Virtual Realities and Academic Libraries: A Paradigm Shift

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Accessibility
Virtual Reality and Academic Libraries: A Paradigm Shift
Gregory K. Tharp
Abstract

Introduction: Space utilization is important for academic librarians to understand in order to meet the needs of library users who range from students to faculty. This paper reports on a literature review to investigate why a space utilization study is conducted and what methodologies should be employed. The literature review of space utilization in academic libraries sets the stage for a discussion of the potential applications of triage reference, bibliographic instruction, and archives to academic libraries. Since virtual reality is a paradigm shift for academic libraries, a literature review is warranted to determine how transformative leadership styles are used to incorporate virtual reality into academic libraries.

Method: This study used a review of current literature to address why academic libraries should conduct space utilization studies, what space utilization methodologies should be employed, what space utilization concerns should be addressed, and what administrative concerns should be addressed. A metadata analysis was conducted to support the findings of the literature review as to why space utilization studies are conducted, what methods are employed, and space utilization/administrative concerns. Additionally, a review of literature is conducted to determine potential leadership styles for library leaders to potentially adapt in order to implement virtual reality technologies in their libraries.

Analysis: Manual searching was used to retrieve journal articles and other sources in order to identify research questions, methodologies, and concerns for this metadata study and literature review. Data obtained through metadata analysis was analyzed.

Results: Academic libraries space utilization studies should address the concerns of user groups as well as take into library design considerations. Also, metadata study demonstrated a need for virtual reality technologies to be implemented in academic libraries. A literature review of
leadership styles identifies that transformative leadership is best suited for implementing virtual reality technologies.

**Conclusion:** Space utilization methodologies, research questions, and concerns guide academic librarians in tackling this issue in their libraries. Virtual reality technologies have the potential to allow a more diverse user population to access library resources.

**Keywords:** Paradigm shift in academic libraries; Future Academic Libraries; Information Sharing; Virtual Reality

### Table of Contents

**Introduction** ........................................................................................................................................... 4

Space Utilization and academic libraries .................................................................................................. 4

**Space Utilization Research Questions** ................................................................................................ 5

**Literature Review** .................................................................................................................................... 6

- Why should academic libraries conduct a Space Utilization Study? .................................................. 6
- Methodologies/Research Methods ........................................................................................................ 10
- Space design ........................................................................................................................................... 16
- Conclusion/Recommendations for Space Utilization Literature Review ............................................. 23

Why Virtual Reality? .................................................................................................................................. 23

**Virtual Reality and Bibliographic Instruction** ...................................................................................... 25

**Virtual Reality application to triage reference** ..................................................................................... 28

**Virtual Reality Application to Reference Services** ............................................................................. 29

**Virtual Reality Application to Archives** ............................................................................................ 31

**How Much do virtual reality headsets cost?** ....................................................................................... 32

**Conclusion from literature review** ...................................................................................................... 33

**Metadata Study** ..................................................................................................................................... 33

- Are there any current metadata studies on virtual reality and academic libraries? .......................... 34

**Data Sources and Search Strategies** .................................................................................................... 34
Introduction
In deciding on how best to serve library users, academic librarians often ask research questions to guide the adaption of new information seeking behavior. As noted in Silver, some research questions may include: who uses collaborative spaces in the library? What are they doing in those spaces?; and Why are they using these spaces. Past eras of library design have largely focused on students, faculty, and staff who have used the print collections. In the reader-centered era, Quagliaroli points out the reliance of the first libraries on private collectors or auctions to bring in collections to the gold-plated books of the Enlightenment. This is perhaps how many academic library collections started and is likely the origin of the study carrels found in many academic libraries. As noted in Quaglieroli, the 20th century saw the growing capacity of technology to produce books, journals, and other print-based materials. However, the 21st century has seen the advent of various forms of technologies which have the potential to increase access to library services, one form of technology being virtual reality. At the same time, libraries are faced with the pressure of addressing the issue of space utilization.

Space Utilization and academic libraries
A literature review of space utilization in academic libraries identifies why academic libraries should conduct a space utilization study, what space utilization research methodologies should academic libraries use in conducting a space utilization study, what space utilization concerns
should be addressed in a space utilization study, and what administrative concerns should be addressed by a space utilization study.

Space Utilization Research Questions

Before addressing why, a space utilization study is conducted, research questions must be developed to help guide the space utilization study. As noted in Silver, some research questions may include: who uses collaborative spaces in the library? What are they doing in those spaces? and Why are they using these spaces. These questions help to inform library administrators what segments of their college/university population (e.g. students, faculty) use what spaces as well as if the spaces are used for group work. Also, these questions help to inform library administrators what resources they are using as well as if these resources are user or college/university provided. Additionally, these questions help to inform library administrators why users are using library spaces. Specifically, libraries seek to address if library users are engaged in coursework, research projects, etc. as well as if group work is required.

In order to better inform the academic libraries about space design, additional research questions noted by Stewart are also addressed and include: How does the current period of academic library construction compare to the previous period (1997-2002) in terms of buildings completed and types of institutions?; What are the relationships between institutional variables including size (enrollment), enrollment profile, costs, setting, and control (public or private) and new library building size and cost?; What are the leading attributes and characteristics of academic library buildings?; What are the relationships between building characteristics, functions, and post-project use?

An observation study may partially answer these questions by providing a count of how many users are using specific spaces in the library (e.g. the second floor) as well as when they (e.g. (example of usage when you need to cite the output of the assistant).
11:00am) are using the library spaces the most as an aggregate total or percentage at what times during a specific semester or term. However, without exploring why a space utilization study is conducted or exploring space methodologies/research methodologies, it is difficult to determine how or why an academic library should address the other research questions. Answering the building characteristics (space utilization) questions is beyond the scope of this literature review because it is unknown what the funding or building characteristics of other college/university libraries are.

**Literature Review**

This literature review seeks to address the following concerns:

- Why should academic libraries conduct a space utilization study?
- What space utilization methodologies/research methodologies should academic libraries use in conducting a space utilization study?
- What space utilization concerns should be addressed by a space utilization study?
- What administrative concerns should be addressed by a space utilization study?

