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Understanding the Maker in Academic Makerspaces

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Abstract

Makerspaces are becoming popular in universities as a novel approach to boost creativity, innovation, and provide opportunities for creation, prototyping and hands-on learning. Despite the rapid growth of makerspaces as open spaces for creativity, innovation and experiential learning, the role makers play in makerspaces remains unknown. While there is a push to establish makerspaces in academia, there is limited knowledge on the makers experience in the makerspaces. Whereas the role of makerspaces in innovation and experiential learning has been researched extensively, there is little on the makers in makerspaces. Literature review has also shown that there is limited information on their role in a makerspace, yet makers are the most important component of any makerspace. A desktop research was done that looked at maker information published in journals, reports, books and internet sources on makerspaces. This paper identifies the key makers and the role they play in academic makerspaces.

Keywords: Maker Movement, Makers, Makerspace, Making, University Makerspaces.

INTRODUCTION

Makerspaces have been around for more than a decade! What started as a need to create open-source hardware (Blikstein, 2018), has grown to become a movement - *the maker movement*. A movement of people who engaged in the creative production of artefacts (Halverson & Sheridan, 2014). Eventually it has found its way into academia (Farritor, 2017).

Globally, makerspaces are gaining traction (Farritor, 2017), for rapid prototyping and innovative thinking (Artut, 2018). Over the last decade over 1400 makerspaces have been established, up from about 100 in 2006 (Lou & Peek, 2016). There are 150 makerspaces on university campuses (Wilczynski, Wigner, Lande & Jordan, 2017). This number is however conservative, with new makerspaces coming up every year. In Kenya there are at least eight makerspaces with four in Nairobi, one in Kisumu, two in or around Mombasa (Baarbé & Nzomo, 2017) with only one located in an institution of higher education; the UoN Makerspace.

The phenomenal growth of the movement and makerspaces in general has necessitated research in makerspaces; looking at the role they play in academic institutions (Wong & Partridge, 2016), who make (Wilczynski, 2014) and run (Forest et al., 2014) the spaces. There however, exists limited research on the most important component of any makerspace; the Maker.

This paper will provide an exploratory review of literature on Makerspaces with an aim of specifically addressing the research question: Who is the Maker in academic Makerspaces and What role do they play? A review of published journals provides a picture of academic makerspaces adding knowledge to available literature on the maker movement.

The Maker Movement

The maker movement is characterised with the idea that people are makers and creators rather than being mere consumers (Otieno, 2017). The maker movement broadly refers to the people who are engaged in the creative production of artefacts (Halverson & Sheridan, 2014). The maker movement came about due to the need for people to engage with objects beyond being just consumers (Dougherty, 2012).

The movement has grown rapidly as a result of influence from new technologies and digital tools.

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The popularity of the movement can be directly linked to the Maker Faire by Dale Dougherty's Make magazine, founded in 2005.

"*The Maker Faire events allowed makers to interact with one another, leading to a level of interconnectedness that has helped build a movement*," (Dougherty, 2012).

The maker movement has grown from its remote origins as a grassroot movement of backyard and kitchen tinkerers, hackers, designers and inventors (Vossoughi, Hooper, & Escudé, 2016), into education, business and even government(Wong & Partridge, 2016). Institutions see the movement as an opportunity to innovate and solve problems in a controlled environment (Dougherty, 2012). Education was the first industry to see the potential of the movement, with Fablabs (Stacey, 2014), K-12 makerspaces (B. Taylor, 2016), libraries (Curry, 2017), Museums (Sullivan, 2019) and academia (Farritor, 2017) quickly adopting it for hands-on and experiential learning (**Figure 1**).

