Semiotic Analysis of a Science Library: Inclusion and Messaging

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The purpose of this study is to investigate what semiotic analysis can reveal about how welcoming and inclusive a science library space is for patrons. A space was examined in terms of its messaging to patrons of various genders, abilities, races, ethnicities, nationalities, and disciplines. Findings are presented about the space's messaging regarding the disciplines it serves, inclusion of patrons from minoritized demographics, and general expectations of visitors. Recommendations for library practice and future research are discussed.

Introduction

A study of Association of Research Libraries (ARL) member institutions demonstrates a thirty-year trend of closing and consolidating branch libraries that support the sciences. As library services have been redirected and spaces renovated to meet changing user needs, an emphasis on providing "a comfortable, inviting study space" has emerged as a priority for successful spaces (Doty & Majors, 2019). This includes assessing library patron perceptions of the inclusivity of library spaces and services (Elteto, Jackson, & Lim, 2008; Morgan-Daniel et al., 2021).

The purpose of this study is to investigate what semiotic analysis can discover about how welcoming and inclusive a science library space is for patrons. Semiotic analysis examines the meanings that individuals interpret places as having. It involves the study of objects, which can range from images and words to physical items, and their meanings as individual interpreters understand them (Hall, 1997).

While issues related to race, ethnicity, religion, nationality, gender, and ability are by no means new to higher education, these struggles evolve in the way they are discussed on campuses over time. As social activists advocate for more inclusion, what constitutes inclusive symbolism in spaces is changing (Grindstaff, 2022; Thomas, 2001). The lack of racial and gender diversity in STEM is a persistent challenge despite the growth in the number of STEM jobs and STEM degrees earned (Pew, 2021). Blacks and Hispanics remain underrepresented in the

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STEM workforce and in the number of STEM degrees earned, while Whites and Asians are overrepresented in these fields (Pew, 2021). In engineering disciplines, for example, Black and Hispanic faculty members comprise only 2–3 percent of all faculty, despite a growth in student enrollment in these majors and faculty hired to teach them (McGee & Stovall, 2020). Women comprise a higher percentage of overall STEM jobs and degrees, however; their representation is concentrated in the health sciences (Pew, 2021). "In the Physical Sciences, women are still generally and markedly underrepresented, with women comprising less than 25 percent of researchers in these fields" (Elsevier, 2017). The barriers to racial and gender diversity in the sciences are both systemic and sociocultural, including tokenism, white male worker norms, hyper-competitiveness, racial bias and stereotyping, and negative racial climates (aka microaggressions) on campuses (Grindstaff, 2022; Lee et.al, 2020; McGee & Stovall, 2020). Therefore, and because most STEM jobs require post-secondary degrees, it is vital that universities and university libraries stay current with changes in expectations for inclusive learning climates. They should also evaluate their science spaces as critical places on campus to create a welcoming atmosphere for all demographics.

Since students from lower socioeconomic backgrounds and international students may have living spaces that are not conducive to study or fewer options for access to technology, library spaces are of particular importance for these patrons. Therefore, it is vital that these students feel comfortable in libraries. This study uses semiotic analysis to investigate the messaging that a science and engineering library space communicates to students of various backgrounds.

Literature Review

Semiotics provides researchers with a framework for analyzing signs, or objects that are considered to have meaning. Ferdinand de Saussure, influential linguist and philosopher, conceived of signs as a dyadic relationship between signifiers and signifieds. A signifier is an object that an individual perceives (Saussure, 1966): for example, a red, octagonal sheet of metal bearing the word STOP. A signified meaning is the concept that this object communicates thanks to shared cultural background. In this case, the red sheet of metal communicates the need to slow to a halt. This approach to objects and their meanings is important to understand, as it serves as the basis of semiotic analysis in many library studies.

Charles S. Peirce, an American philosopher with a scientific background, conceived of another approach to semiotics. His formulation is grounded in a triadic relationship between sign, object, and interpretant. By including an interpretant's role, Peircian semiotics provides for an understanding of meaning as both rooted in an objective reality and subject to interpretation (Peirce, 1998). An object under analysis is real, which stimulates an interpretation. The reality of the object provides a shared basis for interpretation, however; these may ultimately vary among individuals, especially those with differing cultural backgrounds (Thellefsen et al., 2017).