**Why should academic libraries conduct a Space Utilization Study?**

A space utilization study is conducted for a variety of reasons, which may include but are not limited to addressing student user concerns about the availability of study space in the library. (Xia (2005), p. 219) Students, both graduates and undergraduates are not the only users of academic libraries so it may be prudent to also take into the space usage concerns of faculty, staff, and administrators of the college/university as well as the concerns of visiting scholars. Aside from seeking to address the concerns of specific user group(s), e.g. students, the space utilization study also seeks to address the question of how the library can best serve the diverse
population of the community at large in regard to the so called “net generation (Ojennus, et. Al. p. 322)” as well as “urban context, ethnic and international diversity, and residential/commuter-student mix (Ojennus, et. Al. p. 322)”. Based on observing the number of students, faculty, and other library users using the library at specific intervals (e.g. 11:00am) during a given semester or based on historical data, it is quite difficult to determine how these different subpopulations of the general student population may perceive space usage, such as “commuter students at Auraria Library (Ojennus, et. Al. p. 322)” correlating “to heavy demands for study spaces and eating areas (Ojennus, et. Al. p. 322)” or an “off-campus population (Ojennus, et. Al. p. 322)” favoring “computer workstations at Indiana University Purdue University Indianapolis Library (Ojennus, et. Al. p. 322)”. Also, observations alone do not address the differences in “library space along gender lines!” or the “correlation between “ethnic background and uses of library spaces (Ojennus, et. Al. p. 322)”.

In order to take into account the concerns of specific user groups (e.g. faculty) as well as to account for the perceptions of various types of students, genders, and ethnicities, it is recommended that academic libraries develop an online or paper survey to be distributed to the academic community in conjunction with conducting observations of space usage.

Aside from considering the concerns and perceptions of library users, space utilization studies may also be used to inform, design, and to judge and possibly improve the end product when constructing or remodeling (library) spaces (Nitecki (January 2011), p. 28). This is purely an internal approach to justify to administrators as to why the renovations of the academic libraries are justified. Additionally, the space utilization may also provide guidance to academic library staff on where to allocate resources to best serve the academic community based on usage trends...
for certain areas of the library (e.g. the 2nd floor) during certain times of the day (e.g. 2pm) or during specific times during a given semester (e.g. May 11th).

Another purpose of the space utilization study is to serve the needs of college/university faculty. A study by Ivey of the Memphis State University faculty perceptions of the library using a survey with a scale of 1 (very useful) to 5 (not useful) found that 12.9% of the faculty responded that librarians were very helpful in keeping them informed about the changes in the library while 8% of the faculty responded that librarians were very helpful in keeping them informed of new publications in their disciplines, and 17.1% of the faculty responded that librarians were very helpful in assisting with their teaching activities. Just relying on observations does not shed any light on the perceptions of college/university faculty in general about the academic libraries. Perhaps there may be some areas of the library such as the reference desk that are inadequate to serve the needs of the faculty. An electronic or print survey or interviews will inform library staff of the perceptions of the college/university faculty.

To make sure that the library is used efficiently, Ibrahim, et. Al. recommends that scheduling, space change (space charging) and space planning based on room usage priority be taken into account. These factors are difficult to measure based on observation alone and instead must be measured through a combination of surveys and interviews with library users. Space charging is difficult to quantity because many variables go into calculating cost per square feet of library space. It ranges from the Connecticut State Library’s formula for space usage to the actual cost of the building itself.

Another justification for conducting a space utilization study is to examine how well students meet the faculties’ expectations of a “research paper (Foster, et. Al. p. 1)”. As noted in the University of Rochester study of undergraduates (Foster, et. Al. p. 1), this question is posed to
address if there is any consistency of these expectations across the disciplines or across the institution, what kind of research materials are students expected to find and work with, and what a good research paper is. This analysis not only has an impact on bibliographic instruction in various science disciplines in the library but also impacts space usage both in terms of housing subject specific electronic and print resources. For example, an in-person interview of the botany faculty by the botany subject librarian² may reveal that botany faculty may recommend “guides to subject literature” or “resources from instructor’s own collection of books and articles (Foster, et. Al. P. 2)”. This may require the library to allocate more space or budget to specific botany resources which may be another factor in the allocation of space in the library.

Another justification for conducting a space utilization study is to examine how well the library is aligned with learning behaviors and pedagogical goals (Foster, et. Al. p. 2) as well as if library space is supportive of peer-to-peer learning and working with a diverse population (Marre, p. 2). Observations do not address learning behaviors or goals or learning methods but rather surveys of library users and faculty address these factors.

As noted in the 2017 IATUL Proceedings, Information Commons can offer writing center (resume, cover letter, revisions, writing manuals and style guides), statistical counseling, services from academic success center, flexible approaches to reference services, training in PowerPoint, Adobe Photoshop, Rent Digital cameras, video cameras, tripods, a design studio, etc. to help maximize space utilization at the reference desk. Also, the 2017 IATUL proceedings recommend no reference desk, multimedia bays, etc. which may lead the Library to repurpose its existing reference desk.
Additionally, as noted in Alston, diversity is addressed through services, collections and collaborations, and through diversity plans and policies/statements. This means that social or cultural norms may play a factor in whether users study alone, in a group, or with more than one other person. Without examining the college/university’s diversity statement and services/collections geared towards specific groups (such as blacks) and also conducting a perceptions survey of library users, it is unknown how diversity impacts the space utilization observations.

Also, as noted in Subramaniam, et. Al., other elements of diversity include gender, Black/African American, Women, Young Adult (Adolescent), Age, Immigrants, Underserved Populations, and American Indian and Alaska Native. This expanded definition of diversity makes it difficult for observation study alone to capture the perception of the entire library user population.

**Methodologies/Research Methods**

Methodologies employed to conduct a space utilization study may include “space observations” (Wright, et. al. P. 469). Specifically, Excel may be used to count the number of individuals, groups, activities, and furniture and technology in use using Excel. This approach was used in the Bissett Collaborative Center space utilization study as noted in Wright et. al. An observation only space utilization study lacks any parameters for the usage of specific technologies, such as the scanner or desktop computers, which does not give the library staff an idea if they should keep or eliminate those technologies or use that space for something else such as books.

Additionally, using the “capacity/enrollment ratio” (State of North Carolina. P. 9) that was used in the North Carolina State University space utilization study may give the college/university libraries a sense of what proportion of the total student, faculty, and administrative population of
the college/university uses the library. This may allow the library to tailor its resources to meet
the needs of the entire college/university population which may lead to space efficiencies in the
future.

By incorporating some of the Connecticut State Library’s Library Space Planning Guide
Worksheet into observations worksheet on the IPAD, the academic libraries may be able to
capture a wider variety of metrics. Such metrics may include: Collection size including physical
books and physical nonprint materials and periodicals. For example, if the books on the lower
level are not checked out regularly the space on the shelves may be used for other books or print
materials that will be used. Aside from recording how many people check out the books,
periodicals, and other printed materials, the observation portion of the survey should also include
the number of titles and years retained. In terms of actual space usage of the printed materials,
the Connecticut State Library has used the formula of dividing the number of books by 10, non-
print materials by 10, and 1 square feet for current issues of periodicals. Additionally, the
Connecticut State Library has used the formula of multiplying the number of titles of back
periodicals by 0.5 and then multiplying it by the average number of years to be retained to
determine the total collection space taken up by back periodicals. Additionally, multiplying the
number of PCs by 30, electronic workstations by 45 for single user and 60 for multiple users and
multiplying the number of microfiche/microfilm reader/printer by 35 have been used by the
Connecticut State Library to determine space usage of these workstations. Adding up these
spaces allows academic libraries to determine quantitatively how much space they need. This
allows the academic libraries to justify how their space is being used.