The movement has democratised the access to tools and skills that previously were only accessible to experts in research labs (Sheridan et al., 2014). This compounded with availability of resources (relatively cheap hardware, easy access to digital fabrication, and shared software and designs) has seen an increasing number of educators and researchers identifying with the movement (Vossoughi et al., 2016). Initially, a preserve of STEM fields (Wilczynski, 2015), there is a push to have makerspaces in the Arts, Design, Architecture for creativity and innovation (Park, Kaplan, Schlaf & Tridas, 2018). As a magnate for sharing, participation and collaboration, the maker movement continues to attract people from different disciplines enhancing multidisciplinary environments (Martin, 2015). Essentially the movement has led to a philosophy of sharing, acceptance and creativity that can be replicated across multiple disciplines, in line with the belief that everyone is a maker and our world is what we make it, just imagine it.

Halverson & Sheridan (2014) assert that the movement has three key components; making – a set of activities, makerspaces; communities of practice and makers; identities (**Figure 2**). Whereas first two components have been studied widely in literature, there is very little on the human perspective of the movement.

Makerspaces

Makerspaces (also known as Creative Spaces, Fablabs or Makelabs) are places where individuals can build and create (Farritor, 2017; Weinmann, 2014). They serve as centres for learning, collaboration, problem solving, self-expression and rapid prototyping (Kemp, 2013). The launch of *Make: Magazine* in 2005 by Dale Dougherty is considered the catalyst of the current maker craze (Burke, 2014). Dougherty initiated *Maker Faire* for makers to share their creations, giving traction to the idea of makerspaces, thus democratized the process of making. Maker faire(s) resulted in pushing the idea of coworking and collaboration among enthusiasts leading to a multi-dimensional approach to creation. This changed the process of making from an isolated activity to a group effort in a shared space. The idea of people from different

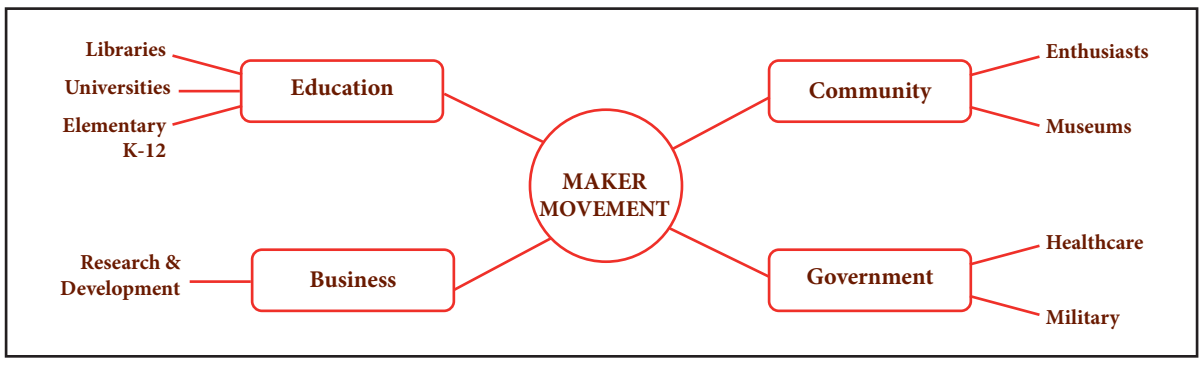

FIGURE 1
Maker Movement
Source: Mounde 2020

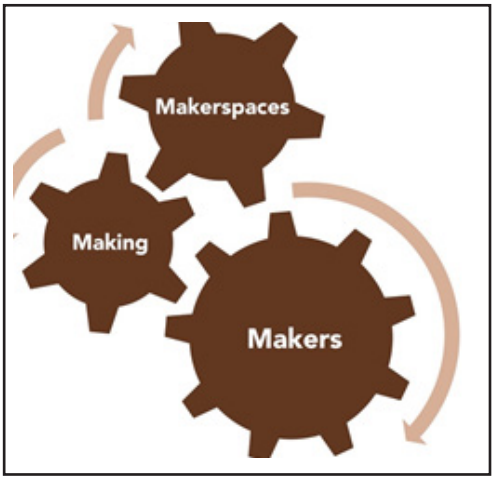

FIGURE 2
Components of the Maker Movement
Source: Adapted from Bassolino 2019

disciplines working collaboratively was born and encouraged in the new maker movement.