Researchers have used semiotic analysis in a number of ways to examine objects and their meanings in academic spaces. Wagner (1992) investigated how public library buildings in Australia conveyed messages of political control or approachability. Hart, Bains, & Jones (1996) examined how the architectural reference points of UK library buildings evoked messages of formality and elitism or modernity and equality. The present study also seeks to employ semiotic analysis to discover how objects may communicate approachability and equity.

This method has not been prevalent in the library spaces literature in recent decades, during which libraries have updated many of their values and campus climates are facing different struggles. Revisiting this method with modern library values and challenges promises new opportunities to understand strengths and areas for improvement of library spaces.

Thomas (2001) used semiotic analysis to examine posters displayed in libraries to encourage reading. She found evidence of stereotyping of females as passive and minority males as delinquent. Hayati, Nurul, and Lolytasari (2019) studied Islamic symbols in Indonesian university libraries. Evers (1997) examined the Islamic and state symbolism at the National University of Malaysia. He also observed that pure science disciplines were given locations that are more prominent, while abstract subjects were given less prestigious locations. Our study seeks to combine these perspectives to understand the messages that people of different genders, religions, disciplines, and other backgrounds may see in a university space.

A 2021 study in one university science library found that patrons did not feel the space was welcoming to patrons with physical accommodation needs or patrons for whom English was not their first language (Morgan-Daniel et al., 2021). Their study used customer satisfaction surveys to elicit feedback from patrons. In addition, a 2019 survey of African American students at predominantly white institutions found that these underrepresented students felt that the physical environment of libraries was important to their perceptions of welcomeness on campus (Stewart, Ju & Kendrick, 2019). Our study seeks to examine a science library space for these issues of diversity, equity, and inclusion through semiotic analysis.

Groisman, Shapiro, and Willinsky (1991) used semiotic analysis to examine a university science classroom's messaging to learners. They observed that the classroom reinforced the idea of a dichotomy between the learners and the teacher by the arrangement of the student desks facing the teacher's desk. The furniture also reinforced the power differential between students and teacher through smaller and lower desks for the students than for the teacher. Leijon (2016) noted similar feelings of hierarchy in another university classroom space, while Ravelli (2018) documented a university's attempt to create more equality in a classroom by forgoing a desk for the teacher and providing groups of students with display screens to share their own ideas with the class. The present study also examines a science space for higher education but concentrates on a science library.

Nichols (2011) examined public library placement within communities to determine what a library's proximity to commercial districts, public transportation, and easy walking paths communicated to patrons. She also scrutinized the insides of the public library spaces to determine their physical appeal to the specific patron group she was interested in: beginning readers. She noted that a significant distance to the children's area from the main entrance was off-putting to families. We are similarly interested in how factors such as the placement of an academic library on campus or its placement inside the science building affects patrons.

Tancheva (2005) examined the image of the library in the media. We focus in this study on real libraries rather than media representations of libraries. The image of the librarian has also been investigated through the method of semiotic analysis. For example, Radford & Radford (2003), Adams (2000), and Badovinac and Juznic (2009) examined impressions of the librarian in media. While it is important to investigate the image of librarians and library staff, especially considering the predominance of white librarians and the importance of serving patrons from minoritized racial groups, the present study focuses on impressions of library spaces.

Research has demonstrated a correlation between student sense of belonging and retention (Morrow & Ackerman, 2012). While this sense of belonging is often measured through relationships with faculty and peers, library spaces also contribute to a student's sense of belonging. It is a space to meet peers, get assistance aside from faculty, and escape the isolation of a dorm room. Campus space design can convey welcome or exclusion. Efforts to increase a sense of belonging through welcoming messages to students of various ages, races, and genders have met with success (Silver Wolf, Perkins, Butler-Barnes, & Walker, 2017). Therefore, our study of the signifiers that may contribute to patrons' feelings of belonging in a science library space has implications for student success.

