International Journal of Library and Information Services
Volume 12 • Issue 1

The Creation and Adoption of Technology-Centred Makerpaces in South African Academic Libraries

Tlou Maggie Masenya, Durban University of Technology, South Africa

ABSTRACT

Libraries of today are not just a place to consult books and other pedagogical materials but have completely transformed into a space where users can interact, create, and collaborate. Library and information centres are creating spaces called makerspaces in this digital transformation era, whereby researchers work together and share ideas in their various areas of specialisation. Makerspace are relatively new phenomena that create a collaborative and innovative environment for individuals to work on projects and learn about emerging technologies. Technology-centred makerspaces are increasingly being built in academic libraries, typically featuring high-tech machines and software that facilitate creation and design. This study investigated the creation and adoption of technology-centred makerspaces in academic libraries and the impact that makerspaces have on academic innovation. The study utilized literature review analyzed secondary data from articles, journals, periodicals, and publications to identify the need to design makerspaces, what is required in setting up a makerspace, and how academic libraries utilize makerspaces. The benefits accrued from makerspaces, barriers to effective adoption of these spaces, factors enabling adoption of makerspaces, and the state-of-the-art facilities offered by the library were also explored in this study. It is recommended that library management should not hesitate to establish makerspaces in their respective academic libraries, as this will aid in promoting knowledge-sharing, collaboration, creativity, and innovation.

KEYWORDS

Academic Innovation, Academic Library, Collaborative Learning, Digital Innovation, Digital Library, Hackerspace, Knowledge-Sharing, Makerspace

INTRODUCTION

Academic libraries are ever-changing hubs, resolutely benefitting the students, faculties and communities that support them. However, with the advent of digital technologies, academic libraries have lost their monopoly as the primary information providers. As noted by Filar-Williams and Folkman (2017), the future of libraries is to be user communities engaging in creating content and using it for community-building, connecting people, engaging students, assisting researchers, advancing knowledge production and promoting knowledge-sharing. Makerspaces, also called hackerspaces or fablabs, make a unique contribution to the partnership between academic libraries

DOI: 10.4018/IJLIS.320224 *Corresponding Author

This article published as an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/) which permits unrestricted use, distribution, and production in any medium, provided the author of the original work and original publication source are properly credited.

and digital humanities by providing a creative space for learning new skills and knowledge, experimenting, and sharing materials and equipment. The American Library Association (ALA) pointed out that library makerspaces cultivate community around learning and that they reinforce learning, spark innovation and build problem-solving skills. De Beer et al. (2017) describe 'making' as applying creative skills using technologies and tools both digital and analogue, and maker-community activities as driven by values of collaboration, experimentation and problem-solving. The term 'makerspace' has been in use since the publication of *Make* magazine in 2005, and the subsequent launch of Maker Faire, an event that demonstrated the popularity of making and showcasing new technologies (Wong & Partridge, 2016).

Makerspace is a collaborative space where people with ideas and interest in technology come together to learn new things, work with their peers on projects, invent new projects, share ideas and consider new ideas. It thus provides the physical space that promotes collaboration between individuals with various and distinct areas of knowledge, which is fundamental to fostering a creative environment. As noted by Konopasky and Sheridan (2020), the making happens across a variety of spaces where there is an educational focus, both informal (i.e, museums, community centers and libraries) and formal (from K–12 to higher education). Makerspace movement thus aimed at supporting a range of learner activities and outcomes including equity, access to technology, virtual community and support, social interaction and creativity (Konopasky & Sheridan, 2020). This expansion of academic library space and function is broadly meant to allow the library to more aptly house functions that support academic success and provide opportunities for faculty and students from different disciplines to mingle (Lewis, 2017).

The establishment of makerspaces encompasses a variety of spaces that match the variety of ways whereby students and faculty do their work quietly and privately in groups with their own technology and with technology supplied by the library (Lewis, 2017). Libraries have remained an ideal setting for makerspace events, and many makerspaces offer community resources like software, hardware, electronics and more. Makerspaces vary depending on the library, but involve providing access to a litany of creative tools like laser cutters, 3D printers, sewing machines, bike repair facilities, microcontrollers, circuits, clay and porcelain (Mestre, 2020). Makerspaces are also associated with creating, building and crafting, and getting hands-on experience in activities ranging from woodworking, sewing and building computers to audio-recording and video editing (Fourie & Meyer, 2015). The success of makerspaces at drawing students to the library is gaining global attention, and universities worldwide are turning to academic libraries as a model on which to base their own makerspaces (Curry, 2017).

While many makerspaces in public libraries are not necessarily high-tech, the ones in academic libraries are almost always centred on technology (Curry, 2017). Makerspaces are also an emerging phenomenon in the United Kingdom, with some universities such as Cardiff, Falmouth, Strathclyde, Kent and University College London (UCL) having developed these technology-based community workspaces (Curry, 2017). The Department of Library Services at the University of Pretoria (UP) is also a home to the first library makerspace in South Africa, and it is open to all students and staff, whether for assignments or personal interest. The UP makerspace gives students access to some of the latest technology trends such as 3D printing, 3D scanning, electronics and 3D design software. Access to the UP makerspace is free, and there are a handful of library assistants waiting to help users. UP or academics are also welcome to contact the makerspace for assistance and guidance for enhanced teaching and learning.

RATIONALE FOR THE STUDY

Traditionally, academic institutions have not promoted environments in which individuals and students play an active role in their own education as well as that of their peers. A makerspace is a technology-enabled space for making things, or an environment where individuals come together to

share knowledge and ideas. Makerspaces often host events called hackathons, where people come together and work on a given project (Briscoe & Mulligan, 2014). Although there has been great interest in makerspaces in the public sector and strong confidence in their value to the innovation ecosystem, little academic research has been undertaken on the creation of makerspaces in academic libraries (Oswald & Zhao, 2021). It seems apparent that makerspaces aid in the innovation process, but there is a lack of theoretical explanation on the benefits and adoption of makerspaces in academic libraries and what underlying mechanisms are at play. As such, this research is an exploratory dive into the adoption of the makerspace in academic libraries.