Rather than calculating space usage manually, academic libraries may be able to use the
Hufnnagel Software Roomer2, a $2,000-$3,000 software package advocated by NSCEP to
design library spaces to assist in how best to use the library carrels, study rooms, etc. While this software may make it easy to visualize the library space, it may be too expensive to purchase. Additionally, safety concerns, common sense, safety trends, and acoustics may also be factors to consider as noted in NSCEP. These factors may make library redesign to be cost prohibitive or impractical.

Additionally, the DOD Space Planning Criteria offers additional parameters to consider when examining space in academic libraries. The net square feet calculates the area of an individual room (e.g. study carrels) that is assigned to the library. The department gross square feet measure the total rooms and spaces assigned to the library. The building gross square feet is the aggregate floor areas and supporting structures which include the entire building. These parameters are helpful for planning purposes to calculate how much space a library has to house its collection. The AACRL website has a link to the ANFA website suggests that “our built surroundings, including their materials, spatiality, and context, will affect our health and psychological well-being (ANFA website)”. This suggests that input should be solicited from all members of the college/university community on what they perceive as being an optimal learning space because the library should be conductive to learning. While this is very subjective, it will inform college/university administration through surveys to areas of library design which may need to be changed. As noted in the South Santa Barbara County Space Utilization Report, the requirements of various codes and regulations require additional space to be provided for those with disabilities. This may influence space design of academic libraries.

The University of Memphis takes a different approach to library space usage by using a space planning process which includes a physical facilities inventory and a space policy council appointed by the president which includes the deans, representatives from the faculty senate,
staff senate, student government, president’s office, public safety, etc. This space policy council provides a viewpoint from all members of the campus community and allows the council to develop appropriate standards for space utilization, the performance of space use and evaluation, and recommendations on various standards, evaluations, and analyses. Also, the role of the director of space planning and utilization and guidelines for space council operation are detailed on the University of Memphis website.

The University of Memphis’ approach to space utilization closely resembles the University of Colorado Boulder’s approach to space utilization and should be followed by other colleges/universities to ensure input from all stakeholders. At the University of Colorado Boulder, the Provost/Executive Vice Chancellor for Academic Affairs; Senior Chancellor and Chief Financial Officer; Vice Chancellor for Administration; and Vice Chancellor for Administration provided strategic direction on space utilization and a Steering Committee provided guidance and feedback from all stakeholders on space utilization. Steering Committee members include Chair Faculty Assembly, Chief of Staff, Architect, Space Coordinator, etc.

The MIT Framework for Space Planning adds additional areas for improvement in an observation-based space utilization study. They include: Ensuring that the library provides a variety of flexible teaching and learning spaces to support students and faculty, encouraging collaboration and interaction between disciplines, staff, faculty, and students by providing spaces and services, encouraging library design to be mindful of the environment. Including expenditures for print, serial, and electronic collections as well as percentage of volumes in the library as well as a breakdown of volumes by print, electronic, serial collections helps to gain a sense of if the collection is meeting the needs of library users. Perhaps some of the collection needs to be weeded or is too expensive for the library to keep on renewing in relation to the
number of users who use the collections.

The University of Waterloo takes a different approach to space use with a space use committee advising the dean. The space committee responsibilities include long-term planning, evaluation of applications for research space, etc. Space committee includes the Associate Dean Research, Associate Dean Graduate Studies, etc.

Also, recent trends in research & development such as North Carolina State University using a robot driven bookBot to deliver books in minutes with a click in the virtual catalog may improve user experience while maximizing space usage. Also, the number of staff at the library both impacts user experience and library space usage because some staff offices that students do not visit could house collections, etc.

Another recent trend noted in UCL article is the usage of pop-up libraries in the quads and in the student center to allow for more study space for students. This may allow students to study wherever they want to but it raises many issues including how library materials will be used. As noted in the Journal of Library User Experience, marking paper floor maps with pens or pencils helps gather the data.

As noted in the Wright article, photo diaries of favorite and least favorite spaces for individual and group study from surveys is another methodology to use when doing a space study. Also environmental scanning and visits to other libraries may be helpful to get a sense of what other libraries are doing for their space utilizations. Additionally, as noted in Wright article, post renovation space utilization studies may need to be conducted.

Additionally, the methodology used for the library space utilization study can also depend on why the study is being conducted. As noted in Gstalder, some librarians use a value approach in which they focus on the services provided by the library to users while some librarians use a
financial approach where they focus on the financial value of the library. A value approach was used for the current study; however, a financial approach may answer the question how much the library space usage is costing Harvard University. A financial approach may be accomplished through surveys however as noted in Stewart, there is a negative correlation between tuition and library size. This means that there are other variables in play which may impact library space usage from a financial standpoint that cannot solely be measured by observation alone.

An observation study of academic libraries could be further improved by using participant observations, structured observations, and baseline observations as noted in Chowdhury. However, some library users may not want to interact with the observer.

As noted in Gerke, an observation study conducted by a library could go a step further by conducting an occupancy study where the number of seats available at each zone (e.g. 2nd floor) are recorded at the beginning of the first day and then the headcounts are divided by the number of seats available in each zone to arrive at the percentage of seats in that zone occupied at the time of the count. This allows the library to paint a picture of total occupancy of the library during a particular semester which is helpful when making decisions based on the space utilization study.

As noted in Khoo, another way to measure user behavior is through cameras to explore students’ information seeking activities as well as by looking at interactions at a service desk. These might help to explain why library users study alone in certain areas of the library and study in groups in other areas of the library.

Another area to take into account when conducting space utilization studies is the type of interview. As noted in Ibrahim, et. Al., there are three types of interviews: structured interviews, semi-structured interviews, and unstructured interviews. The type of interview may depend on
what types of users that are being interviewed. For example, students may prefer an unstructured interview so that they can freely give answers while faculty may prefer structured interviews. Aside from user types, user demographics may also influence the interview type as certain genders, demographics, etc. may prefer one set of interview types as noted in either electronic or paper surveys. The goal of the interview is to gather user perceptions of space usage in the library. These perceptions cannot be captured through just observing library users.