Context

The science library space we investigated serves as a case study highlighting the ways in which library spaces can communicate messaging to patrons of various backgrounds. The University of Massachusetts Amherst Science and Engineering Library (SEL) is a highly valued and well-used branch of the University Libraries. SEL is situated in the Lederle Graduate Research Center on the north end of campus, close to several science classrooms and laboratory buildings. It is the only branch library on campus, providing collections and services for the College of Engineering, the College of Information and Computer Sciences, the College of Natural Science (including the Stockbridge School of Agriculture), the College of Nursing, and the School of Public Health and Health Sciences. Together, these Schools and Colleges represent 54 percent of undergraduate students, 39 percent of graduate students, and 47 percent of full-time instructional faculty at the University (UMass Amherst, 2021).

The purpose of this research is to investigate what messages the Science and Engineering Library sends to visitors and whether those messages reflect the purpose and values of SEL. The Science and Engineering Library is guided by the principles of respect for all patrons and excellent customer service at all times, including innovative thinking and expertise in our roles.

> Our priorities are to provide the best possible service to our patrons in all aspects of our work and to support the STEM and health sciences students, faculty, and user communities in their teaching, research, and learning endeavors (Science and Engineering Library, 2018).

This commitment is further guided by the mission of the University Libraries, which identifies diversity and inclusion as a central principle (UMass Amherst Libraries, 2018).

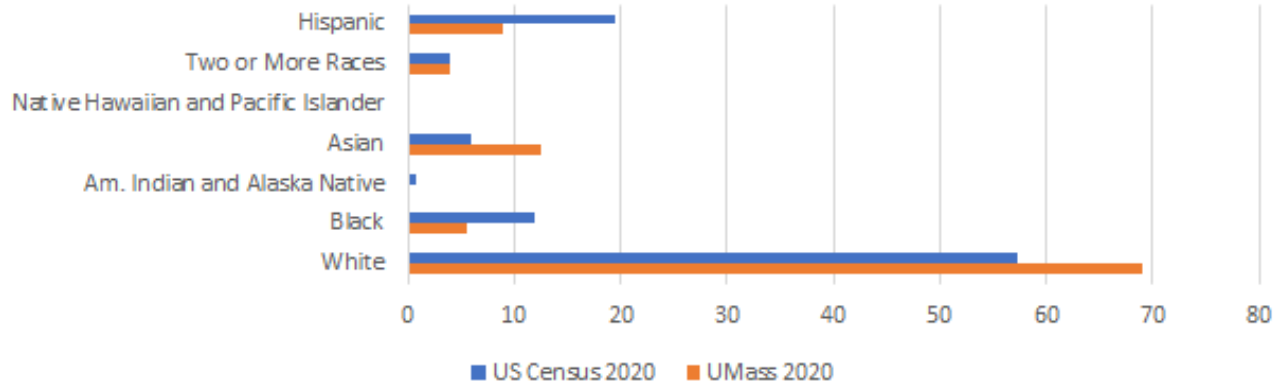
In fall 2019, the student population of the university was 50 percent female and 50 percent male (UMass Amherst, 2021). Full time faculty were 47 percent female and 53 percent male (UMass Amherst, 2021). We do not have data regarding how many students and faculty identify their genders otherwise. In fall 2019, the undergraduate student population majoring in the sciences was 50 percent female and 50 percent male. Science majors include those in the colleges of engineering, information and computer sciences, natural sciences, nursing, and public health. Women are underrepresented in engineering (22 percent) and computer science (17 percent), and overrepresented in nursing (80 percent) and public health (76 percent).

Science faculty at the university are only 41 percent female, with 16 percent of computer science, 40 percent of natural science, and 19 percent of engineering faculty identifying as female. Since female faculty are underrepresented in the sciences, we felt it was important

to investigate whether female students were being welcomed to the Science and Engineering Library. It is important that campus spaces welcome women scientists, since women are dramatically underrepresented in computer science and engineering among scholars across institutions (Elsevier, 2017). Since the underrepresentation of women in the sciences generally is reflected in the student population at UMass, we felt this institution was an appropriate choice as a case study to examine the semiotics of university science spaces.

Latinx/Hispanic, Black, American Indian, and Alaska Native individuals are underrepresented at this institution in comparison to the U.S. population (figure 1; UMass Amherst, 2021; U.S. Census Bureau, 2020.). White and Asian individuals are overrepresented.

