graduate students. The 5-story Marston Science Library (MSL) is in the center of campus and encompasses 26,000 square feet. The library serves the UF scientific community through collections in agriculture, biological sciences, chemical & physical sciences, engineering, and mathematics & statistics.

Originally constructed in 1987, the first renovations of the library began in the basement in 2014 and included the entry level floor. The renovations created new public spaces that included collaboration spaces, a visualization conference room, study rooms, and a makerspace. In 2017, the third floor of the library was renovated. As a result of these renovations, building traffic increased from approximately 700,000 visitors each year to more than 2 million annual visitors.

In 2018, when the Association of Research Libraries (ARL) initiated the Research Library Impact: Pilot Models for Scalable and Sustainable Assessment (https://www.arl.org/research-library-impact-pilots-2/), the MSL team was motivated to conduct an evidence-based assessment of how its library spaces facilitate innovative research, creative thinking, and problem-solving. The library also recognized the need for strategic planning for its fourth and fifth floors, which still had their original floor layouts and furniture from 30 years earlier. The library teamed with the UF Department of Interior Design (IND) in the College of Design, Construction and Planning. The IND had been involved in the previous renovation design for the MSL basement and entry floor and brought experience evaluating learning and mixed-use learning environments.

Literature Review

Renovating an existing library space requires a large capital expense so it is important to consider the preferences and behaviors of students. Prior to the 1990's, academic libraries were designed to maximize space for physical collections, a trend that changed with the introduction of digital collections. As more materials became available on-line, librarians began rethinking the use of their physical spaces to focus more on optimizing student learning experiences. As a result, the shift in design occurred from individual study, book-centered library spaces to a group-study learning environment [1].

Generation Z (Gen Z) college students, those born from the late 1990's to the early 2000's, expect to have choices. When it comes to space, they want to have control of their choices [2]. Controlling choices in the moment of need by the student is the definition of an ideal library space [3]. Students see their academic library as a multi-purpose destination. They use the library for both individual and group study, reference services, computer use, and meeting and socializing [4,5].

Engineering students are somewhat unique compared to students in other disciplines. They tend to search for information themselves rather than ask a librarian for assistance [6]. Engineering students participate in both individual and group study on a regular basis but they also engage in more individual study than non-STEM majors [7].

Academic libraries use space studies to understand how their spaces are used by students [8]. For a library renovation at Ohio Northern University, the library conducted a survey and used student and faculty focus groups to understand how students study and use library spaces The results indicated that students frequently work in groups and that group study was an integral part of their learning [9]. Depending upon the class and assignments, students may switch between individual study and group study. To accommodate this shift, libraries need to offer flexible spaces with multiple uses and seating options.

Library patrons often study together in a dedicated quiet space. Some students require total silence when studying while other students value noise in a space, as a challenge, but also a feature that provides a sense of togetherness. Incorporation of a variety of furniture types allows students to decide where and how to study [10].

The ideal creative environment can be very complex. Some students feel most creative working alone, while others feel more creative working collaboratively. Still other students feel that they need a mix of solo and collaborative spaces to facilitate their creativity and problem-solving abilities [11].

This study examines how engineering students use their academic library and what they envision as an ideal space. Since engineering students are one of the primary groups that use the MSL, their input was sought along with other patrons in the redesign of the fourth and fifth floors.

Methodology

Assuming that libraries need to provide a mix of private and public space, as well as independent ("I" space) and collaborative ("we") space, the MSL-IND team examined the library spaces using these interior design concepts, with an emphasis on developing tools for exploration. The MSL-IND team implemented a mixed-method study that included an online survey utilizing a checklist of 14 pairs of adjectives designed to elicit student perceptions of existing space and desired/ideal spaces. An Institutional Review Board (IRB) review of the survey entitled Association of Research Libraries' Academic Library Impact Framework Initiative, IRB # 202002105 was completed. Participation in the survey was optional and responses were anonymous.

To assess student's ideal space, the 14 adjective pairs or Adjective Checklist (ACL), developed by Gough in the mid-1960's and later expanded to include widely used creative personality subscales [12,13] was used for this study. The IND research team worked with the MSL team to adapt the ACL for use in examining student perceptions of the library spaces. The end user impressions of library spaces were gauged by utilizing pairs of contrasting adjectives (i.e., semantic differential scale).