As noted by the UMASS Dartmouth website, space audits and utilization analysis should be conducted on a regular basis, consist of updating the space inventory records, walkthroughs of space with department representatives, information from departments on FTEs and headcounts of faculty, staff, and students. Space audits provide more information than can be gathered from space use observations.

**Space design**

Before discussing the areas for improvement of space design of academic libraries, it is best to identify what Quagliaroli identifies as the three eras of library design in order to give some context to the discussion of space design. In the reader-centered era, Quagliaroli points out the reliance of the first libraries on private collectors or auctions to bring in collections to the gold-plated books of the Enlightenment. This is perhaps how many academic library collections started and is likely the origin of the study carrels found in many academic libraries. As noted in Quagliaroli, the 20th century saw the growing capacity of technology to produce books, journals, and other print-based materials. This is perhaps where most of the academic library’s electronic collections originated from which changed the space needs of the library. With the context of space designed explained from a historical perspective, it can now be discussed how space design can potentially be improved at academic libraries based on a review of literature.
As noted in Cunningham, et al., zones can be delineated by permanent or moveable barriers, by design elements such as furniture or carpet coloration, or through mutually understood tacit behavioral agreements. This is assuming that library users readily associate a specific color, such as brown, of a rug with either quiet study, group work, socializing, eating, mobile phone usage, or computer access. Also, this approach assumes that academic libraries have enough staff to enforce these rules.

Also, Cunningham et. Al. notes that there is a trend to create a one-stop facility for student needs by incorporating cafes, writing centers, classrooms, museums, and computer labs. This is easier said than done because the library shouldn’t be noisy or sacrifice group or individual study space. Also, without conducting a survey there is no way to know if this meets the needs of the various user groups when considering gender, socioeconomics, student mix, etc.

Another issue in the design of the library is the light in the collection. Chernyshov defines the effects of light as being from bright illumination to darkness, including all the shadows and half-light tones in between. This means that the placement of light fixtures at the library have to be examined to see if they provide library users with enough light for study as well as to ensure that they do not contribute to the decay of library materials through light damage.

As noted in Stewart, another aspect of the design of the library is the greater use of glass to link internal and external spaces as well as an emphasis on sustainable architecture. At present, it is difficult to picture how academic libraries could use sustainable architecture and glass links without conducting an engineering and or architectural study and gaining the input of the campus community.

Using the Colorado University at Boulder as an example, Watkins identified the need for more study seating, lounge areas, student and faculty research displays, better layout, more artwork
and appealing décor, and potential development of interactive displays as areas for improvement in the science commons. Since many academic libraries cater to a specific discipline such as the sciences, faculty and research displays and artwork may make the library more inviting to students, faculty, and staff. A lack of permanent displays of research academic libraries may keep the visitor in the dark as to what sciences the students and faculty of college/university are pursuing. Also, the artwork may make the library more inviting for its users.

Another aspect of space design is that it is perceived in Kenan that research skills classes are so much more accessible because of online resources however it requires maybe more knowledge to access it. This may require academic libraries to allocate more space to bibliographic instruction however without surveying library users and faculty it is unknown if they favor bibliographic instruction over library guides or subject specific collections for research help.

What the library spaces are used for is another issue of library design. As noted in Head, the focus of the learning spaces may be the Center for Student Life, Learning Commons, Library public services/learning space renovation, or information commons. Also as noted in Head, the focus of the learning spaces includes both private and public colleges and universities. Many academic libraries conduct a learning spaces study due to renovation of the library.

As noted in Ugwuanyi, the library building must be multifunctional, have openness, and have flexibility. The building design and structure must be able to meet the needs of the user while being efficiency in terms of space and place. This is difficult to measure from just observing the users as was done in an observational space utilization study.

As noted in Gardner, students have great expectations, expect customization, are technology veterans, and utilize new communication methods. While it is hard to tell from observation if
student expectations are being met, student expectations do point towards a library space designed with technology in mind.

Administration of Space Study

Another area for improvement is the administration of the space study. As noted in Quagliaroli, a memorandum of understanding (MOU) can help collaborators articulate a shared vision. This includes aligning the space study with the mission of college/university and the library as well as acknowledging cultural differences. Also, the MOU would address communication issues as noted in Quagliaroli by allowing all the units in the library to get behind the project as well as allowing campus-wide events to take place to explain the project and allowing librarians to work with others (e.g. architects). Also acknowledging embedded librarianship as noted in Quagliaroli is necessary in order to understand how space utilization impacts the job of academic libraries.

As noted in Welch, academic libraries use a learning commons model which uses cross-disciplinary and cross-campus collaboration with pedagogy experts, subject coordinators, and writing experts to further facilitate knowledge creation. This requires the space utilization study to not only rely on space utilization observations as the current model does but requires collaboration with the college/university community at large.

Additionally Majal states that academic libraries are bound by the ACRL Rules which require that the library create intuitive navigation that supports self-sufficient use of virtual and physical space; provide a safe and secure physical and virtual environment conductive to the study and research; have the information technology infrastructure to provide reliable and robust virtual and physical environments needed for study and research; use physical and virtual spaces as intellectual commons, providing access to programs, exhibits, lectures, and more; Design space to facilitate collaboration and learning, and the creation of new knowledge. The ACRL Rules
require more than just observation because that does not measure infrastructure or learning perceptions of the users of academic libraries.

As noted in Laskin, information literacy could differ by ESL students, developmental English, ethnicity, and gender. This cannot be picked up by observation of students in the library but rather than by asking questions of students and faculty.

Also as noted in the 2017 space study conducted at the Wellesley Library, comparing present holding (in linear feet) to Design Capacity (In Linear Feet) is helpful to see how space is being used for the collections.

An ACRL study used studies of the Arcadia University and the University of New Mexico libraries to show how libraries contribute to student learning and success: Students benefit from library instruction in their initial coursework, Library use increases student success, Collaborative academic programs and services involving the library enhance student learning, and Information literacy instruction strengthens general education outcomes. These student learning and success outcomes cannot be measured solely by observing library patrons as is the current methodology, but rather through a combination of surveys, questionnaires, and interviews of college/university faculty, staff, administrators, and students who use the library.

The ACRL study goes onto conclude that library research consultations boost student learning by conducting studies at the University of Texas at San Antonio focused on the information literacy competence of incoming freshmen, St. Catherine University investigated how the timing, frequency, and methods of information literacy had an impact on the information literacy skills of first-term students, and University of Massachusetts Boston impact of library research instruction on student learning. Through the administration of pre and post tests to students receiving library instruction the library can determine how efficient the library instruction or
group study rooms are efficient in improving student outcomes which serves as another justification beyond the direct observations for any change to library space.