FIGURE 1
US Census Data Compared With UMass Undergraduate Enrollment 2020

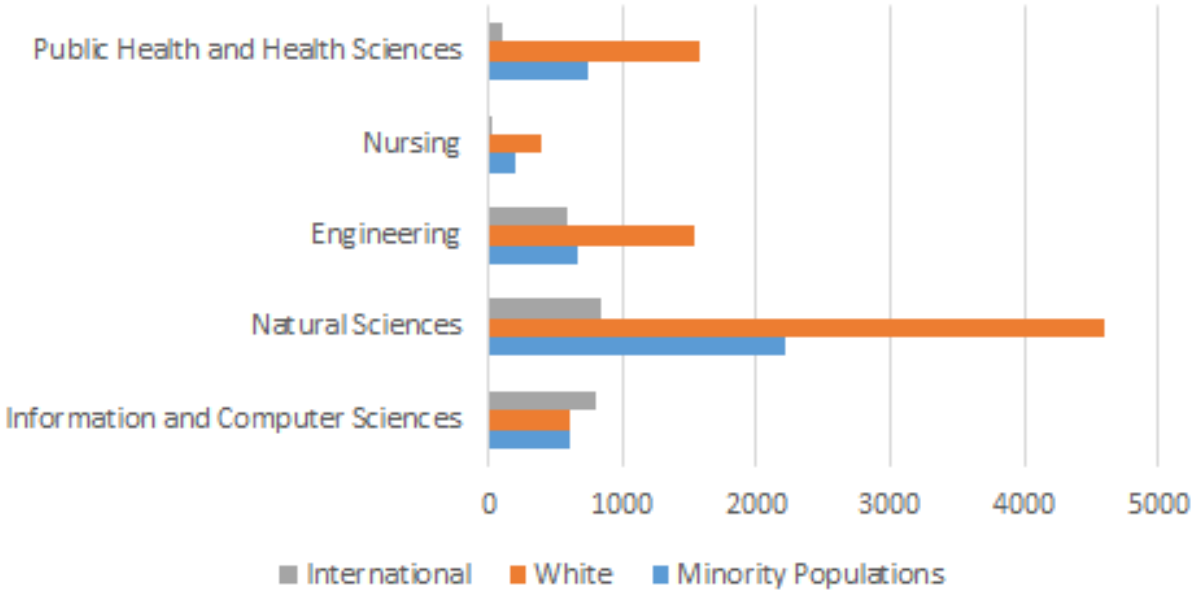


Among science majors in fall 2019, ALANA students represented 36 percent of undergraduate students, with the majority of ALANA students identifying as Asian. ALANA students are those who indicated that they were African American or Black, Latinx/Hispanic, Asian, Native American, Alaska Native, Native Hawaiian, Other Pacific Islander, or multiple races on the ethnicity question on their admissions applications. Among computer science majors, Asian students comprised the largest group of students (43 percent Asian; 40 percent White), whereas in all other science majors White students made up the majority, usually around 60 percent. Among nursing majors, the majority of ALANA students identified as Hispanic (33 percent), followed closely by Asian (30 percent). Since White and Asian students are overrepresented in the undergraduate science population, it is important to support Native American, Black, Latinx, and multiple race individuals. This study examines how signifiers in educational spaces may foster or hinder ALANA student inclusion.

The university has a larger than average proportion of international students and Asian students compared with other U.S. higher education institutions (figure 2, NCES, 2022). Many of the university's international students come from China and India (UMass Amherst, 2021). It is important for university spaces to welcome students who are studying outside their home countries, as well as students whose demographics are underrepresented.

In alignment with the library's mission to connect with students whose background differs from that of majority populations on campus, we investigated what the library space might be communicating to students with minority identities and international students. Campus spaces should also be welcoming to minoritized faculty members and staff. Of the

FIGURE 2
Student Demographics by Area of Study



university's faculty population, 29 percent identify with racial or ethnic minoritized identities, and 19 percent of the university's staff population also identify with these groups (UMass Amherst, 2021).