Semantic differentials are a social science tool that measures how an individual subjectively perceives and reacts to the meaning of a concept, an object, an activity [14], or in the case of this study, a library space. Students rated a library space (library floor), using the 14 place-based, semantic differential (PBSD) adjective pairs designed to capture perceptions of specific library floors. Using a series of contrasting adjectives (i.e., descriptive word pairs with opposite meanings) that describe the potential study spaces (e.g., pleasant/unpleasant), the survey methodology asked each respondent to place their perceptions along a scale that ranged from "strongly pleasant" on one end to "strongly unpleasant" on the other, with "neutral" in the middle.

A five-point Likert scale was used to develop means that would provide comparison data points with which to review the participants' responses to the current space and their envisioned ideal space. The data were examined for outliers and only one response was removed. The survey layout was designed to indicate to the user that the adjectives were identified with the extreme ends of the scale. Analysis focused on the mean, so that individual responses could be compared between the two sets of responses, showing the movement between scores. With a minimum of outliers, this was an appropriate choice for these data.

Students were asked to focus on their perception of the current MSL spaces and their view of library spaces they might consider as ideal. Drawing on interior design methodologies, the PBSD questions included visual prompts comprising images of the current library spaces as well as images of other academic libraries from around the world. Qualitative data were obtained through open-ended questions were also used to solicit specific details about the student's perceptions of the space they "typically use" and their ideas for potential future library renovations. The questionnaire used for this study is provided in Appendix A.

To recruit students for the survey and because of COVID-19, an online questionnaire was distributed to the entire student population using email addresses acquired from the registrar's office. The survey was restricted to those who had actually visited the library at least one time. To aid their memories, images of the library were inserted into the survey.

Results

The online survey was distributed November 9-21, 2020, and 544 respondents initiated the survey. After removing incomplete data and respondents who had not yet visited the library, the data remaining for analysis was 337 completed surveys distributed across all 16 of the university's colleges. Respondents primarily represent five colleges including **Engineering (n=84),** Liberal Arts and Sciences (n=78), Agriculture & Life Sciences (n=56), Business (n=43) and Design, Construction & Planning (DCP) (n=15).

Selected for discussion are the results for the group of 84 engineering students. Of the engineering students who participated in the survey, 76% (n=64) were undergraduates and 24% (n=20) were graduate students. The general UF student population comprises 68.9% undergraduates, 22.6% graduates, and 8.5% professional or other students. The results of the complete study for all science library patrons was presented to the Association of Research Libraries in a report dated September 16, 2022 [15]. The results for all students were similar to the results for engineering students with the differences being that engineering students tend to spend more time in the library than other students and they favor the quiet study floors.

Library floor usage

The entry level to the 5-story library is on the second floor and the prescribed noise level in the library decreases as the floors ascend, with the basement being the loudest and the fifth floor being silent. The basement, renovated in 2014, includes a "commons" space that has a combination of group and individual study spaces. The second-floor entry, also renovated in 2014, and the third floor renovated in 2017, are also collaborative study floors, with the fourth and fifth floors designated as quiet and silent study floors, respectively. Table 1 presents the users' responses when asked which floor of the library they typically use.

Table 1. Library floor respondents typically use.

	Total	Basement	Entry Level	Third Floor	Fourth Floor	Fifth Floor
Total Count	84	29	6	29	11	9
Undergraduate						
Count	64	22	2	23	11	6
Percent	76%	34%	3%	36%	17%	9%
Graduate						
Count	20	7	4	6	0	3
Percent	24%	35%	20%	30%	0%	15%

Approximately 70% (n=58) of engineering students claimed to "typically" use the basement and the third-floor spaces. Twenty-four percent (n=20) of engineering students indicated they typically use the fourth and fifth floors of the library.

Interestingly, 62% (n=40) of undergraduates and 45% (n=9) of graduate engineering students used the top three floors, while 37% (n=24) of undergraduates and 55% (n=11) of graduate students used the basement and entry level floors. This finding challenges the assumption that graduate students seek quiet, individual spaces in which to work while undergraduates seek more social common areas.

Time spent in the library

Engineering students used the library for both individual and group study. The basement and third floors were primarily used by students for group study while the fourth and fifth floors were used for individual quiet study. Students were asked to estimate how much time they spend in the library each week and on the floor they primarily visit. Table 2 presents the responses indicating how many hours each week respondents typically spend in the library.

Table 2. Typical number of hours each week respondents spend in the library.