Academic libraries face many perennial challenges, including promoting collaboration, improving learning achievement, strengthening knowledge, and technology transfer. A less explored area is the adoption of makerspaces in academic libraries and academic librarians and information professionals have been passive in implementing makerspaces (Onifade & Olatoye, 2022). It is therefore important to enhance scientific knowledge creation and sharing processes in academia for significant transformation. Numerous studies have examined issues of knowledge-sharing in both the private and public sector organizations, however, as noted by Hira and Hynes (2018), comprehensive research in the area of makerspace implementation with the aim of promoting knowledge-sharing among staff in academic institutions is limited. Dougherty (2012) believes that academics academic institutions should look to the maker movement to understand how to create a truly innovative economy with an ecosystem full of talent, connections and learning. These institutions need to recognize knowledge as a vital resource in management activities, for spurring growth and innovation (Njiraine & Le Roux, 2011). But what should academic libraries in South Africa be doing to ensure effective implementation and adoption of makerspaces? This paper thus aims to fill a gap in the literature by identifying the factors enabling effective adoption of makerspaces within academic libraries. The paper looks into the mechanisms, models and theories being established in various organizations in different parts of the world for effective implementation of makerspaces in academic libraries, with a view to developing an integrated conceptual framework applicable to academic libraries in South Africa. The research objectives formulated for this study were to:

- Investigate the benefits of using makerspaces in South African academic libraries.
- Establish the extent to which makerspaces are being created and adopted in South African academic libraries.
- Determine the barriers to effective adoption of makerspaces in South African academic libraries.
- Determine the factors enabling the adoption of makerspaces in South African academic libraries.

CONCEPTUAL FRAMEWORK

A combination of theories and models were required to give grounded coherence to the study and to understand the factors enabling successful development and adoption of makerspaces in academic libraries. These included the platform model; SociaLib system: collaborative digital library model platform; collaborative learning theory and Vygotsky's (1978) theory of social development, all of which were used as theoretical frames to guide the study.

Platform Model

The platform model is a model of librarianship in which librarians offer common areas to facilitate group study and collaboration, and provide tools and technologies for patrons to come together and use them in the library (Mestre, 2020). Mattern (2014) describes the platform model as a system upon which developers create new applications, technologies and processes, and resources are laid out for users to execute various tasks. As noted by Fourie and Meyer (2015), students and staff can enter a makerspace and tinker, however, the librarian's role is to make the spaces and tools available. According to Weinberger (2012), a library as a platform would give rise to messy, rich networks of

people and ideas, continuously sparked and maintained by the library's resources. Fourie and Meyer (2015) described the emphasis of the platform model as being on providing physical spaces and tools, and ensuring an environment that encourages trying, doing, creating spontaneously, enjoying and physical output, with reference to the traditional roles and responsibilities of libraries related to information resources and information literacy.

SociaLib System: Collaborative Digital Library Model Platform

SociaLib system is a theoretical model of a cooperative digital library, developed and implemented using Drupal, a free and open-source Content Management System (CMS), which is suitable for the development of many different types of websites such as community Web 2.0 portals, discussion sites and social network sites (Mitropoulos et al., 2014). According to this model, a social community was created based on the Online Public Access Catalogue (OPAC) of the digital library (Chalon et al., 2008). Mitropoulos et al. (2014) described the goal of the SociaLib system as the effective incorporation of an environment of collaboration and interworking between users for all the main functionalities of digital libraries. Chalon et al. (2008) further noted that this collaborative model or system can encourage students to use the digital library services of their institution, something that at present has not been achieved to a satisfactory degree. SociaLib system creates a hybrid model that covers the needs of both old and new users while providing innovative services, and it aims towards two new targets while offering a variety of functionalities to digital library users (Mitropoulos et al., 2014), including:

- The integration of all the aforementioned functionalities into one social and collaborative digital library system, while utilizing the power of widespread social networks, both those focused solely on socializing (i.e., Facebook, Twitter) and those focused on bringing professionals together (i.e. LinkedIn).
- To discuss the pros of embedding such a system in a traditional library environment, as this relates to providing solutions to both librarians and library users.

SociaLib system creates an environment that provides the functionality of easy and immediate inter-networked cooperation between users for executing various tasks. This environment thus gives users the capability to contribute in the development and improvement of digital library services using Web 2.0 technologies and services (Mitropoulos et al., 2014). As noted by Maness (2006), this system abides with the principles of Library 2.0 and allows the creation of user groups, as well as the capability to improve library services. SociaLib system also provides the following functionalities in an academic environment as summarised by Mitropoulos et al. (2014):

- Members of a work group are provided with the capability of digital cooperation, and the postgraduate or undergraduate students who may not have adequate available time to meet physically in the library may cooperate through SociaLib.
- It unifies the digital cooperation means of communication of its members through selected Web 2.0 services such as wiki groups, Really Simple Syndication (RSS) feeds, synchronous conversations, discussion forums and group blogs. Cooperation among group members is enhanced through rating, commenting and tagging for the cooperative improvement of the digital library and therefore, users who are satisfied with the unified environment of collaboration are encouraged to assist in the improvement of the environment itself (Chalon et al., 2008).
- It can be applied in an interdepartmental academic environment and allows users to work and cooperate with their teams from where they are located and through any means.
- It publishes large global digital libraries available to users, provides them with links to facilitate their research, enriches the library with the views of users regarding its content, and strengthens search capabilities by using social tagging.

- It offers the possibility for immediate help in questions raised regarding a task by a member who knows the answer, through a response in the community forum. Requests for help in one's work can be announced to the rest of the community through RSS feeds.
- It offers access to the library portal via mobile devices and to the web-based workspace via authentication, whereby the user can see the news of his work group and respond to them using his mobile phone.

SociaLib system thus constitutes an intelligent way to bring students, teachers and researchers closer to the library using the social community and tools of Web 2.0, as they use these technologies in their everyday life (i.e., Facebook, Windows Live Messenger) and are increasingly familiar with them. In this way, visits to the digital library can be increased, while, step-by-step, an active web educational community can also be developed (Mitropoulos et al., 2014).

Collaborative Learning Theory

As noted by Singh (2018), members within makerspaces embrace the do-it-yourself spirit by building and learning together. Laal and Laal (2012) describe collaborative learning theory as a process whereby a group (or groups) of individuals learn from each other by working together to solve a problem, complete a task, create a product or share one's thinking. It is the educational approach of using groups to enhance learning through working together, whereby groups of two or more learners work together to solve problems, complete tasks or learn new concepts (Vygotsky, 1978). The collaborative learning theory describes how collaborative learning, in combination with various types of learning and various learning complexities, increases the skills of members and the community as a whole (Stacey, 1999). Skill development is therefore a continuous outcome, while the process of collaborative learning creates two final types of outcomes: innovation and venture creation. As noted by Oswald and Zhao (2021), innovation is the creation of a new product or service resulting from projects at the makerspace, while venture creation occurs when an idea or a project turns into a registered business. These outcomes occur when one or more members become experts and create a product or service that causes innovation or results in a created venture (Oswald & Zhao, 2021).

The individual benefits of collaborative learning include the following: it turns learning into a truly active process, it promotes learning from others' viewpoints, it teaches how to think critically and quickly, it promotes listening to criticism and advice, it develops public speaking and active listening skills and it improves cooperation (Gokhale, 1995).