Method

We conducted a semiotic analysis of a Science and Engineering Library to determine how well the signs and signifiers in the space reflect its goals. To that end, we examined which behaviors are encouraged and discouraged, whether the space promotes scientific disciplines to its visitors, and how diverse groups of patrons might interpret elements in the space. This includes how well the space promotes science programming, science collections, and science learning.

The idea for this study came about during the early months of the Covid-19 pandemic, when our campus was essentially shut down. Most in-person classes went remote, and the libraries were closed to patrons and the vast majority of staff. Assessment activities involving in-person participation ceased, and we needed to adapt our approach as the pandemic changed the ways in which we could serve our patrons. Without the usual commotion of library traffic, it seemed an opportune time to examine our physical spaces.

One strength of the semiotic analysis method is that it enables us to gauge the inclusiveness of a space without burdening patrons with participation in research. Because many patrons are still struggling with challenges from the COVID-19 pandemic, many of them are overwhelmed without additional demands on their time. Patrons from minoritized identities have faced even more challenges during the pandemic, and we wanted to be particularly respectful of their university experiences and success. We acknowledge that our interpretation of signs may not match those of patrons.

We now provide positionality statements outlining our researcher identities and their potential effects on the analysis. Author F identifies as female, in her 30s, and white. Her disciplinary expertise is in educational administration. Author R identifies as female, in her 40s,

and white. Her educational background is in philosophy. Author C identifies as trans and is in his 20s. His background is in the field of area studies. Author S identifies as female, in her 40s, and Asian American. Her disciplinary expertise is in education. We hope that the diversity of our research team in terms of gender, disciplinary background, and ethnicity contributes to the strength of our analysis, but we also acknowledge that a more diverse team might have contributed even more robust findings to support inclusion.

Early in the fall semester of 2021 we toured the Science and Engineering Library space, first individually, and then as a group in the mid-morning when relatively few students were utilizing the space. Moving systematically through the three flours of the branch library, we noted and discussed signs and other significant objects in the space as a group. In the course of this tour, we also took photographs to capture aspects of the space that we deemed salient. Since one member of our group works full-time in SEL, she was able to add additional layers of insight to our discussion based on daily observations of how students interact with the space. Using grounded theory (Glesne, 2011), we developed three major themes to better understand how students and other users of the library may interpret signs and other objects in the space (behavioral expectations, science representation, and representation of diversity).

Findings

Based on our semiotic analysis, the Science and Engineering Library's passive communication to its patrons succeeds more in promoting science and encouraging desired behavior (or discouraging undesired behavior) than in promoting diversity and inclusion.

General Description

The science and engineering library that we examined is located on the north edge of campus on the second floor of the Graduate Research Center. It is west of a residential area and east of many science buildings including engineering, computer science, and astronomy. The brutalist, utilitarian 1960s concrete of the building exterior contrasts sharply with the decorative, neo-Georgian style of the residential buildings across the street to the east, as well as with the modern new physical sciences building directly adjacent to the south. To access the main entrance of the library, one must enter the building and climb the stairs or venture down a long hallway to find an elevator. As Nichols (2011) noted, a significant distance between the entrance to the building and the destination in the library can discourage patrons from visiting. The main entrance to SEL (figure 3) is made of glass so that patrons can see inside; however, thick vertical bars and wired glass punctuate the windows and door.

Directly across from the entrance is a large service desk in front of a wall of beige metal shelving. Immediately to the right of the entrance, public access computers line the wall on generic tables with plastic chairs. The remainder of the space is populated with tables and chairs for individual and group study. There are several group study rooms along the perimeter of the space. To the left of the entrance is a foyer leading to a classroom and a small alcove of shelves that hold reference books. Additional study space is available on the third floor, which also holds the majority of the library's print monograph collection.

Like the outside of the building, the inside of the library also has a utilitarian aesthetic. There is fluorescent lighting, drop ceilings, hardwearing floor materials, and beige metal stacks for books. Most of the walls are painted beige, with maroon and white directional

FIGURE 3
Entrance to the Library

signs. Much of the furniture on the main floor is gray and generic. The utilitarian style is somewhat disrupted by upholstered armchairs, some of which display decorative leaf upholstery, whimsical stump-like coffee tables, and homelike lampshades. The study space on the third floor is cramped. It contains a combination of metal and wooden tables with functional wooden chairs as well as upholstered armchairs with mismatched leaf and geometric upholstery.