Duration Time in the Library	Total	Basement	Entry Level	Third Floor	Fourth Floor	Fifth Floor
Total Count:	84	29	6	29	11	9
<1 hour	16	8	2	4	1	1
2-4 hours	15	3	2	7	1	2
5-7 hours	20	7	2	5	4	2
8-10 hours	15	6	0	6	1	2
11+ hours	18	5	0	7	4	2

Approximately 39% (n=33) of the engineering students spent more than 8 hours per week in the library. As expected, students spent the least amount of time on the entry level floor, often just stopping in between classes or to talk with librarians at the circulation and reference desks. Students spent the most time on the third floor followed by the basement, indicating they spent a substantial time studying around others. The fifth floor was occupied the least, perhaps reflecting that it is a silent floor with no talking or group study allowed.

Activities conducted while in the library

When engineering students come to the library, what are they doing? How much time do they spend on each activity? As noted in Table 3, 77% (n=65) of the engineering students reported spending time in frequent or very frequent individual study, while 42% (n=35) said they used the library for very frequent or frequent group study.

Table 3: Frequency of library use for the following tasks.

Library Usage	Team Project	Group Study	Individual Work/Study	Socializing	Take a Break	Other
Very frequently (>4x/week)	5	11	40	3	6	3
Frequently (1-2x/week)	16	24	25	15	15	4
Infrequently (1-2x/month)	18	15	6	10	15	8
Intermittently (as needed)	20	9	6	14	15	3
Rarely (once in a while)	25	25	7	42	33	66

Observational analysis of space use, conducted during the first phase of the overall study, confirmed that seating intended for group work is often used for those working individually, especially when students visit the library in groups but are clearly engaged in individual activities.

Student Perceptions Surveyed Using the ACL

Students rated their experience in the library using 14 adjective pairs designed to capture perceptions of specific library floors. Figure 1 provides the PBSD adjective pairs used to survey student perceptions of the existing and ideal library spaces. Students were asked to indicate their feelings about the library (Strongly Pleasant = 1, Slightly Pleasant = 2, Neutral = 3, Slightly Unpleasant = 4, Strongly Unpleasant = 5). In this case, when the mean was less than 3, it meant that respondents favored the first term. When the mean was greater than 3, respondents favored the second term. The PBSD Likert Scale was used twice for each adjective pair: once to gauge students' feelings on the current space and then to focus on the students' perceptions of an ideal space.

	Strongly	Slightly	Neutral	Slightly	Strongly	
	1	2	3	4	5	
Pleasant	○	○	○	○	○	Unpleasant
Relaxing	○	○	○	○	○	Distressing
Sleepy	○	○	○	○	○	Arousing
Exciting	○	○	○	○	○	Gloomy
Energetic	○	○	○	○	○	Calm
Quiet	○	○	○	○	○	Noisy
Playful	○	○	○	○	○	Serious
Social	○	○	○	○	○	Unsocial
Collaborative	○	○	○	○	○	Self-Reliant
Public	○	○	○	○	○	Private
Informal	○	○	○	○	○	Formal
Authentic	○	○	○	○	○	Superficial
Friendly	○	○	○	○	○	Unfriendly
Crowded		○	○	○	○	Uncrowded

Figure 1. Adjective checklist.

Table 4 provides a summary of the means for both the students' current and ideal perceptions of the library space. The means for the set of adjectives based on current use indicated that respondents perceived the MSL space as more serious than playful (mean=3.4) and more calm than energetic (mean=3.2). Students felt strongly that the MSL space was more pleasant than unpleasant (mean=1.9). In general, students perceived the library to be a pleasant, relaxing, friendly, public space for serious study either as an individual or in a collaborative group.

Table 4. Means for place-based semantic differential adjectives.

	Means (n=84)		
Adjectives	**Current**	**Ideal**	**Δ**
Pleasant/Unpleasant	1.9	1.3	0.6
Relaxing/Distressing	2.3	1.8	0.5
Sleepy/Arousing	3.0	3.9	0.9
Exciting/Gloomy	2.8	2.1	0.7
Energetic/Calm	3.2	2.7	0.5
Quiet/Noisy	2.4	2.3	0.1
Playful/Serious	3.4	3.0	0.4
Social/Unsocial	3.1	2.6	0.5
Collaborative/Self-Reliant	3.1	2.2	0.9
Public/Private	2.4	2.5	0.1
Informal/Formal	2.5	2.5	0
Authentic/Superficial	2.4	1.9	0.5
Friendly/Unfriendly	2.4	1.7	0.7
Crowded/Uncrowded	2.7	3.7	1.0

When asked about their ideal space, students thought the library should be less crowded (Δ=1.0), more arousing (Δ=0.9), more collaborative (Δ=0.9), more exciting (Δ=0.7), and more friendly (Δ=0.7). The playful/serious adjective pair responses moved into the middle range of the 1-5 scale, indicating that students may have different needs, sometimes seeking energetic or playful spaces and sometimes calm and serious spaces, depending on the work or research phase they find themselves engaged in.