Vygotsky's Theory of Social Development

Vygotsky's (1978) social learning theory puts an emphasis on the importance of social interaction for the development of learning and cognition, and it approaches learning from a sociocultural viewpoint, arguing that individual development does not happen without being informed by social and cultural contexts. This theory suggests that human learning is largely a social process, and that our cognitive functions are formed based on our interactions with those around us who are more skilled (Hausfather, 1996). According to the sociocultural perspective, our psychological growth is guided by people in our lives who are in mentor-type roles such as teachers and parents. Vygotsky's (1978) social learning theory presents the idea that if you visualise what a person can and cannot do as 'zones,' between these zones is a third zone known as the 'zone of proximal development.' This zone bridges the gap between what is known and what can be known. As stated by Crawford (1996), this is the distance between the actual development level (of the learner) as determined by independent problem-solving, and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers. It is what a person is able to learn with guidance and it is in this zone that new skills in the process of development are found. Therefore, according to Vygotsky (1978), a person will learn the skills found in their zone of proximal development when he/she has an access to other people who will teach him/her.

Vygotsky (1978) also developed the concept of the More Knowledgeable Other (MKO), a person who already has the knowledge or experience that the learner is seeking. It could be a parent, teacher or older adult, but could just as easily be a peer. It is through interactions with this knowledgeable person that a learner can see desired behaviours modelled or receive important information. Vygotsky (1978) termed this as 'collaborative dialogue,' as the learner seeks knowledge, internalises the information provided by the MKO, then uses that information to guide their own actions. MKOs allow the learner to operate within the zone of proximal development. Children are able to progressively extend this zone as they are allowed to stretch their skills and knowledge, often by observing someone who is slightly more advanced than they are. Hausfather (1996) believed that this lifelong process of development was dependent on social interaction and that social learning actually leads to cognitive development. Vygotsky's (1978) social development theory thus views human development as a socially mediated process in which children acquire their cultural values, beliefs and problem-solving strategies through collaborative dialogues with more knowledgeable members of society. Hausfather (1996) concurs that one of the ways students gain knowledge is by collaborating with their peers or mentors on activities that involve problem-solving skills and real-life tasks. Therefore, a student can perform a task under adult guidance or with peer collaboration that could not be achieved alone. Vygotsky (1978) thus recognized that social settings and learning were closely entwined and therefore one must identify and implement strategies that are effective in a social context.

RESEARCH METHODOLOGY

This article critically reviewed the literature, using the qualitative content analysis method in order to analyse the adoption of makerspaces in academic libraries in South Africa. Content analysis is suitable for analysing various qualitative and unstructured data, such as those collected during unstructured or semi-structured interviews or web-based documentary research. Roller and Lavrakas (2015) describe qualitative content analysis as the systematic reduction of content, analysed with special attention to the context in which it was created, to identify themes and extract meaningful interpretations of the data. Although content analysis has served mostly as a complement to other research methods, it has also been used as a stand-alone method, and there are some specialised forms of qualitative research that rely solely on the analysis of content (Bowen, 2009). Like other analytical methods in qualitative research, content analysis requires that data be examined and interpreted in order to elicit meaning, gain understanding and develop empirical knowledge (Corbin & Strauss, 2008). The analytic procedure thus entails finding, selecting, appraising or making sense of and synthesising data contained in documents. For the current study, content analysis was applied for reviewing literature and empirical studies reporting on previous studies in the creation and adoption of makerspaces in academic libraries, following the guidelines advanced by Kitchenham (2004). The review protocol was composed of the following elements:

Inclusion/Exclusion Criteria

The inclusion criteria aim to identify studies that provide direct evidence about the research questions (Kitchenham, 2004). The literature review on the creation and adoption of makerspaces in the library context was conducted in major databases such as EBSCOhost, ScienceDirect, Springer, Emerald insight, Scopus, Web of Science and Google Scholar, to ensure inclusion of all relevant studies in content analysis. The review process begun with the researchers identifying and selecting documents on the basis of their usefulness and relevance to the study. Only peer-reviewed journal articles written in English and published from the years 2013–2022 (within a period of ten years) were considered and included in the content analysis, and they were therefore taken as units of analysis. The ten-year timeline was chosen because there has been an exponential growth in networked technologies and innovation in academic libraries in the digitization and digital transformation era. Academic libraries have been increasingly implementing and integrating digital or innovative technologies into their

practices and services in the last ten years. The types of studies considered for inclusion in the literature review thus included all qualitative, quantitative and mixed-methods studies. The editorials, theses, books and all other articles not focusing on the creation and adoption of makerspaces in academic libraries were thus excluded from this study.

Search Strategy

The search strategy aimed at finding peer-reviewed articles and was conducted using some of the databases that provide access to publications in a variety of fields, namely: EBSCOhost, Emerald insight, Springer, Scopus, Web of Science and Google Scholar. Databases such as EBSCOhost allow using complex search strings and filters, which makes it easy to apply complex selection criteria; and it is therefore considered a suitable choice for systematic literature reviews (Wang & Noe, 2010). The search terms or keywords were used to collect data from related studies reporting on the creation and adoption of makerspaces in academic libraries, as shown in Table 1. The retrieved articles were screened over two rounds for the study's selection. In the first round, the researchers reviewed the titles and abstracts according to the inclusion and exclusion criteria; whereas in the second round of the review, the full texts of the selected articles were screened to determine if they met the outlined criteria and to delete duplicates.

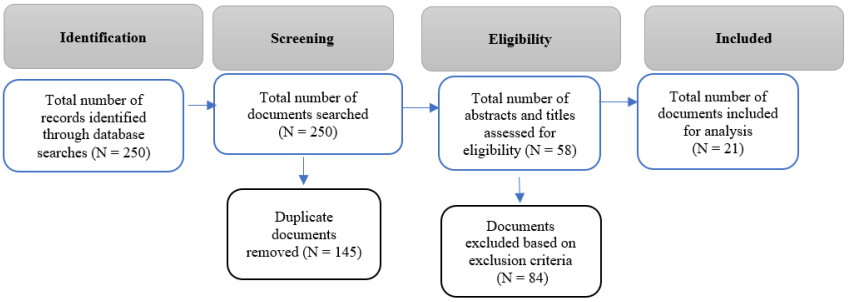
STUDY SELECTION

In the first round, many articles related to the study were retrieved as per titles and abstracts. However, some of the articles, including all the duplicates, were removed after a thorough reading of all the articles, mainly because of their irrelevance to the topic of interest and research objectives; thus, the sample size was considerably reduced. The selection criteria included systematic literature reviews,