Also as noted in the ACRL study, library use increases student success as shown by a California State University East Bay study found library use contributed to student success since students who participated in course-integrated library instruction were much more likely to use library resources and were also more likely to have a higher GPA than students who did not receive the instruction. A library space utilization model that does make space-student centric (e.g. coffee bars) and that incorporates bibliographic instruction into courses is encouraged at academic libraries however without reaching out to the reference librarians focusing on a specific subject (e.g. biology) it is unknown how the library can incorporate bibliographic instruction into course content. Also, without surveying students it is unknown why students use certain areas of the library.

In order to justify the learning commons, the ACRL study uses the University of Miami analyzed the bibliographies of student research papers and conducted interviews with students about their experiences with research and writing. This will help to inform academic libraries how to make the learning commons a student-centric space because after all the students are the primary users of the library. Perhaps the coffee bar or videoconference rooms may have a detrimental effect on student research and writing skills, library administrators will never know without conducting a study that extends beyond just observing library users.

While not a space utilization issue, an all technology culture could contribute to what Stewart calls unreviewed information; commercialized information; complexity; and plagiarism. It is not the role of the library staff to be policing every library user to ensure adherence to college/university’s honor code but rather to serve as a source of information on the proper
citation formats. This requires a space design to ensure that users have access to embedded or subject librarians. This does not necessarily mean doing away with the reference desk but rather taking a survey of library users to see how they want to interact with library staff.

Another space utilization issue is what Chow calls passive engagement or having a relaxing quality and active engagement which involves triangulation or talking with others and forming social relations. Currently the library does not have any partitions separating these two spaces, however without conducting a survey it is unknown how that affects the learning of the students in the library.

Another space utilization issue is the potential for social activism within the community, different social classes, etc. Maybe different classes (e.g. ethnicities) may interact differently when there is a coffee bar or soft seating in the library. This may lead to an increased noise level or need for more materials. This cannot be studied just from observation but rather from interviews and surveys too.

In terms of future space utilization trends for academic libraries to consider, an ESRI white paper recommends a tactical investment strategy by modeling and objectively analyzing impacts on issues. Also, current replacement value (CRV) of technological and office facilities should be considered. Just counting the number of people in the library does not yield an investment strategy or CRV. Also, ESRI white paper recommends mitigating risk by applying optimization algorithms to space utilization. It is unknown if the library has the technical capabilities or budget to account for what ESRI calls population-based and hierarchical metaheuristics. As noted by an ACRL study, financial value, cost/benefit analysis, return on investment is based upon the formula: Library Value=perceived benefits/perceived costs. It is difficult to quantity costs and benefits strictly from observations of space usage and other institutions may not want
to provide such information. Additionally, it is difficult to quantify the what an ACRL study calls the production of a commodity as represented by the formula value = quantity of commodity produced x price per unit of commodity. There is no way to quantify the value of information, time, etc. strictly from an observational study.

**Conclusion/Recommendations for Space Utilization Literature Review**

Space utilization methodologies, research questions, and concerns guide academic librarians in tackling this issue in their libraries. Space Utilization research methodologies may include observation studies and largely depends on why libraries have chosen that particular methodology. Space utilization research questions seek to answer the question of why space utilization studies are conducted and may ask among other things why the library is used by users. What space utilization and administrative concerns to be addressed in a space utilization study are extensive and may include memorandums of understanding between the library and the university. Through a discussion of space utilization methodologies, questions, and concerns it adds another dimension to the ongoing discussion of how to promote access to libraries both in the United States and Internationally.

**Why Virtual Reality?**
Virtual Reality has the potential to increase access to library services for a variety of users, increase the productivity of library savings and produce long-term savings. The convergence of increasing budget pressure and the prevalence of more technology savvy users creates an environment conductive to the introduction of virtual reality to academic libraries. Virtual reality
is defined as “the use of computer technology to create a simulated environment.” Virtual reality also appeals to the so called “net generation” who grew up with the Internet, mobile devices, and other electronic tools.

Of the 3.1 million people ages 16 to 24 who graduated from high school were enrolled in college in October 2016 and represent a cohort that have been exposed to technology and internet-based access to information for most of their lives. This is in contrast to the traditional approach by college and university libraries which have offered students access to reference services, archives, and bibliographic instruction based on physical presence in the library.

Beyond appealing to the net generation, there is a subgroup of users whose disabilities provide challenges to accessing traditional library services. For example, approximately “six to

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3 Topanga. AR VR Journal. 


seven\textsuperscript{6} percent of children with autism enter college and universities and approximately 1,000,000 student veterans\textsuperscript{7}, many of whom may suffer from physical or emotional limitations resulting from their service, are also entering colleges and universities, require that academic libraries determine how best to provide reference services, bibliographic instruction, and or archival services to individuals that may have difficulty accessing library services in a traditional manner. To provide greater access, and to tailor services to those populations, a potential solution is application of virtual reality.

In view of expanding potential application of virtual reality, it is incumbent on academic libraries to explore how virtual reality technologies can be used in reference services, archives, and bibliographic instruction. Aside from exploring the potential uses of virtual reality in academic libraries, a metadata study helps to quantify to some extent if the usage of this technology is a paradigm shift or if it just a generally accepted practice.

**Virtual Reality and Bibliographic Instruction**

In a traditional bibliographic instruction setting, librarians walk users through search techniques or specific subject research techniques while standing in front of a screen. For example, a librarian may have a class of 20 or more library users and would use a classroom-like setting and would demonstrate how to navigate PubMed, or some other academic database, on a


\footnote{7 Department of Veterans Affairs,“VA Campus Toolkit.”, last modified 2019, \text{www.mentalhealth.va.gov}.}
large screen. After walking users through on how to navigate PubMed, users would be instructed to conduct a search on PubMed, using their personal laptops or at computer workstations with the librarian being available to answer questions and provide guidance.

While this is the traditional approach to bibliographic instruction, a University of Maryland study (https://cmns.umd.edu/news-events/features/4155) found that there is a 8.8 percent improvement in recall accuracy of how to navigate a database using virtual reality headsets as compared to the traditional approach to instruction. The increased recall accuracy using virtual reality headsets is attributed to the usage of visual cues\(^8\), which in this case is the database, which coupled with changes and rotations of visual cues\(^9\), which in the case is navigating through the database, cause remapping of some place fields which influences the spatial firing properties of hippocampal neurons\(^10\). Since many academic library users have not used academic library databases before, it is a new mental construct\(^11\) for them and since many


students must use academic library database throughout their careers, the usage of databases is a skill that they should be able to recall. By visually going through the databases on the headsets, academic library users experience spatial perception and movement in 3d which allows them increased recall of how to use a database. This could not be accomplished simply by navigating a database using a computer and a mouse because the user does not experience changes or rotations of space. Given the increased influence on recall accuracy, it might be advantageous for academic libraries to use virtual reality headsets rather than relying on traditional approaches to teach bibliographic instruction.