Student perceptions of ideal library spaces

In addition to the quantitative assessment, the research team used qualitative data to ascertain student perceptions about the library spaces they currently use and those they would ideally use. The students were asked to submit comments regarding their desires for renovations of the library. The engineering students provided 282 comments which were categorized by concepts such as aesthetics, amenities (e.g., power outlets and computers), fenestration (connection to the outdoors), and furnishings. The following is a representative sample of their suggestions for improvements:

> "A cozy spot for study breaks. Couches. Softer overall lighting with brighter lamps at tables."
> "More power outlets"
> "Different layouts of seating, more areas dedicated to collaboration"
> "A variety of seating and desk options on the 4th and 5th floors"
> "More relaxing/natural features such as indoor plants"
> "More places to sit facing the windows"
> "Update the furniture, making sure the chairs are comfortable"
> "More high tables"
> "Modern design but still maintain a comfortable/homey feel"

"More sound-absorbing materials"
"I really value that Marston prioritizes both group and individual study areas and mixes them together somewhat so I can find a quiet corner in a busy room."

The comments and survey findings indicated that students were looking for a natural feel in the space, with plants and more neutral tones. Students wanted to be able to have some privacy when they work but they also want to feel the comfort and energy of having other users around them. The ideal space would "feel more authentic" or, in design terms, reflect a use of natural lighting, more live plants, natural materials used in décor and lighting that can be managed by the student in the space (dimmers, lamps, windows with blinds). This was a theme that prior research had found in the MSL, but our work further explored and revealed how important this element is.

The results from this study were used in the MSL fourth and fifth floor renovations which began in summer 2022 and were completed in early 2023; photos are included in Appendix B. The responses from the survey for the fourth floor indicated that the students wanted the space to feel arousing, exciting, social, collaborative, friendly and uncrowded. As a note, the adjective dimensions social/unsocial and collaborative/self-reliant were statistically correlated, meaning that as the score for collaborative increased, so did the score for social. The fifth floor was desired to be more arousing and exciting and uncrowded as the fourth floor; also responses indicated an ideal space would have more playful and collaborative features. Table 5 lists the survey recommendations for each floor.

Table 5. Floor renovation recommendations based on survey responses.

Fourth floor:	**Fifth floor:**
• Increase the cubicle seating, but also provide a variety of seating • Increase space between the tables • More outlets needed • Increase visibility of restrooms • Relocate computers (less glare) • Maintain quiet zones on upper floors	• Different types of individual and group seating with focus/private spaces • Cluster spaces that define distinct zones with different characteristics (I/We, Public/Private spaces) • 1/3 collaborative, 2/3 individual space • Update finishes, lighting, amenities, etc. • Maintain quiet zones on upper floors

Conclusions

In support of a major 2022 renovation of the MSL, we asked our patrons what they wanted in an academic library space. Since engineering students make up 25% of the library users and can spend more than 8 hours per week in the library, their input was particularly important. The goal of the renovation of the top two floors was to complement the other three previously renovated floors and to ensure that students have access to the types of space and resources that they need for studying, research, innovation, and collaboration. The findings were analyzed to create a design that identified and illustrated an ideal library space, including furniture selection that maximized the potential of the libraries to foster innovation, creativity, and problem-solving competencies. Students' responses showed that they want a space with clean lines, abundant

power outlets, and some control over ambient features such as noise, lighting, and furniture use. They also were looking for a natural feel, with plants and neutral tones. Students want to have privacy when they work but they want to feel the comfort and energy of having others around them.

The most surprising finding that the team discovered was that the assumption that graduate students want an isolated, quiet-only space is faulty. The evidence in the results suggested that graduate and undergraduate students actually wanted many of the same elements in an ideal space: clean lines, clean furniture, plenty of power outlets, a variety of spaces and some control over ambient features such as noise, lighting and furniture use. The study methodology can be used by other engineering libraries who wish to perform an analysis of their own space usage and student design preferences.