Table 1. Databases, search terms and number of retrieved articles

Databases	Search terms/keywords	Number of retrieved articles/results
EBSCOhost Year range: 2013–2022	Makerspaces and academic libraries	44
Emerald Insight Year range: 2013–2022	Adoption of makerspaces and academic libraries	19
Scopus Year range: 2013–2022	Creation of makerspaces and academic libraries	16
Web of Science Year range: 2013–2022	Academic libraries innovations	27
Google Scholar Year range: 2013–2022	Technology-centred makerspaces	15
Springer Year range: 2013–2022	Makerspaces and academic libraries	18
EBSCOhost Year range: 2013–2022	Adoption of makerspaces and academic libraries	33
Emerald Insight Year range: 2013–2022	Creation of makerspaces and academic libraries	24
Scopus Year range: 2013–2022	Technology-centred makerspaces	13
Google Scholar Year range: 2013–2022	Academic libraries innovations	41

Figure 1. Flow chart of the process of the study selection for the systematic review guided by the PRISMA method



empirical studies and other reviews published in peer-reviewed journals focusing on the creation and adoption of makerspaces in academic libraries. The articles relevant to the study were initially identified after the second round of the search, following an iterative process of manual screening. The search thus resulted in the retrieval of 250 articles, whereby a total of 145 duplicate articles were removed, and the remaining 105 articles were screened for relevance using the inclusion criteria. A total of 47 articles that were determined to be irrelevant to the study were removed, and a total of 58 articles were evaluated for eligibility. Furthermore, a total of 37 articles that did not cover the entire scope of the review were excluded based on the exclusion criteria used in the study. A total of 21 articles that met the inclusion criteria were included in the final review, which largely focused on the creation and adoption of makerspaces in academic libraries.

DATA ANALYSIS AND SYNTHESIS

Descriptive-analytical narrative method was used to systematically analyse the qualitative data or text extracted directly from previous studies focusing on the creation and adoption of makerspaces in South African academic libraries. Of the 21 selected articles, the majority focused on the adoption and use of makerspaces in academic libraries (n = 8). Other remaining articles focused on the awareness and use of makerspaces in academic libraries

(n = 3), collaborative learning in makerspaces (n = 3), competencies and skills acquired in makerspaces (n = 3) and other makerspace initiatives in academic libraries from different countries (n = 4). Table 2 presents the selected articles or studies focusing on the creation and adoption of makerspaces in South African academic libraries, including the title, author with year of publication, and country where the article was published.

Overview of Literature Review on Technology-Centred Makerspaces

A makerspace is a highly collaborative and creative space that is set aside for the conception and construction of art, design, and technology projects using materials that are provided for this purpose (Hussain & Nisha, 2017). It focuses on developing innovation, exploration, creative problem-solving, prototyping and design thinking. Design thinking is a human-centred approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology and the requirements for business success (Brown & Katz, 2011). Makerspaces are referred to as a gathering point for people, tools, projects, mentors and expertise (Hlubinka et al., 2013), and therefore people using these spaces are called 'makers,' while the development of creators or makers around the world is called the Maker Movement.

Table 2. List of articles in the systematic literature review for the creation and adoption of technology-centred makerspaces in South African academic libraries

ID	Author	Title	Country/state
A1	Colegrove (2013)	Editorial board thoughts: Libraries as makerspace	California
A2	Slatter & Howard (2013)	A place to make, hack, and learn: Makerspaces in Australian public libraries	Australia
A3	Dugmore et al. (2014)	Making the makers: An exploration of a makerspace in a city library	New Zealand
A4	Burke (2015)	Making sense: Can makerspaces work in academic libraries?	Portland
A5	Fourie & Meyer (2015)	What to make of makerspaces: Tools and DIY only or is there an interconnected information resources space?	South Africa
A6	Koh & Abbas (2015)	Competencies for information professionals in learning labs and makerspaces	United States
A7	Moorefield-Lang (2015)	Change in the making: Makerspaces and the ever-changing landscape of libraries	Colombia
A8	Okpala (2016)	Making a makerspace case for academic libraries in Nigeria	Nigeria
A9	Bowler & Champagne (2016)	Mindful makers: Question prompts to help guide young peoples' critical technical practices in makerspaces in libraries, museums and community-based youth organizations	Canada
A10	Wong & Partridge (2016)	Making as learning: Makerspaces in universities	Australia
A11	De Beer et al. (2017)	A scan of South Africa's maker movement	South Africa
A12	Curry (2017)	Makerspaces: A beneficial new service for academic libraries?	England
A13	Hussain & Nisha (2017)	Awareness and use of library makerspaces among library professionals in India: A study	India
A14	Lee (2017)	Campus-library collaboration with makerspaces	United States
A15	Hira. & Hynes (2018)	People, means, and activities: A conceptual framework for realizing the educational potential of makerspaces	United States
A16	Michalak & Rysavy (2019)	Academic libraries in 2018: A comparison of makerspaces within academic research libraries	United States
A17	Mestre (2020)	The troubling trend of academic makerspaces	United States
A18	Efe (2021)	Awareness of the concept of makerspace: The scenario of university libraries in Nigeria	Nigeria
A19	Oswald & Zhao (2021)	Collaborative learning in makerspaces: A grounded theory of the role of collaborative learning in makerspaces	China
A20	Rose & Brian (2021)	Social work digital storytelling project: Digital literacy, digital storytelling, and the makerspace	Canada
A21	Onifade & Olatoye (2022)	Awareness, adoption, and implications of makerspaces in academic library in Nigeria	Nigeria

Literature Review Findings

The findings are presented under the following themes, based on research objectives: the benefits of using makerspaces in academic libraries, the adoption and use of makerspaces in academic libraries, barriers to effective adoption of makerspaces in academic libraries and factors enabling the adoption of makerspaces in academic libraries.

Benefits of Using Makerspaces in Academic Libraries

The Institute of Museum and Library Services (2012) describes makerspaces as part of a growing movement of hands-on, mentor-led learning environments to make and remake the physical and digital world. Makerspaces are "places where making happens in community" and where learning occurs (Litts, 2015), and they foster experimentation, invention, creation and exploration. Makerspaces are a special blend of community, space and tools that provide community members with a 'third place' (Litts, 2015). These spaces offer highly rewarding services to students, faculty members, and staffers and make them learn new things while working with their peers, considering new ideas, exploring, tinkering and inventing (Hussain & Nisha, 2017). Makerspaces can provide safe and friendly learning environments for individuals to explore and learn about information technology through the process of creation and experimentation. Hussain and Nisha (2017) further described the makerspace as a physical space in the library that allows sharing of information, knowledge and experience, and which hosts different people who may have different backgrounds academically, ethnically and socially.