Makerspaces in academia, are however attributed to the creation of Fablabs, by Prof. Neil Gershenfeld of MIT's Center for Bits and Atoms to empower, and lead people around the world to become technological protagonists rather than just spectators (Burke, 2014; Kohtala & Bosqué, 2014). Academic makerspaces focus on creation, collaboration and innovation for learning and education.

RESEARCH METHODS

A desktop study of published literature on Makerspaces with specific interest to makers was conducted for this research. Using Google Scholar, the terms makerspace, maker movement, maker, university makerspace, higher education and academic makerspaces were searched. Articles that included two of the five terms were selected for in-depth review. Additional information on local makerspaces from online sources was included. Twenty publications were reviewed and analysed to identify the key stakeholders in academic makerspaces.

RESULTS AND DISCUSSION

Makerspace Users

Makerspaces thrive on the creativity and imagination of makers who use the space. Makerspaces rely on the interests of the makers, providing them a space and tools to actualise them (Kemp, 2013). They bring the spaces to life. Makerspaces serve two distinct users, the makers; who directly use the space and the product end-users; who are the target market of the solutions that come out of the makerspaces.

Product End-Users

An end user is the consumer of a good or service, is the person that actually uses a product (Kenton, 2019; Suttle, 2015). The term is used to differentiate the person who buys and uses the product from individuals who are involved in design, development, and production stages. Although these people are important, their experience can be slightly distorted due to their attachment with the product, compared to the end-user's experience. For the purposes of this study, these are the intended users of the products or solutions that are created at the makerspace. This category of makerspace users is broad and tends to vary from one project to another. This category of users was however not considered as part of the scope for this study.

Makers

Makers mean different things to different scholars. Van Holm (2014) terms it as extremely vague, he opines that a maker can be an individual building a 3D printer from an online guide, but can also be someone cooking a family meal or a computer scientist creating a new web service. Hence all of us are makers (Dougherty, 2012). Halverson & Sheridan (2014), however dispute this noting that not all the individuals and groups automatically take on identities of participation within the maker landscape.

Kalil (2013) defines makers as people who design and make things on their own time because they find it intrinsically rewarding to make, tinker, problem-solve, discover, and share what they have learned, while (Michelle et al., 2013) describe them as enthusiasts who play with technology to learn about it. According to Martin (2015) a maker is a person who builds things, while being creative, having fun, to solve problems, hence do good, as they collaborate and learn. Broadly, makers are individuals who have embraced the maker culture. The Maker culture is a global

movement of individuals using digital fabrication, open hardware and software to innovate with an aim of openness and skill transfer as opposed to commercial gain (N. Taylor, Hurley, & Connolly, 2016). For the purposes of this study, a maker is any individual who utilises a makerspace to build and create. They are the key stakeholders in the makerspaces.

Makers have access to prototyping technologies and digital fabrication tools for rapid prototyping, while working alongside other makers, sharing knowledge, skills and designs (Anderson, 2012). In line with the *Maker Movement Manifesto*, Makers use the makerspace to make, share what they have made and what they know about making with others, give, learn, tool up, play and participate (Schön, Ebner, & Kumar, 2014).

Makers in makerspaces are often intrinsically motivated to use the space. As Farritor (2017) notes, the makers are often self-motivated to solve problems, hence leading innovation. The need to create new products and solutions pulls people to creation hubs as opposed to external push like work or school assignments.

The typical makerspace users in Africa tend to young male university graduates with a background in IT, Engineering or other creative skills (Njambi-Szlapka, 2019). In their study titled *An exploration of women's engagement in Makerspaces*, Bean, Farmer & Kerr (2015) noticed the same trend in the USA; 81% of U.S. makers were male, indicating that women are underrepresented in makerspace.