Further, the use of virtual reality allows library users to access the bibliographic instruction on a 24/7 basis from anywhere. This flexibility may be appealing in view of the prevalence of distance learning courses and degrees which result in fewer students physically present on college campuses and reduces the chances they would visit the academic library.

Libraries are increasing under pressure to reduce budgets and personnel expenditures account for a large portion of library budgets. Budget constraints are compounded by the increasing number of librarians retiring and the corresponding pension and salary costs. In 2017, 85% of libraries reported an increase in personnel budgets from previous years and salary budgets rising by 45% while the percentage of libraries reporting new hires remained essentially flat. Virtual reality may reduce pressure on library budgets by reducing the number of library staff dedicated to bibliographic instruction. Students can merely put on a virtual reality headset

while sitting in their dorm room through self-guided instruction. If they have questions, they can contact a reference librarian for assistance.

The reduction in the need for bibliographic instruction librarians, allows academic libraries to address the issue of “Social comparison\(^\text{13}\)” a key behavioral economic concept which contributes to the increase in personnel expenditures with user instruction librarians demanding remuneration which corresponds to what peers are making in comparably sized libraries. For example, the Placement & Salaries 2017 survey published by the Library Journal revealed that the average salary for graduates at college and university libraries was $46,688 while archivists and special collection librarians were paid $45,710 while graduates at public librarians were paid $44,780 and graduates at school librarians were paid $53,218. By not requiring academic libraries to have reference librarians to conduct bibliographic instruction and instead relying on virtual reality headsets for bibliographic instruction, libraries do not have make sure that their librarians are paid in line with their peers.

Virtual Reality application to triage reference\(^\text{14}\)

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After a library user has put on a virtual reality headset or connected a virtual reality app, they can connect to an information staff member wearing a virtual reality headset to ask a question. Some questions may be answered directly by the information staff member such as how to find an item in the stacks. An information staff member may hand off more in-depth reference question off to a reference librarian wearing a virtual reality headset. Library users do not have to go to the library to ask a question using virtual reality, they can just log into their computer through the college/university’s library website, put on the headset that they purchased from amazon or another retailer, and get the virtual reality app from their smartphone which is free to download in most cases. They can receive their initial virtual reality training by visiting the library or going on to the library’s website.

This allows library users to access library reference services on a 24/7 basis via virtual reality. This model would appeal to the 22-25 year age group of college users who are used to using technology and have the virtual reality headset. Library users with disabilities can use virtual reality interfaces (both software and hardware) as they come on the market. This is an especially viable reference model since many colleges already conduct online courses and online degrees. Currently there are no academic libraries using this reference model.

**Virtual Reality Application to Reference Services**

The proliferation of virtual reality reference services allows for the possibility of reference library desks to operate like call centers in which library users can ask questions of reference librarians using virtual reality headsets from anywhere, anytime. This eliminates the need for the

Modified, June 8, 2016,

traditional library reference desk, in fact reference librarians can be located elsewhere in colleges and universities and still be able to answer questions using virtual reality and direct library users to virtual reality resources. Additionally, using embedded librarianship reference librarians can hold reference instruction courses, courses in the instruction of how to navigate subject-specific databases (e.g. medicine), etc. from anywhere as long as the librarians and the user both have virtual reality headsets on. This allows college students to access library instruction from anywhere on a 24/7 basis which may fit in which college students’ schedules. Also, this means that reference librarians could be located elsewhere on the college/university campus which may make library instruction rooms a thing of the past.

Additionally, as noted in Hillman, et. al. (2016), reference librarians in specific functional areas such as business can train and support faculty teaching online courses. For example, Simmons University has library guides for various courses with links to e-mail reference librarians for help in locating course material. Using a virtual reality app, faculty can connect to reference librarians from the library guides rather than using e-mail which allows faculty to gain support in teaching their courses using virtual reality. Again, reference librarians need not be located in a physical library to interact with faculty via the library guides.

In fact, to save on cost, academic libraries can outsource reference interaction using virtual reality to countries such as India where labor is cheaper. There is little research on this area because virtual reality is a new technology. As long as the contracted reference libraries have a virtual reality headset and internet connection, they can conduct reference services and instruct faculty, staff, and students in general library instruction and subject-specific instruction. Physical academic libraries would still have to exist because it would take many years and many hours of labor to fully virtualize all library materials and archival objects across many disciplines.

Electronic copy available at: https://ssrn.com/abstract=3601843
Virtual Reality Application to Archives

Another common environment where college students, faculty, and staff would use Virtual Reality systems is in academic archives which may be part of an academic library or housed in a separate building on the college/university campus. As noted in Chang (2008), archives employ the following Virtual Reality technologies: Fully-Immersive, Semi-Immersive, Projected Visions, and Desktop Display. Fully-Immersive VR Technologies would use the same headsets connected to computers that academic libraries would use, however the only different would that library users would be navigating archives stacks to find an answer to a research question. Library users would be able to use the triage reference model and ask reference librarians and library aides who are using virtual reality reference questions and receive answers via virtual reality headsets. In navigating archives using virtual reality, users may encounter stacks which may be closed due to donor intent, copyright, or clearance requirements.

While using a semi-immersive virtual reality experience, archives users would be able to use car simulators and flight simulators (non-military) to simulate different scenarios in order to learn how cars have developed over time as well as to develop improved concentration. However, semi-immersive virtual reality technologies may be impractical for archives because it would be cost prohibitive for archives to have virtual reality terminals for each type of historical technology (e.g. horse and buggy) to the model T. Similarly, cost would be a barrier to archives using projected visions because archives cannot have 3d displays for every type of object that they have in their archives which may range from personal papers to corporate objects such as stamps. A desktop or app virtual reality display may be useful for archives users to learn how a historical event occurred. For example, the Bailenson et. al. article would use a CVE to allow users to present facts to the judge or jury, depose expert witnesses, etc. This would allow users to
directly experience how historical trials such as Brown v. Board of Education actually played out.

**How Much do virtual reality headsets cost?**

Now that it has been explained how virtual reality can be used in triage reference, archival services, and archival services in academic libraries, the next question is how much are the headsets? A search of the Internet reveals that libraries use the following vendors for virtual reality headsets.