Makerspaces provide an opportunity for libraries to build upon services they already offer, while reaching out to students and faculty who do not frequent the library on a daily basis. By implementing a makerspace in an academic library, universities can make the library more approachable to students and staff from all academic departments. In these spaces, individuals synthesizing knowledge across disciplinary boundaries are able to interact with members of communities of practice in a non-threatening learning environment, developing and testing ideas, and developing rapid prototypes in software or physical media, with the assistance of a librarian who may provide resources and advice regarding intellectual property opportunities or concerns (Colegrove, 2013). Libraries' makerspaces can provide access to a wide variety of tools and technology; facilitate group interaction, knowledge and resource sharing; supply access to physical space for individual project development; and provide an open environment for expression of creativity and innovation, as well as access to equipment for prototyping project ideas for users, as noted by Abram (2013).

The implementation of makerspaces and collaboration technology thus provides institutions with a testing ground for future trends and can encourage academic departments to independently adopt new instruction trends in the classroom. The Institute of Museum and Library Services (2012) outlined some benefits of the makerspace including providing organized activities and a safe environment for users to explore, allowing users to develop skills relevant in this twenty-first century, providing community service outlets for users to engage and develop themselves, and enabling users to explore and pursue their educational goals, as well as to access online applications useful to them. In addition to the services provided by the space, students benefit from the opportunity to participate in a more creative and kinaesthetic style of learning that stimulates their decision-making skills (Lee, 2017).

Academic libraries nurture critical thinking and learning, and they are therefore a perfect environment for makerspaces. A makerspace is a physical location in which to share resources and knowledge, and work on network projects by different people from different academic backgrounds. It is a hub to create, invent, explore and discover using a variety of tools and materials to develop certain skills. It may be pronounced a community centre that provides technology, manufacturing equipment and educational opportunities to the public. Makerspaces are an effective means of applying knowledge, and they tap into new resources for learning, and allow free exchange of ideas and resources through exploration, experimentation, engagement and interactions of peer groups. Hussain and Nisha (2017) described a makerspace as a community-operated workspace where people with common interests, usually in computers, mass production, science, technology and digital or

electronic art can meet, socialise and collaborate. This space is intended to allow community members to experience technology or activities that they previously were not able to access, and, as many makerspaces include technology like 3D printers, sewing machines, soldering guns, coding, robotics and wood carving machines, patrons are invited to experiment freely. The purpose of a makerspace is thus to inspire an interest in science, technology, design and lifelong learning in the people who are served by the library. Makerspaces are also intended to allow minorities or underrepresented populations, like women, or people with disabilities, to become involved with technology and fields they may not have previously considered (Bean et al., 2015). Collaborative learning environments are where people come together to share materials and learn new skills, and get an opportunity to engage in discussions, and thus become critical thinkers (Laal & Laal, 2012).

Cavalcanti (2013) further described a makerspace as a conducive environment where people are able to design products starting from nothing, a place designed to democratize the act of making something from scratch. It is place where people can collaborate, innovate and create using information, resources, tools and collections provided at the library. Makerspaces offer students the opportunity to learn a range of skills and meet a number of curriculum objectives, including digital technologies and computational thinking, coding, mathematics, humanities, the arts, prototyping and engineering, just to name a few. All the core skills, knowledge, understanding and mindsets that we consider key to our children's success can also be found and learnt in a makerspace; and the students can also learn resilience, as well as gain skills in problem-solving, teamwork and communication. Workshops are frequently offered to teach users a new craft or how to use a piece of machinery.

The Adoption and Use of Makerspaces in Academic Libraries

Makerspaces, which have grown wildly popular in public libraries and are now appearing in academic spaces, give students affordable access to expensive tools such as laser cutters, sewing machines and virtual-reality technologies. Many libraries and museums across the world have recently invested resources to implement maker programs or makerspaces. Some notable examples of these institutions include the University of Ottawa's Richard L'Abbé Makerspace, which was established in 2014; the Invention Studio at Georgia Tech; Taubman School of Architecture's FabLab; the University of Victoria's MakeLab; the Centre for Technical Vocation Education Training and Research College (a mobile makerspace) established by the University of Nigeria, Nsukka in 2015 (Efe, 2021). These innovative spaces support a range of maker-themed programmes and are thus being embraced by academic libraries. They enable peer learning, collaboration, creativity, knowledge networks, trans-literacy, etc. The role of makerspaces in academic libraries is thus to support learning, encourage collaboration, provide access, expand library services, follow the library's mission and provide opportunities for individual creation. Efe (2021) describes makerspaces, also known as do-it-yourself spaces, learning spaces, tech shops and innovative spaces, as spaces where individuals or groups try the hands-on stuff, share ideas and invent new things. For example, Madison Public Library in the United States has a media lab as part of its Bubbler programme, which engages people who are interested in creating and making (Chan & Spodick, 2014). Burke (2015) demonstrates and elaborates on the rise of library makerspaces, making activities and technologies in library makerspaces, the profile of academic library makerspaces and how makerspaces connect to learning in higher education as well as motivations for creating a makerspace, considerations when planning a makerspace and justifications for an academic library makerspace.

Dugmore et al. (2014) carried out an analysis of makerspaces in Auckland libraries in New Zealand and revealed that there has been a growing awareness amongst the community with respect to accessing maker activities. Dugmore et al. (2014) further noted that amongst library staff, there is a growth of knowledge and enthusiasm for interacting with the community in this way, and building maker culture into their traditional service delivery to create value for customers. Rich (2014) analysed the creation of makerspaces in American academic libraries and identified that the reasons for implementing a makerspace in an academic library and amongst others are: democratisation of

technology, the maintenance of the library's perception as a leader in technology innovation and the need to support scholarship. Respondents also indicated that makerspaces were necessary to keep them abreast with the changing needs of their patrons and to support ongoing scholarship.

Slatter and Howard (2013) conducted a study on makerspaces at Australian public libraries and further identified the essential benefits of makerspaces, including higher community commitment and the development of a new form of library as the heart of an institution. Furthermore, the study proved the relevance of such spaces within a library setting by focusing more on the creation and formalisation of maker community practices and the budgetary constraints. The study by Wong and Partridge (2016) on the adoption of makerspaces in 31 Australian universities revealed that only 12 universities have makerspaces, and among these institutions are: the University of South Wales, the University of Sydney and Monash University. Michalak and Rysavy (2019) also conducted a study on the comparison of makerspaces with academic research libraries, and the findings revealed that nearly one-quarter of Association of Research Libraries (ARL) institutions (23%) indicated they have makerspaces. Nordicity (2018) stated that many community-based organizations play active roles in developing digital literacy skills within the communities they serve. For example, public libraries provide a variety of programs and services to promote digital literacy, increase digital comfort and encourage the adoption and use of digital technologies among community members (Cole & Ryan, 2016). A key ingredient in digital literacy advocacy by such community-based organizations is the makerspace, a physical place where informal, collaborative learning can happen through hands-on creation, using any combination of technology, industrial arts and fine arts (Bowler & Champagne, 2016). Makerspaces provide environments where people are free to experiment with and learn about new technologies in the process of creating or building digital or analogue technological artefacts (Bagley, 2014; Bowler & Champagne, 2016). However, the level of adoption of makerspaces is still at an early stage in academic libraries in African countries, particularly in South Africa (De Beer et al., 2017).