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Appendix A: ARL Framework Study Questionnaire (IRB # 202002105)

This survey asks you to evaluate the current space you are working in at the Marston Science Library. You will be asked how the space **currently** makes you feel as well as how it **ideally** should function.

Important Note:

This survey is about your perceptions; therefore, there are no right or wrong answers.

This survey should take no longer than 15 minutes to complete

Q1 Have you ever visited the Marston Science Library in person?

- Yes
- No
- N/A

Q2 Please indicate which floor of the Marston Science Library you are currently using:

- Basement
- Entry level
- Third floor
- Fourth floor
- Fifth floor
- I am currently working off-site

Display This Question:

Please indicate which floor of the Marston Science Library you are currently using: = I am currently working off-site

Q3 If you are currently working off-site, can you describe which area of Marston Science Library (floor, etc.) you typically use and what you like or do not like about this space?

Q4 What, if anything, do you like about working on this floor of Marston Science Library?

Q5 Can you elaborate on what specific characteristics of the space contribute to your answer above? (Please be as descriptive as possible

Q6 What, if anything, would you improve about this floor of Marston Science Library? (Please be as descriptive as possible)

Q7 For each of the following adjective pairs, please respond to the statement by checking the box in the appropriate column. **The <u>current</u> space of Marston Science Library that I am working in feels . . .**

	Strongly	Slightly	Neutral	Slightly	Strongly	
	1	2	3	4	5	
Pleasant	○	○	○	○	○	Unpleasant
Relaxing	○	○	○	○	○	Distressing
Sleepy	○	○	○	○	○	Arousing
Exciting	○	○	○	○	○	Gloomy
Energetic	○	○	○	○	○	Calm
Quiet	○	○	○	○	○	Noisy
Playful	○	○	○	○	○	Serious
Social	○	○	○	○	○	Unsocial
Collaborative	○	○	○	○	○	Self-Reliant
Public	○	○	○	○	○	Private
Informal	○	○	○	○	○	Formal
Authentic	○	○	○	○	○	Superficial
Friendly	○	○	○	○	○	Unfriendly
Crowded	○	○	○	○	○	Uncrowded

Q8 For each of the following adjective pairs please respond to the statement by checking the box in the appropriate column. **<u>Ideally,</u> I wish this space of Marston Science Library would be . . .**

	Strongly	Slightly	Neutral	Slightly	Strongly	
	1	2	3	4	5	
Pleasant	○	○	○	○	○	Unpleasant
Relaxing	○	○	○	○	○	Distressing
Sleepy	○	○	○	○	○	Arousing
Exciting	○	○	○	○	○	Gloomy
Energetic	○	○	○	○	○	Calm
Quiet	○	○	○	○	○	Noisy
Playful	○	○	○	○	○	Serious
Social	○	○	○	○	○	unsocial
Collaborative	○	○	○	○	○	Self-Reliant
Public	○	○	○	○	○	Private
Informal	○	○	○	○	○	Formal
Authentic	○	○	○	○	○	Superficial
Friendly	○	○	○	○	○	Unfriendly
Crowded	○	○	○	○	○	Uncrowded

Q9 Is there anything else that could be improved at the Marston Science Library?

Q10 How many hours per week do you typically spend at the Marston Science Library?

- ○ <1 hours.
- ○ 2-4 hours.
- ○ 5-7 hours.
- ○ 8-10 hours.
- ○ 11 or more hours.

Q11 How frequently do you use the Marston Science Library for the following tasks?

	Never	Occasionally	Regularly
Team Project Work	○	○	○
Group Study	○	○	○
Individual Work/Study	○	○	○
Socializing	○	○	○
Taking a Break / Passing Time	○	○	○

Q12 Please list your class status

- ○ Undergraduate
- ○ Graduate
- ○ Professional
- ○ Other (please describe)

Q13 Please select your college:

- ○ Agriculture and Life Sciences
- ○ Arts
- ○ Business
- ○ Dentistry
- ○ Design, Construction and Planning
- ○ Education
- ○ Engineering
- ○ Journalism and Communications
- ○ Liberal Arts and Sciences
- ○ Nursing
- ○ Public Health and Health Professions
- ○ Health and Human Performance
- ○ Law
- ○ Medicine
- ○ Pharmacy
- ○ Veterinary Medicine

Q14 Please provide your major

_____

Q15 Please provide your age range

- 22 years and under
- 23-38 years
- 39-54 years
- 55 years or over

Appendix B: Photographs

Fourth Floor

Before the renovation

Fifth Floor

Before the renovation

After the renovation

After the renovation