Behavioral Expectations

Bike racks outside the building and sidewalks and crosswalks around the building encourage ecofriendly transportation to the library. Recycling bins inside also encourage ecofriendly behavior. These signifiers are consistent in spaces across the University, which has a strong sustainability program. Inside the lobby of the building, there is one inconspicuous sign for the library across from the entrance, and a decal with an arrow to the library on the underside of the stairwell. These signposts guide people to the main entrance of the library on the second floor, which has a large sign identifying the space.

Immediately inside the main entrance to the Science and Engineering Library (figure 3), there are ropes and theft detectors around the doors. This creates a feeling of suspicion or surveillance. Exhibits are displayed behind glass, which makes them less inviting and interactive.

The public access computers are freely accessible to patrons as they walk into the space. The group study rooms on the main floor are made of glass without sound barriers. This also creates a feeling of surveillance and a lack of privacy. Conversely, this may help students feel a sense of safety if they feel nervous about harassment based on their gender or differences. Elteto, Jackson, and Lim (2008) found that students reported sexual harassment in library spaces.

Questions are encouraged by placement of the service desk front and center, near the entrance. The desk has a plexiglass barrier as a safety precaution for the coronavirus pandemic. On it are posted signs for library hours and signs requiring facemasks in the facility. The service desk has several informational flyers about library services and connecting to the campus Wi-Fi network. These flyers are not legible from a distance, therefore patrons with questions about services must walk up to the desk to browse the flyers or ask staff. On the periodical shelf amid the colorful trade magazine and journal covers is a large sign that reads "Please Ask for Assistance," negating the invitation to browse suggested by the design of the shelf and display of materials.

Directional indicators constitute much of the signage on the main floor. The walls have decals calling out the photocopier, printers, and office supply station. Two small and highly placed signs indicate the scanning station and the library classroom. These are legible but placed close to the ceiling, making them easy to miss. There is a large translucent floor directory on the window next to the stairwell. Directional signs are a mixture of materials and designs, combining older with newer ones. Signs for the restrooms are located on the restroom doors and not in a more obvious location. Additional signs indicate appropriate behavior in the space. There is equipment and signage to encourage pandemic safety. There are hand sanitizing stations, signs to mandate masks, and a bust wearing a mask. There are signs to forbid cell phone use. There is no obvious place to use cell phones, nor are there instructions regarding where cell phone use would be acceptable; however, there is also a large and obvious "Charging Locker" where patrons can plug in their devices securely. More sound barriers, including assigned areas to use cell phones, would improve the utility of the space for studying.

The third floor includes very little directional or information signage. There is a single large call number directory at the top of the stairwell to this floor and restroom signs on the restroom doors. The Seed Library encourages self-service in a multitude of handwritten notes and colorful placards within the small, dedicated area. The positive messaging in the seed library aligns with the vibrant colors and makes this one of the most welcoming spaces in the library.

Although much of the library design is utilitarian, carpeted floors and soft upholstered chairs invite patrons to stay and be comfortable. These pieces of furniture appear to have been pulled randomly from other places rather than purposefully chosen to enhance the space.

Science

There are science related posters on the walls throughout the library. On the main floor, these posters are connected with the current exhibit, which at the time of writing is on Visual Storytelling. The installation includes data visualizations from biology, geographic information systems, environmental science, and anthropology as well as visualizations related to graphic design and data management. These posters are colorful but small and widely spaced. Some of these installations are framed and some are not. The introductory signage for the exhibit is located outside of the library entrance and is disconnected from the content of the exhibit.

The exhibit reflects the range and value of data visualization for communicating scientific information, although the content is somewhat disjointed and difficult to read. The exhibit could be a more effective encouragement of scientific inquiry if the signage was more prominent and connected to the exhibit.

On the third floor, there are posters celebrating modern achievements of women scientists of diverse backgrounds (figure 4). These are brightly colored illustrations that represent an assortment of scientific disciplines, including biology, chemistry, public health, aeronautics, computer science, and astronomy. They send a message of inclusivity to female patrons of various ethnicities and abilities.