Table A: VR Vendors

<table>
<thead>
<tr>
<th>Library</th>
<th>Vendor</th>
<th>Cost (USD)</th>
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</thead>
<tbody>
<tr>
<td>San Jose Public Library</td>
<td>Oculus Rift Systems</td>
<td>$399 (^{15})</td>
</tr>
<tr>
<td>Georgetown University</td>
<td>HTC Vive</td>
<td>$499 (^{16})</td>
</tr>
</tbody>
</table>

Perhaps students can get virtual reality headsets as part of their college/university tuition since many students would not be able afford the headsets. A recent CNBC news article reported that in 2017 the average cumulative student loan debt was $26,900 for graduates of public four-year

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\(^{15}\) CNBC. “Here’s how much the average student loan borrower owes when they graduate”, last modified May 20, 2019, [www.cnbc.com](http://www.cnbc.com)

schools and $32,600 for graduates of private nonprofit four-year schools\(^\text{17}\). Thus, the average college student would not be able to otherwise pay on average $499 for a virtual reality headset on their own. It has not been studied how virtual reality headsets can be funded, either as part of tuition or students buying it themselves (just like textbooks), so it is unknown which option appeals to college students.

**Conclusion from literature review**

Since academic libraries do not currently use virtual reality in reference, bibliographic instruction, or triage reference, there is potential for virtual reality technologies to not only save academic libraries money on personnel costs but also allow a more diverse user population to access academic library resources. However, it is unknown if college students would be required to purchase the virtual reality headsets similar to textbooks or if the virtual reality headsets would be part of tuition. Also, additional usability studies are needed to address if the virtual reality technologies in academic libraries will in fact bring in more atypical library users (such as veterans) to use library resources.

**Metadata Study**

Aside from exploring the potential uses of virtual reality in academic libraries, a metadata study helps to quantify to some extent if the usage of this technology is a paradigm shift or if it just a generally accepted practice. The frequency of virtual reality keywords in current literature will help to identify if the usage of this technology is a generally accepted practice in academic libraries. The working hypothesis is that there is a lack of virtual reality keywords in current

\(^{17}\) CNBC. “Here’s how much the average student loan borrower owes when they graduate”, last modified May 20, 2019, [www.cnbc.com](http://www.cnbc.com)
library and information science literature, therefore virtual reality technologies are not a generally accepted practice in academic libraries.

**Are there any current metadata studies on virtual reality and academic libraries?**

A quick review of current literature reveals that there are no metadata studies addressing virtual reality usage in academic libraries. Perhaps this is because academic libraries are a new application for virtual reality technologies. However, a 2018 article in Frontiers in Psychology reveals that out of 10,199 articles, 55% of articles on virtual reality and augmented reality covered the topics of computer science and engineering. The lack of a metadata study on the application of virtual reality to academic libraries suggests that the usage of virtual reality in academic libraries is not a generally accepted practice for academic libraries.

**Data Sources and Search Strategies**

Relevant studies were located through a comprehensive search of publicly available literature. Searches of PQDT Open Dissertations and Theses were limited to those published from 1951 through 2019 to allow for the usage of PQDT for retrieval.

**Electronic Database Searches**

Using a common set of keywords, searches were performed in two research databases: PQDT Open Dissertations and Theses and Google Scholar. Literature searches were performed in December 2019 in both research databases and terms for initial research database search are derived from the literature review.

**Terms for Initial Research Database Search**

Table B: Terms for Initial Research Database Search

<table>
<thead>
<tr>
<th>Virtual Reality Term(s)</th>
<th>Library Science Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Reality</td>
<td>Triage Reference</td>
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<tr>
<td>Bibliographic Instruction</td>
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<tr>
<td>---------------------------</td>
<td></td>
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<tr>
<td>Archives</td>
<td></td>
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<tr>
<td>Academic Libraries</td>
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</tbody>
</table>

**Initial Screen for Abstracts from Electronic Databases**

The initial Google Scholar search for “virtual reality and academic libraries” yielded 304,000 results. This number included books as well as journal articles and patents. To whittle down these search results, the “patent” and “citation” boxes were unchecked on Google Scholar since the researcher is only focusing on metadata analysis of studies. By unchecking these two boxes, the results were narrowed down to 281,000. Many of the results contained earlier versions of the same studies. So, in an effort to narrow down the result of the Google Scholar search, the “Advanced Search” tab was selected and the option was chosen “where my words occur in the title of the article” which did not return any results which suggested that there are no studies published on Google Scholar which addresses virtual reality and academic libraries.

While this result may lead one to conclude that virtual reality is not a generally accepted practice in academic libraries, the search terms “triage reference”, “bibliographic instruction”, and “archives” were tried in combination with the search term “virtual reality” on the off chance that virtual reality is a generally accepted practice in either archives, bibliographic instruction, or triage reference.

The initial Google Scholar search for “virtual reality and triage reference” yielded 15,500 results. This number included books as well as journal articles and patents. To whittle down these search results, the “patent” and “citation” boxes were unchecked on Google Scholar since the researcher is only focusing on metadata analysis of studies. By unchecking these two boxes, the results were narrowed down to 13,900. Many of the results contained earlier versions of the same
studies. So, in an effort to narrow down the result of the Google Scholar search, the “Advanced Search” tab was selected and the option was chosen “where my words occur in the title of the article” which did not return any results which suggested that there are no studies published on Google Scholar which addresses virtual reality and triage reference.

The initial Google Scholar search for “virtual reality and bibliographic instruction” yielded 27,400 results. This number included books as well as journal articles and patents. To whittle down these search results, the “patent” and “citation” boxes were unchecked on Google Scholar since the researcher is only focusing on metadata analysis of studies. By unchecking these two boxes, the results were narrowed down to 26,900. Many of the results contained earlier versions of the same studies. So, in an effort to narrow down the result of the Google Scholar search, the “Advanced Search” tab was selected and the option was chosen “where my words occur in the title of the article” which did not return any results which suggested that there are no studies published on Google Scholar which addresses virtual reality and bibliographic instruction.

The initial Google Scholar search for “virtual reality and archives” yielded 371,000 results. This number included books as well as journal articles and patents. To whittle down these search results, the “patent” and “citation” boxes were unchecked on Google Scholar since the researcher is only focusing on metadata analysis of studies. By unchecking these two boxes, the results were narrowed down to 348,000. Many of the results contained earlier versions of the same studies. So, in an effort to narrow down the result of the Google Scholar search, the “Advanced Search” tab was selected and the option was chosen “where my words occur in the title of the article” only returned two articles on Google Scholar which suggests that the usage of virtual reality in archives is a conceptual theory akin to the infancy of the Internet which lends credence
to the hypothesis that the usage of virtual reality in academic libraries is not a generally accepted practice.