Barriers to Effective Adoption of Makerspaces in Academic Libraries

Library makerspaces are transformative, inviting library users to create, innovate and collaborate. Although the rapid growth of makerspaces in academic libraries speaks to the positive accomplishments of the trend, there is no escaping the reality that such a focus on technology brings with it an often-enormous price tag. Like any new initiative, makerspaces also bring up a host of unique challenges. These questions arise: how do academic libraries get started? How can they work within their library's staff and budget constraints? Library budgets simply cannot shoulder the price tag associated with this calibre of makerspace, so they turn to other options of funding, like procuring grants or corporate sponsorships for new developments and innovations (Mattern, 2014). Private tech companies like Intel are releasing their own manuals for assembling makerspaces using their specific products (Fawkes, 2015). Some of the challenges hindering the successful adoption of makerspaces in academic libraries include: lack of training for patrons and staff, security and funding issues, resistance to change, copyright and intellectual property issues, staffing and scheduling, lack of sufficient space in the library building, technophobia, high costs, maintenance of equipment, internet bandwidth, hardware and software (Slatter & Howard, 2013; Burke, 2015; Moorefield-Lang, 2015; Efe, 2021).

In order for libraries to transform and remain relevant in this digital world, library management and staff must rethink the library culture as well as what job skills are needed to be successful in this maker environment. The willingness of staff to be open to change is important; support for staff to gain skills through informal or formal education, conferences, networking with others and learning by doing need to be prioritized. This openness to constant change, innovative ideas and new knowledge will move libraries forward and better serve their communities (Filar-Williams & Folkman, 2017). This initiative also calls for a solid understanding of the library's user community, and the ability to collaborate and to serve diverse people, as each community's needs are unique (Koh & Abbas, 2015). One challenge is the need to communicate that makerspaces are for all university patrons

across disciplines, not only for specific students. Lee (2017) identified the cost of implementing makerspaces, including the required technologies and tools, and the actual space as an additional challenge for implementation of makerspaces. For example, will someone have to give up part of their office space, or will certain departments need to be relocated? A makerspace also needs to reflect the needs of the students and be able to draw them into the space through their individual interests. A third challenge is how the space will be governed and shared. A final concern is the training of staff on new technologies in such a way that the new makerspace can be adequately staffed, with knowledgeable personnel who can facilitate learning. Lee (2017) further stated that, initially, the makerspace will probably need to have limited hours for patrons, but as its popularity grows, so will the need to hire more staff and provide training.

Whilst bringing together innovators, thinkers, and creators, these spaces critically require physical space, an integrated plan and all the necessary resources, including staff and finances. This 'fight-or-flight' state libraries face today has libraries fighting to stay responsive to the ever-changing needs of their users (Fourie & Meyer, 2015). Makerspaces allow for self-directed learning and are a perfect space for individuals who learn by doing; they can foster a highly collaborative learning dynamic and can also promote a multidisciplinary thinking and learning environment. These innovative and collaborative spaces are being incorporated into a variety of institutions; they can be big or small and hold any number of tools and materials for users to investigate and learn. The purpose of having a makerspace is thus to present people with an opportunity to explore their interests through hands-on and creative projects. Additionally, makerspaces create a culture of curiosity and creativity, encouraging users to learn about a variety of technologies as well as craft-making.

Factors Enabling the Adoption of Makerspaces in Academic Libraries

Wong and Partridge (2016) investigated the experience of Australian universities with makerspaces and revealed that these makerspaces employ specialist staff, contain 3D printers and laser cutters and offer facilities to conduct coursework as well as personal and collaborative projects. The study by Okpala (2016) on the benefits of makerspaces in academic libraries in Nigeria reveals that users' attention is drawn towards library when it comes to fostering creativity and invention. Training and workshop opportunities for librarians were proposed to make them well equipped with makerspace skills. Taylor et al. (2016) identified additional roles that makerspaces play, namely: as social spaces, in supporting well-being, by serving the needs of the communities they are located in and by reaching out to excluded groups. Koh and Abbas (2015) investigated the competencies required for the successful performance of professionals in library and museum learning spaces in the United States. Their findings included top competencies (i.e., ability to learn, adapt to new situations, collaborate, serve as an advocate and serve diverse people) and skills (i.e., management, program development, grant writing, technology and facilitating learning) required for professionals, as well as relevance of higher education to prepare them for their current positions. The study generated curricular design implications for library and information science, with an emphasis on teaching and learning with technologies.

Informal science education experts developed a Tinkering Learning Dimensions Framework using research-based evidence, which can help guide makerspace programming. It identifies four key learning dimensions that can occur with making activities including: engagement, initiative and intentionality, social scaffolding, and development of understanding (Bevan et al., 2015). Through the framework, they also offer examples of indicators that learning is occurring and examples of activities to foster this. The Making + Learning Project, a cooperative agreement between the Children's Museum of Pittsburgh and the Institute of Museum and Library Services, also developed a framework for designing spaces and programming to foster learning in makerspaces (Rose & Brian, 2021). The final report from this project contains a wealth of information that librarians could use.

CONCLUSION AND RECOMMENDATIONS

This study investigated the creation and adoption of makerspaces in academic libraries in South Africa. A makerspace is a new concept in academic libraries; however, most of these institutions have adopted makerspaces, although some are too slow to adopt these collaborative spaces in their libraries. It was also evident from the literature that only a few scholars have written on the adoption and use of makerspaces and librarians' awareness of the makerspace concept in academic libraries in South Africa. Academic libraries should therefore consider creating and adopting makerspaces, as this will help introduce new technologies, boost the library's image, build a community of collaborators and promote social cohesion among underprivileged communities. Collaboration and partnership with other institutions can benefit academic libraries in deploying smart systems and engaging in smart knowledge-sharing platforms through makerspaces. The idea of creating makerspaces in the library goes beyond fostering creativity and invention among users.