FIGURE 4
Posters Depicting Diverse Women Scientists

There is a brightly decorated seed library section tucked into a back corner of the third floor, and old file cabinets have been repainted in shades of bright green to house the library's plant patent collection. There is a nature theme to some of the furnishings throughout the library. For example, as noted above there are leaf patterns on armchairs and wood stump coffee tables. There is a yellow-green color used in accents. There are decorative plants. This theme connects to the science orientation of the library. The vibrancy of these spaces and elements contrast with the more utilitarian decoration of the majority of the library space, which does not effectively encourage scientific inquiry.

Adjacent to the service desk is a periodical shelf, which contains trade magazines and journals from a range of disciplines with bright and inviting cover images. Next to that is another shelf displaying new scientific book titles. The covers are printed on paper and displayed with QR codes to the catalog record for each book. These shelves represent the intellectual content of the library's collections and invite people to browse and investigate them.

An early calculating instrument and busts of Galileo and Copernicus are on display, representing the history of Western science (figure 5). Two of these are located on the second floor. In contrast to these historical artifacts, there is a 3D-printed model molecule representing recent advances in science and research methods.

There are two display monitors that advertise events at the branch, including those related to science. This messaging aligns with the library's mission to provide and promote science programming.

FIGURE 5
Objects Representing the History of Western Science

Many of the furnishings and finishes throughout the space are worn or dated. This conflicts with the Science and Engineering Library's goal to project a focus on science, since science is generally associated with modernity and progress.

Diversity, Equity, and Inclusion

In contrast to the science classroom described by Groisman, Shapiro, and Willinsky (1991), the Science and Engineering Library is not arranged with clear power discrepancies between an authority and the students. Instead, all patrons, including faculty as well as students, are free to seat themselves throughout the space and choose the type of seat that suits them best. They can interact freely rather than having to pay attention to the head of a classroom. In the library space, everyone is given equal opportunity for access to research and learning space, scholarly resources, and technology. The library includes a Learning Studio, which is a dedicated space for information literacy instruction as well as special events, presentations, and open study. There are multiple interactive displays and white boards on three walls, which are brightly painted. Technology for distance learning and a sound system are integrated. The furnishings are flexible and can be moved easily into configurations that encourage group interaction. The studio is ADA accessible and the instructor station moveable and height adjustable. These technologies make the space more welcoming for patrons of varying physical abilities.

The signs for the elevator are not very visible. This diminishes accessibility for patrons who have challenges with mobility. Some signs, such as the elevator sign, have only text and not pictograms. Better signage could improve the utility of the space for patrons with varying abilities. On a positive note, the parking area provides ADA accessibility. Footstools are provided for patrons of different heights to reach the stacks. Because this is a higher education space and a library, there is an expectation that visitors will be literate. Several signs in the library do not have braille for patrons with vision impairments.

The restrooms throughout the Science and Engineering Library are binary, and the nearest gender-inclusive restroom is inconveniently far from the library. However, it is helpful that the library offers directions to a gender inclusive restroom in the building.

There is one poster related to the University's inclusivity campaign, "Building a Community of Dignity and Respect," posted on a bulletin board the inside of the library, and three of Hafuboti's "Libraries are for Everyone" posters are hung throughout the main floor in Greek, Urdu, and identity icons. Like other posters on the main floor, they are dwarfed by the walls and hard to spot. On the main floor, there is also a small exhibit of books in a display case near the entrance related to marginalized voices in science, but there is no signage to draw attention to it. This effort at inclusivity would be more impactful if its purpose were clearly communicated. Posters on the third floor display diverse scientists (figure 4). These include women, Muslims, scientists with disabilities, and Black, Asian, and Latina scientists. Though they are clearly celebrating diversity, these posters are located deep inside the library and are not visible to patrons who come in to pick up materials or use the public access computers. Though the library includes signage and messaging that celebrates diverse populations, it is overwhelmed or displaced by the signage for behavioral expectations and may have a nullifying effect. Additional signage that incorporates Black, Hispanic, Asian, women, and disabled patrons in its messaging would enhance inclusiveness.