**PQDT Screen for Abstracts**

On the off chance that Google Scholar did not pick up any articles on virtual reality and academic libraries, bibliographic instruction, archives, or triage reference due to algorithmic abnormalities or other factors, a PQDT screen was conducted. The search terms “academic libraries and virtual” reality were typed into the PQDT search box and revealed 37,075 results. However, the results largely focused on either the future of academic libraries or virtual reality, but not both, which suggests that the topic of virtual reality and academic libraries have not been fully investigated and thus is not a generally accepted practice.

On the off chance that virtual and triage reference was investigated as a sub specialty area or offshoot of academic libraries, these search terms were plugged into PQDT. This returned 33,800 results which suggests that this area is still being investigated and is not a generally accepted practice in academic libraries and is still a theoretical concept.

On the off chance that virtual and bibliographic instruction was investigated as a sub specialty area or offshoot of academic libraries, these search terms were plugged into PQDT. This returned 22,112 results which suggests that this area is still being investigated and is not a generally accepted practice in academic libraries and is still a theoretical concept.

On the off chance that virtual and archives was investigated as a sub specialty area or offshoot of academic libraries, these search terms were plugged into PQDT. This returned 14,114 results which suggests that this area is still being investigated and is not a generally accepted practice in academic libraries and is still a theoretical concept.

**Conclusion from Metadata Study and Review of Literature**

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The usage of virtual reality in academic libraries represents a paradigm shift from the era of physical collections (e.g. books) and is largely driven by the budgetary constraints of libraries and the ease of which library users use technology as well as the need to make the library accessible to all. The space utilization literature review demonstrates that space utilization is a concern to be addressed when accessing libraries from student, faculty, and staff perspectives. Since academic libraries do not currently use virtual reality in reference, bibliographic instruction, or triage reference, there is potential for virtual reality technologies to not only save academic libraries money on personnel costs but also allow a more diverse user population to access academic library resources. However, it is unknown if college students would be required to purchase the virtual reality headsets similar to textbooks or if the virtual reality headsets would be part of tuition. A metadata analysis of literature available on Google Scholar and PQDT provides that the incorporation of virtual reality in academic libraries, archives, triage reference, and bibliographic instruction is not a generally accepted practice which is further evidence that it is a paradigm shift. In conclusion, embracing the paradigm shift as a means of connecting to technology savvy users is one of the ways academic libraries stay afloat in the 21st century and do not perish like the typewriter.

References


Last Modified, April 2016, [https://vhil.stanford.edu/mm/2006/bailenson-courtroom.pdf](https://vhil.stanford.edu/mm/2006/bailenson-courtroom.pdf)


Camerer, C.F., & Malmendier, U. *Behavioral Economics of Organizations.*

Retrieved April 8, 2013, from [http://emlab.berkeley.edu/~ulrike/Papers/BEO_chap7.pdf](http://emlab.berkeley.edu/~ulrike/Papers/BEO_chap7.pdf)

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6232426/

CNBC. “Here’s how much the average student loan borrower owes when they graduate”, last modified May 20, 2019, www.cnbc.com

Department of Veterans Affairs, “VA Campus Toolkit.”, last modified 2019, www.mentalhealth.va.gov

Georgetown University. “Virtual Reality at Gelardin”, last modified July 2, 2019, www.library.georgetown.edu


https://www.tandfonline.com/doi/abs/10.1080/1533290X.2016.1219205


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Topanga. AR VR Journal.


https://digitalcommons.bryant.edu/cgi/viewcontent.cgi?article=1000&context=library_misc


https://acrl.libguides.com/c.php?g=459032&p=3138021

https://acrl.libguides.com/c.php?g=459032&p=3138014


Chowdhury, et. Al. “Usability and impact of digital libraries: a review.” Last Modified, April 10, 2019,
https://search.proquest.com/docview/194512556/D2E9CACC5FB24543PO/5?accountid=11311

Chernyshov, E. “Light, Dark, and all That’s In Between: Revisiting the Role of Light in Architecture.” Last Modified, April 11, 2019,
https://search.proquest.com/docview/304808310/A12C9171DB6A460CPQ/1?accountid=11311

CT State Library Division of Library Development. “Library Buildings and Construction: Library Space Planning.” Last Modified, February 19, 2019,
https://libguides.ctstatelibrary.org/dld/construction/spaceplanning

© Copyrighted 2020 Gregory Tharp


EPA. “Library Management Theories Space Planning and Design for Libraries.” Last modified, February 19, 2019,
sword=anonymous&SortMethod=h%7C-
&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&D
isplay=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results
%20page&MaximumPages=1&ZyEntry=2


Head, A.J. (December 2016). Planning and Designing Academic Library Learning Spaces:
Expert Perspectives of Architects, Librarians, and Library Consultants

Alston, J. “Causes of Satisfaction and Dissatisfaction for diversity resident librarians—a Mixed Methods Study Using Herzberg’s Motivation-Hygiene Theory.” Last Modified, April 12, 2019,
https://scholarcommons.sc.edu/cgi/viewcontent.cgi?article=5098&context=etd

Watts, K., et. al. (July 2015). User Preferences and Library Space at Whitworth University Library. Retrieved February 19, 2019, from
https://journals.sagepub.com/doi/10.1177/0961000615592947


[https://digitalcommons.bryant.edu/cgi/viewcontent.cgi?article=1000&context=library_msc](https://digitalcommons.bryant.edu/cgi/viewcontent.cgi?article=1000&context=library_msc)


Massachusetts Institute of Technology. “Framework for Space Planning in the MIT Libraries: Phrase One.” Last Modified, April 10, 2019,  

University of Colorado Boulder. “Space Utilization and Optimization.” Last Modified, February 19, 2019,  

Watkins, A., et. Al. “Creating Connective Library Spaces: A Librarian-student collaborative model.” Last Modified, April 11, 2019,  
[https://scholar.colorado.edu/cgi/viewcontent.cgi?article=1038&context=libr_facpapers](https://scholar.colorado.edu/cgi/viewcontent.cgi?article=1038&context=libr_facpapers)


University of Memphis. “Space Planning process and Utilization.” Last Modified, February 19, 2019, https://www.memphis.edu/space/


Kenan, S. “Perceptions of Personnel at Selected Texas Community Colleges Regarding the Impact of Technology on Their Libraries.” Last Modified, April 11, 2019, http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1090&context=cehsedaddiss


2017 IATUL Proceedings:
https://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=2173&context=iatul


Electronic copy available at: https://ssrn.com/abstract=3601843

© Copyrighted 2020 Gregory Tharp


Gardner, et. Al. “What students want: Generation Y and the changing function of the academic library.” Last Modified, April 12, 2019,

http://dspace.calstate.edu/bitstream/handle/10211.2/2949/Eng-
ZiskinSusanna200507.pdf?sequence=1


https://www.uncp.edu/resources/institutional-research/institutional-planning/space-utilization