However, the adoption and use of makerspaces can pose challenges if users, staff and patrons within academic libraries are not well equipped with technical knowledge and skills necessary to understand and use technology-centred makerspaces. This calls for training and workshop opportunities for users and librarians using makerspaces. Continuous training programs are thus a key component of creating successful and inclusive makerspaces. The maker movement is gaining momentum, and its widespread awareness and usage can make this initiative a successful platform. Academic libraries should thus equip their staff with knowledge and skills, and also promote awareness programmes to information professionals and users by providing short-term courses and in-house training programmes, organizing workshops and seminars, etc. These institutions can also create blogs or newsletters for the makerspace where they can share events, new technology found in the space and online exhibits of items created in the makerspace.

Successful implementation of makerspaces thus requires collaborative effort from both librarians and users, who should be passionate about learning, embracing new technologies and sharing knowledge and ideas. Academic libraries must also make reference to existing makerspaces or visit makerspaces in other libraries to learn about their success stories for effective creation and adoption of makerspaces. Several recommendations that point to the successful adoption of makerspaces are documented, and these include: enactment of policies, management support, more collaborative and partnership opportunities, developing models for successful makerspaces and improving technology infrastructure to address users' needs. Sufficient funds should also be made available by academic institutions for successful implementation of makerspaces and technologies enabling platforms for knowledge-sharing in their libraries.

REFERENCES

Abram, S. (2013). *Makerspace in libraries, education and beyond Internet@Schools*. Academic Press.

Bagley, C. A. (2014). *Makerspaces: Top trailblazing projects, a LITA guide*. American Library Association.

Bean, V., Farmer, N. M., & Kerr, B. (2015). An exploration of women's engagement in makerspaces. *Gifted and Talented International*, *30*(1–2), 61–67. doi:10.1080/15332276.2015.1137456

Bevan, B., Gutwill, J. P., Petrich, M., & Wilkinson, K. (2015). Learning through STEM-rich tinkering: Findings from a jointly negotiated research project taken up in practice. *Science Education*, *99*(1), 98–120. doi:10.1002/sce.21151

Bowen, G. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal*, *9*(2), 27–40. doi:10.3316/QRJ0902027

Bowler, L., & Champagne, R. (2016). Mindful makers: Question prompts to help guide young peoples' critical technical practices in makerspaces in libraries, museums, and community-based youth organizations. *Library & Information Science Research*, *38*(2), 117–124. doi:10.1016/j.lisr.2016.04.006

Briscoe, G., & Mulligan, C. (2014). *Digital innovation: The hackathon phenomenon.* http://www.creativeworkslondon.org.uk/wp-content/uploads/2013/11/Digital-Innovation-The-Hackathon-Phenomenon1.pdf

Brown, T., & Katz, B. (2011). Change by design. *Journal of Product Innovation Management*, *28*(3), 381–383. doi:10.1111/j.1540-5885.2011.00806.x

Burke, J. (2015). Making sense: Can makerspaces work in academic libraries? In *ACRL 2015 Proceedings*. American Library Association.

Cavalcanti, G. (2013). *Is it a hackerspace, makerspace, techdhop or fablab*? https://makezine.com/article/education/the-difference-between-hackerspaces-makerspaces-techshops-and-fablabs/

Chalon, P. X., Di Pretoro, E., & Kohn, L. (2008, June 23–28). *OPAC 2.0: Opportunities, development and analysis* [Conference paper]. 11th European Conference of Medical and Health Libraries, Helsinki, Finland.

Chan, D. L., & Spodick, E. F. (2014). Space development: A case study of HKUST Library. *New Library World*, *115*, 250–262. doi:10.1108/NLW-04-2014-0042

Cole, B., & Ryan, P. (2016). Public libraries. In D. Koufogiannakis & A. Brettle (Eds.), *Being evidence based in library and information practice* (pp. 105–120). Facet.

Colegrove, P. T. (2013). Editorial board thoughts: Libraries as makerspace? *Information Technology and Libraries*, *32*(1), 2–5. doi:10.6017/ital.v32i1.3793

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (3rd ed.). Sage. doi:10.4135/9781452230153

Crawford, K. (1996). Vygotskian approaches to human development in the information era. *Educational Studies in Mathematics*, *31*(1-2), 43–62. doi:10.1007/BF00143926

Curry, R. (2017). Makerspaces: A beneficial new service for academic libraries? *Library Review*, *66*(4/5), 201–212. doi:10.1108/LR-09-2016-0081

De Beer, J., Armstrong, C., Ellis, M., & Kraemer-Mbula, E. (2017). *A scan of South Africa's maker movement.* http://idsd102019.pbworks.com/w/file/fetch/131552334/A%20Scan%20of%20South%20Africa%E2%80%99s%20Maker%20Movement%20.pdf

Dougherty, D. (2012). The maker movement. *Innovations: Technology, Governance, Globalization*, *7*(3), 11–14. doi:10.1162/INOV_a_00135

Dugmore, P., Lindop, H., & Jacob, B. (2014, October 12–15). *Making the makers: An exploration of a makerspace in a city library* [Conference paper]. LIANZA Conference, Pou Whakairo, Auckland, New Zealand. https://lianza.org.nz/wp-content/uploads/2019/08/Dugmore_P_Making_the_makers.pdf

Efe, R. T. (2021). Awareness of the concept of makerspace: The scenario of university libraries in Nigeria. *Library Philosophy and Practice (e-journal), 4952.* https://digitalcommons.unl.edu/libphilprac/4952

Fawkes, P. (2015). *The maker's manual.* Intel. https://www.psfk.com/report/makers-manual

Filar-Williams, B., & Folkman, M. (2017). Librarians as makers. *Journal of Library Administration*, *57*(1), 17–35. doi:10.1080/01930826.2016.1215676

Fourie, I., & Meyer, A. (2015). What to make of makerspaces: Tools and DIY only or is there an interconnected information resources space? *Library Hi Tech*, *33*(4), 519–525. doi:10.1108/LHT-09-2015-0092

Gokhale, A. A. (1995). Collaborative learning enhances critical thinking. *Journal of Technology Education*, *71*(1), 22–30. doi:10.21061/jte.v7i1.a.2

Hausfather, S. J. (1996). Vygotsky and schooling: Creating a social context for learning. *Action in Teacher Education*, *18*(2), 1–10. doi:10.1080/01626620.1996.10462828

Hira, A., & Hynes, M. M. (2018). People, means, and activities: A conceptual framework for realizing the educational potential of makerspaces. *Education Research International*, *2018*, 1–10. Advance online publication. doi:10.1155/2018/6923617

Hlubinka, M., Dougherty, D., Thomas, P., Chang, S., Hoefer, S., Alexander, I., & McGuire, D. (2013). *Makerspace playbook: School edition.* Maker Media. https://makered.org/wp-content/uploads/2014/09/Makerspace-Playbook-Feb-2013.pdf