The industrial, minimalist look of fluorescent lighting, dropped ceiling, and metal fixtures is a Eurocentric style, which may not be welcoming to students from other backgrounds. Efforts have been made to add color and interest in some areas around the library, but the majority of the library space does not appear intentionally designed to welcome patrons.

There is no dedicated space for prayer in the Science and Engineering Library, in stark contrast to Hayati, Nurul, and Lolytasari's (2019) description of Indonesian university libraries, which all contained at least one mosque, and sometimes multiple mosques per floor. A single carrel on the third floor has been repurposed into a non-denominational "Short Term Booking Room" (figure 6) to accommodate prayer; however it lacks any decorative or functional indicators as to its purpose or directional signage, and it is difficult to find.

Conclusions

We now offer conclusions related to each of the three themes for which we offered findings: diversity, equity, and inclusion; behavioral expectations; and science.

Library semiotics should promote diversity, equity, and inclusion. In keeping with universal design, libraries should provide clear and visible signage for the library itself, as well as its elevators, exits, restrooms, quiet study spaces, group study spaces, and browsable stacks. Libraries should provide gender inclusive restrooms and clearly marked spaces for religious reflection. Libraries can make an effort to choose inclusive art and display artifacts to appeal to patrons from a variety of backgrounds.

FIGURE 6
Library Study Room Doors

Behavioral messaging in libraries should make patrons feel welcome. Libraries can learn from our findings that library signage precluding activities frequently performed by patrons should be accompanied by library signage that directs patrons to locations where they may participate in these activities without disturbing other patrons. This will balance the prescriptive, negative messaging in libraries with positive, inviting messaging. Libraries should consider their priorities in terms of safety versus a feeling of surveillance for patrons when designing study spaces. While glass can help library staff monitor activity in the library, glass walls can also lead to a lack of privacy and a feeling of distrust. Likewise, libraries must make decisions between the security for their materials provided by wired glass and theft detectors versus a more welcoming atmosphere of trust.

Dedicated subject libraries should promote their content with visual cues. A science library should be updated with modern, clean, furnishings in good condition to show respect for its patrons and their work. It is important to represent the interests of patrons a library wishes to welcome in a balanced way. A science library should not have a predominance of science items from any particular science discipline it serves, but provide appealing displays from a variety of disciplines representing both the history of science and modern advances. Educational disciplinary displays can incorporate diverse scientists to promote the inclusion of diverse patrons.

While some of the issues that this semiotic analysis identified can be easily fixed, others will require further investigation and funding to change. For example, updating and balancing signage to be more representative of racial and gender diversity in science and more positive in tone can be done relatively quickly and with little financial investment. On the other hand, updating furniture, setting large-scale exhibits, and creating soundproof areas for group work require more planning and investment. The overarching message from this analysis is that leadership of any library should mindfully select symbols and representations of science that reflect the diversity of the student body as well as the breadth of science disciplines and traditions that are served within the space.

Limitations

Because we chose a research method that would be less burdensome to patrons, we relied on literature to inform our conclusions about what aspects of the space would be welcoming to patrons. Although this allowed us to consider a variety of minoritized perspectives that are difficult to recruit in large numbers, it also meant we did not have direct patron participation in our study. Further, data collection on patron activity in the library, such as group study room use, is limited intentionally to protect patron privacy; therefore, it is difficult to generalize about patron behavior based on the data that we do collect.

Future Directions

We recommend further investigation of library spaces using semiotic analysis to understand the messaging visitors encounter. This can be expanded to libraries other than science libraries. This method allows libraries to identify areas for improved inclusiveness during times when participant research with patrons is difficult. Semiotic analysis of space can also be a useful research method when participant research is possible. For example, Okuyucu and Çoban (2018) employed semiotic principles with a student survey to obtain quantitative measures of how many students experienced university layouts, lighting, furnishings, and colors positively. A scholar-driven semiotic analysis can identify key areas for rating a library space, and a follow-up study can involve the participation of patrons. Further research on library climates is important as prejudice continues and takes different forms. The themes discovered through semiotic analysis can undergird empirical studies with patron participants.

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