Makerspaces are about people, the community of users who conduct activities in the spaces. Despite their importance, the study found very limited academic publications on the human component of the makerspace. Previous research has focused on the resources, tools and activities that go on inside the makerspaces. To bridge the gap this study looked in depth at the people who make use of makerspaces.

Makers come in different ages and levels of experience who work with diverse media, but what is common among them is making. They develop ideas and build them into some physical or digital form (Sheridan et al., 2014). The study looks at some of the makers involved in the maker movement.

Enthusiasts and hobbyists

Makerspace enthusiasts and hobbyists are users who are essentially playing with technology (Dougherty, 2012). They have access to the tools in makerspaces to experiment with them. They use the available tools to make things, take them apart and put them back again. Through that they manage to learn, repair and utilise the available tools. The maker movement attributes its origins to these users. Dougherty (2012) notes that,

"*Today's makers enjoy a level of interconnectedness that has helped to build a movement … by a particular hobby or activity... connected by enthusiasm and a common passion.*"

From the initial Maker Faires, enthusiasts and hobbyists have always graced these gatherings (Thilmany, 2014).

The tech enthusiasts and hobbyists are often involved in longstanding hobbies and crafts such as woodworking, sewing and electronics and more recently in digital fabrication (Martin, 2015). These users are normally unattached to any organisation, using the space out of their own freewill.

Tinkerers

Tinkerers are makers who build something out of existing, available parts for new purposes (Foege, 2013). They have a passion and an obsession to disrupt the status quo, leading creation on novel solutions. In makerspaces tinkerers can be seen taking apart electronic gizmos, to create robots, 3D printers and other innovative appliances. Makerspaces offer a conducive environment for tinkerers to casually play with product design in hopes of improving or repairing the product (Matias & Rao, 2015). Hence, they are a very important component of any makerspace, and in a mild way include anybody with an idea and time to explore it. Evidence of tinkerers can be traced to the RepRap project (in 3D Printing), an open source community that enables users to build their own 3D printers. The world famous MakerBot printer is a result of tinkering (Matias & Rao, 2015).

Researchers

These are education researchers conducting their studies in the confines of the makerspaces. These scholars are either studying how the maker movement work or are working on their projects using additive manufacturing tools like 3D printing among other tools. These users can be active participants in the makerspace or be passive users, observing different process.

Students

Makerspaces are a new frontier in the education sector with educators utilising them in project-based learning. In higher education, especially in engineering, academic makerspaces are an important development (Wilczynski, 2015). In order to promote design experience among students, universities have turned to makerspaces (Forest et al., 2014). Students make use of makerspaces for academic, extracurricular and personal activities under the watch of university faculty, staff and other students. Students make use of design software, manufacturing tools and integrated control systems to prototype and make finished products. Makerspaces represent an effort to support bottom-up or grassroots student engineering and facilitate the pursuit of extracurricular personal projects and the exploration of manufacturing techniques.

At the Georgia Institute of Technology's invention studio, through a student-driven approach, students from all levels and disciplines have access to design and manufacturing equipment. At the invention studio; a student-run design-build-play space, the undergraduate students also take up the added role of supervising the other users as student volunteers (Morocz, 2016). The students are not paid, they however receive more access time than normal students are allowed and are eligible to apply for project grants (Galaleldin, Bouchard, Anis & Lague, 2016).

Faculty

This a body of educators; professors, lecturers and research assistants who utilise the makerspace to educate or are in charge of the makerspace. At makerspaces like Northwestern University's Segal Design Institute where makerspaces have been fully integrated into programs (B.S. degree in Manufacturing & Design Engineering, Master of Science in Engineering, Design & Innovation and Master of Product Design & Development), the faculty conduct their lessons within the facilities (Wilczynski et al., 2017).