Hussain, A., & Nisha, F. (2017). Awareness and use of library makerspaces among library professionals in India: A study. *DESIDOC Journal of Library and Information Technology*, *37*(2), 84–90. doi:10.14429/DJLIT.37.2.10989

Kitchenham, B. (2004). *Procedures for performing systematic reviews.* Keele University. http://artemisa.unicauca.edu.co/~ecaldon/docs/spi/kitchenham_2004.pdf

Koh, K., & Abbas, J. (2015). Competencies for information professionals in learning labs and makerspaces. *Journal of Education for Library and Information Science*, *56*(2), 114–129. doi:10.3138/jelis.56.2.114

Konopasky, A. & Sheridan, K. (2020). *The Maker Movement in Education.* .10.1093/acrefore/9780190264093.013.312

Laal, M., & Laal, M. (2012). Collaborative learning: What is it? *Procedia: Social and Behavioral Sciences*, *31*, 491–495. doi:10.1016/j.sbspro.2011.12.092

Lee, R. J. (2017). Campus-library collaboration with makerspaces. *Public Services Quarterly*, *13*(2), 108–116. doi:10.1080/15228959.2017.1303421

Lewis, D. W. (2017). Libraries as place. In T. Gilman (Ed.), *Academic librarianship today*. Rowman & Littlefield.

Litts, B. K. (2015). *Making learning: Makerspaces as learning environments* [PhD Thesis]. University of Wisconsin-Madison.

Maness, J. M. (2006). *Library 2.0 theory: Web 2.0 and its implications for libraries* [Master's thesis]. University of Colorado, Boulder, CO.

Mattern, S. (2014). *Library as infrastructure*. Places. doi:10.22269/140609

Mestre, J. (2020). The troubling trend of academic makerspaces. *Public Services Quarterly*, *16*(4), 273–279. doi:10.1080/15228959.2020.1819937

Michalak, R., & Rysavy, M. D. T. (2019). Academic libraries in 2018: A comparison of makerspaces within academic research libraries. *Advances in Library Administration and Organization*, *40*, 67–88. doi:10.1108/S0732-067120190000040008

Mitropoulos, S., Baltasis, G. M., Rodios, M., & Douligeris, C. (2014). SociaLib: A collaborative digital library model platform using Web 2.0. *The Electronic Library*, *32*(5), 622–641. doi:10.1108/EL-09-2012-0123

Moorefield-Lang, H. M. (2015). Change in the making: Makerspaces and the ever-changing landscape of libraries. *TechTrends*, *59*(3), 107–112. doi:10.1007/s11528-015-0860-z

Njiraine, D., & Le Roux, C. J. B. (2011). Applying Earl's KM model in IK management: With reference to Kenya and South Africa. *The Electronic Library*, *29*(6), 817–827. doi:10.1108/02640471111188033

Nordicity. (2018). *Technology access in public libraries: Outcomes and impacts for Ontario communities*. https://www.torontopubliclibrary.ca/content/bridge/pdfs/nordicity-full-report.pdf

Okpala, H. N. (2016). Making a makerspace case for academic libraries in Nigeria. *New Library World*, *117*(9/10), 568–586. Advance online publication. doi:10.1108/NLW-05-2016-0038

Onifade, F., & Olatoye, A. A. (2022). Awareness, adoption, and implications of makerspaces in academic library in Nigeria. *International Journal of Academic Library and Information Science*, *10*(5), 194–2022.

Oswald, K., & Zhao, X. (2021). Collaborative learning in makerspaces: A grounded theory of the role of collaborative learning in makerspaces. *SAGE Open*, *11*(2), 1–13. doi:10.1177/21582440211020732

Rich, S. N. (2014). *A survey of makerspaces in academic libraries* [Master's paper]. School of Information and Library Science, University of North Carolina, Chapel Hill. https://core.ac.uk/download/pdf/210609582.pdf

Roller, M. R., & Lavrakas, P. J. (2015). *Applied qualitative research design: A total quality framework approach*.

Rose, T. L., & Brian, D. (2021). Social work digital storytelling project: Digital literacy, digital storytelling, and the makerspace. *Research on Social Work Practice*, *31*(6), 599–609. doi:10.1177/1049731521992427

Singh, S. K. (2018). Sustainable people, process and organization management in emerging markets. *Benchmarking*, *25*(3), 774–776. doi:10.1108/BIJ-02-2018-0038

Slatter, D., & Howard, Z. (2013). A place to make, hack, and learn: Makerspaces in Australian public libraries. *The Australian Library Journal*, *62*(4), 272–284. doi:10.1080/00049670.2013.853335

Stacey, E. (1999). Collaborative learning in an online environment. *International Journal of E-Learning & Distance Education*, *14*(2), 14–33.

Taylor, N., Hurley, U., & Connolly, P. (2016). Making community: The wider role of makerspaces in public life. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery. doi:10.1145/2858036.2858073

The Institute of Museum and Library Services. (2012). *Talking points: Museums, libraries, and makerspaces*. https://www.imls.gov/assets/1/AssetManager/Makerspaces.pdf

Vygotsky, L. S. (1978). *Mind and society: The development of higher mental processes*. Harvard University Press.

Wang, S., & Noe, R. A. (2010). Knowledge sharing: A review and directions for future research. *Human Resource Management Review*, *20*(2), 115–131. doi:10.1016/j.hrmr.2009.10.001

Weinberger, D. (2012). Library as platform. *Library Journal*. https://www.libraryjournal.com/story/by-david-weinberger

Wong, A., & Partridge, H. (2016). Making as learning: Makerspaces in universities. *Australian Academic and Research Libraries*, *47*(3), 143–159. doi:10.1080/00048623.2016.1228163

Tlou Maggie Masenya holds a PhD in information science from the University of South Africa and completed a master's in information technology at the University of Pretoria. She has seven years of work experience in academia, in the field of information science and technology. She is currently a senior lecturer in the department of information systems at Durban University of Technology. She has also worked as a senior lecturer at the University of South Africa and the University of Zululand. She supervises master's and PhD students and also serves as an external examiner for postgraduate studies. She has published book chapters and articles in peer-reviewed accredited journals. She is currently reviewing articles for the South African Journal of Information Management, the South African Journal of Library and Information Science, Mousaion, the Research Metrics and Analytics Journal, the Journal of South African Society of Archivists and IGI Global book chapters. Her areas of expertise encompass ICT4D, digital preservation, technopreneurship, digital entrepreneurship, knowledge management, Indigenous knowledge systems and disruptive technologies. She plans to be an editor for books that cover these topics. She edited a book entitled" Innovative technologies for enhancing knowledge access in academic libraries", published by IGI global in June 2022. She is currently editing a book entitled "Digital preservation and documentation of global indigenous knowledge systems", to be published by IGI Global in June 2023.