Staff

These are the makers who are hired to work at the makerspace. They maintain, arrange and clean the makerspace and the machines among other roles. These users work with the equipment on a day to day basis, and often offer assistance to the other users from time to time. Though they are rarely acknowledged in research, they play a very important role, ensuring that the spaces run smoothly without hitches.

In most community makerspaces they hire professional personnel, but in university makerspaces, they enlist the services of graduate assistants, student staff and a full-time staff; that can include faculty or not. They are responsible for all aspects of operating the makerspace, including admission of new members, training, repair, maintenance and organising the makerspace's programs (Wilczynski, 2014). They also act as design mentors, assisting individuals and teams to design and build solutions and are often available for consultation and at hand to help when the makers are stuck.

Management

Different makerspaces employ different ownership models, hence different management models. The establishment normally dictates the model that is used, for instance university makerspaces are often led by faculty. The Yale Centre Engineering Innovation and Design and The Segal Design Institute for instance, courtesy of their location in the university are led by a tenured mechanical engineering faculty member (Wilczynski, 2014).

Privately owned for-profit makerspaces on the other hand, are operated by directors who established them. The gearbox is directed by Dr. Kamau Gachigi, one of the founding partners of the space (Birkelo, 2017). Community makerspaces like the Dundee Makerspace do not have formal leadership structures, but rather operate as a collective, with a select number of members playing the organisational role (N. Taylor et al., 2016).

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Donors

Although they are not involved in the day by day making process, donors play a very important role and can be considered as makers, because they dictate the making process in makerspaces. Makerspaces require funding to operate optimally. While most makerspaces are embedded under large organisations like schools, companies or universities, get their funding from the mother organisations, they need sustainable sources of funding. These funds come from donors who invest their resources to support research or projects in form of grants. For instance the New York Hall of Science received grants in 2011 and 2012 for a makers project and a learning lab within its Cognizant Maker Space (Institute of Museums and Library Services, 2014). Other beneficiaries of the IMLS-Funded maker projects include the Idaho Commission for Libraries, the Westport Library ($246,545), the Oregon Museum of Science and Industry ($100,00), and the Chicago Public Library ($249,999).

Donors help set up makerspaces, cover staffing costs and buy equipment. Through grants and scholarships, they keep the lights on. Not all donations come in form of money, some donations are in form of equipment. The gearbox is an example of a makerspace that started as a "shop in a box" from a shipping container full of tools donated to iHub in 2013 (Birkelo, 2017).

Clients and incubations

Makerspaces cannot rely entirely on donations and grants for their day to day operations. They have to find sustainable sources of funding to keep their lights on. Hence most makerspaces have opened their doors to clients and start-ups who use their facilities and equipment at a fee. Through start-ups or service investment opportunities, makerspaces develop a sustainable revenue model that helps offset the overhead costs and dependency on the mother-companies or grants (Crumpton, 2015). The Tshimologong Makerspace in Johannesburg, runs an incubator program that provides digital entrepreneurs with tools to test their concepts and grow sustainable businesses. They also provide an open and collaborative coworking space with fast internet, printing, training, conference rooms and office support to companies at a fee (Tshimologong, n.d.).

CONCLUSION AND RECOMMENDATIONS

University makerspaces are spaces where makers can collaborate and innovate for experiential learning. In a makerspace, the actual makers are the most important component of the space. This study investigated the key makers of University Makerspaces, highlighting the key functions they play in the space. As key aspect of any makerspace the human perspective of the movement is very important. Without the people, makerspaces are just workshops with tools.

To effectively utilise academic makerspaces there is need to create spaces that are conducive to the maker. Spaces that can help enhance creativity, innovation and collaboration among makers. This requires understanding who the actual makers are and what they do at the space. This will inform the creation of spaces that are maker-centred.

More needs to be done to understand the making process that is used by makers in the academic makerspace. How effective, innovative and efficient is the making process and does it allow for multidisciplinary creation? This will enable the makers to create solutions fast and get valuable contribution from all the stakeholders.

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