

Innovation Dissemination in Online Makerspace Learning

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Abstract. COVID 19 pandemic has shifted the way makerspace operationalize shifted from purely physical space into an online mode for design collaboration and also information dissemination. With the spirit of maker movement which emphasizes sharing, collaboration and making as the vital core of its operation while the online components of makerspace are the platform for design collaboration and innovation dissemination during the global pandemic and the future globalization of innovation. Due to the establishment and the technological advancement of the digital fabrication and open-source hardware and software which is available to the masses, online learning has been the main drive which shapes the way the online makerspace platform operationalize. While there are a lot of articles and research has been done on the sustainability and mechanism of the physical makerspace environment, there are lack of articles discussing the sustainability of the online components of makerspace. The objective of this paper is to review the operation of the online makerspace upon disseminating innovation and ideas. This concept paper will highlight the power of online makerspace upon disseminating ideas and innovation to further stimulating another innovation. The main finding of this review paper is that the dissemination of innovation can stimulate the other user to create another innovation through memory retrieval and idea transformation.

INTRODUCTION

Rooting from the movement of hobbyist, engineers, tinkerers, hackers and artist who playfully create an artefact, the maker movement is the movement that celebrates arts, craft, technology and design in its core activities. Activities ranging from electronic prototyping, circuitry, woodworking and sewing is the result of the availability of digital fabrication tools and open-source hardware and software while the internet has provided a platform for project sharing, communication, design critique and project instruction [1]. The earlier movement can be traced back to 2005 when the first publication of make magazine and the event of maker faires in 2006 was held [2]. As a result, makerspace, which is a physical space dedicated to making, tinkering, a discussion in among community member, in library or Techshop [2]. Maker movement, which is the primary catalyst for the development of makerspace, is built upon the spirit of making and sharing. What drives this movement resides on the very fundamental human mindset are the maker mindset. Advancement in technology and the availability of the open-source hardware and software also pave the ground for the establishments of makerspace through supplying materials and tools for design and tinkering activities. Since then, the operation of makerspace is no longer circulating through the physical space, new modes of online makerspace have emerged which transformed a small group of makers into cross-culture movement which in turn promoting mass innovation into the masses [3]. Maker education in makerspace applied learning methods such as project-based learning, action learning, problem-based learning, learning by doing/making and collaborative learning.

Research on digital media and learning finds that online communities are fruitful spaces for learners to develop the skills needed to pursue making activities, particularly for new media-related endeavours [4-10]. Earlier research

found that there are a positive impact on learning and connecting in an online community, especially in the context of developing new skills through making activities [11]. Makerspace as an online knowledge-building community has been implemented during COVID 19 pandemic for sustaining making communities [12] while the connectivity of the network between teachers and pupils developed play cultures using various combination of technologies by sharing local activities into online makerspace [13]. This concept paper will explain how the maker communities shape the development of online makerspace and the process of sustaining innovation by sharing and collaboration.

Design Collaboration Through Online Makerspace

The peer learning concept explains design collaboration in education with each member of the team, helping each other to reach the same goal in learning. Collaboration leads to more memory stimulation than working alone; for example, the study conducted by Saunderson and Jin found that collaboration results in more memory stimulation rather than working alone [14]. Explaining ideas to another peer and actively joining activities which they can learn from peers is the central concept for peer learning which is one of the components found in many courses ranging from various disciplines [15]. Interaction is the crucial factor for a successful peer learning process compared to traditional learning because it promotes more hands-on and practical approach during the learning process which in turn resulting in a better learning outcome [15].

During the peer's communication, peers who are in the same class or programmed will establish a learning relationship out from the teacher/lecturer/facilitator monitoring due to the shared assignment given to them [16]. The external design entities which are designed by another designer directly influence the stimulation of cognitive process as a result of collaborative memory which is different from the individual memories which only came from individual own design entities. Individual memory and collaborative memory found to transpire as the design entities are more presumably stimulating memory retrieval through the collaborative setting rather than in the individual setting [14].

As a result, the propensity of a designer to produce creative ideas increase because of the enhancement of the memory retrieval through collaborative setting. In physical makerspace, peer learning resides on the discussion table as the mode of conduct change from physical into a virtual mode; an online mode is introduced through web conference or forum globally resulting in peer discussion not only in class peer but globally.

Collaboration through forum and project is one of the most notable features that one can find on the website where the developer of the free, open-source hardware and software created an online forum discussion which can be cast online via web conference tools or link asynchronously via social media or YouTube channel. One of the examples is in the tinker cad where the design of the electronic circuit and 3D CAD model is developed in real-time which often involved peer online learning within the collaborators and then can be shared via online by the collaborator. Students also can tinker another finished project for better understanding and part of the learning process. On the other hand, availability of websites such as Instructables, Thingiverse which act as a design repository where a lot of finished design has been shared by the user which can be used by another whether to direct copy, manipulation or improvement of the product to suit the student's goals. While the physical makerspace utilizes the dedicated space which its operate on the discussion table, online forum and online video conference have been known for conducting design improvement and iteration through the online makerspace while the finished designed artefact then can be sent into any other fabrication house for product realization.

Dissemination of Innovation Through Online Makerspace

Report from Nesta in 2016 found that the adverse effect of how makerspace has changed China from manufacturing into designing nation with the collaboration between UK and China in developing maker culture that should benefit both parties in search of an innovation-led solution [17]. One of the notable characteristics surrounding online makerspace aside from maker mindset which consists of collaboration, asset-growth and failure positive/resilient is the stimulation of playfulness environment [18] as shown in the experiment conducted by Pederson that overall finding of 3 separate makerspaces located in cross-continent with different nationality establish a culture and communication which resides playfully through google+ group platform [13]. Maker culture has been known in utilizing digital spaces and making through social networks platform as an act to show creativity [19]. The online community that connects through online platforms are recognized by the act of sharing ideas and creation among each other where the culture of creativity then flourishes [20]. Sharing a common interest and gradually posting ideas and creation through online platform is what the maker community are doing by utilizing the

digital platform as a platform of creativity by connecting virtually via online; thus it serves as a strategy upon connecting culture of creativity. Besides, to achieve the optimal online makerspace impact, the design of such program should focus on the five major areas which are program design, facilitation, material and tools, process documentation, sharing and feedback [12]. This paper argues that connectivity is the main factor that contributes to innovation as a result of the ideas generated by the user in online makerspace platform and the utilization of a digital platform for a cross-culture design solution.

Sustainable Environment Model

Creativity played a crucial part in innovation. Creativity comprises of six aspects which are abilities, knowledge, styles of thinking, personality, motivation and environment. Noted that the environment is an external factor which contributes to creativity, such as an environment that supports creativity, whereas the other five aspects are classified into internal factor [21]. In this paper, online makerspace act as an environment where most of the activities in making, tinkering, collaborating and sharing can be classified as promoting creativity through an environment that supports it [22,23]. Jin and Benami proposed that contents or ideas available for designers are generated by specific design operation, which then stimulates the designer's cognitive ability. Those processes are memory retrieval and idea transformation [24]. Concepts that individual has been exposed is directly influencing the ideas they remember, and collaboration will increase exposure to a wide range of concepts [25]. Designers who exposed to another concept or design operation is directly influenced designer's cognitive ability whose processed referred to as memory retrieval and idea transformation. Memory retrieval is essential for creative idea production, as designers begin idea generation by remembering a past idea. Production of creative ideas demands the process of memory retrieval that is where designers are starting new ideas by remembering past ideas. Figure 1 shows how the process of sustainable innovation dissemination couple with cognitive conceptual design process [24].

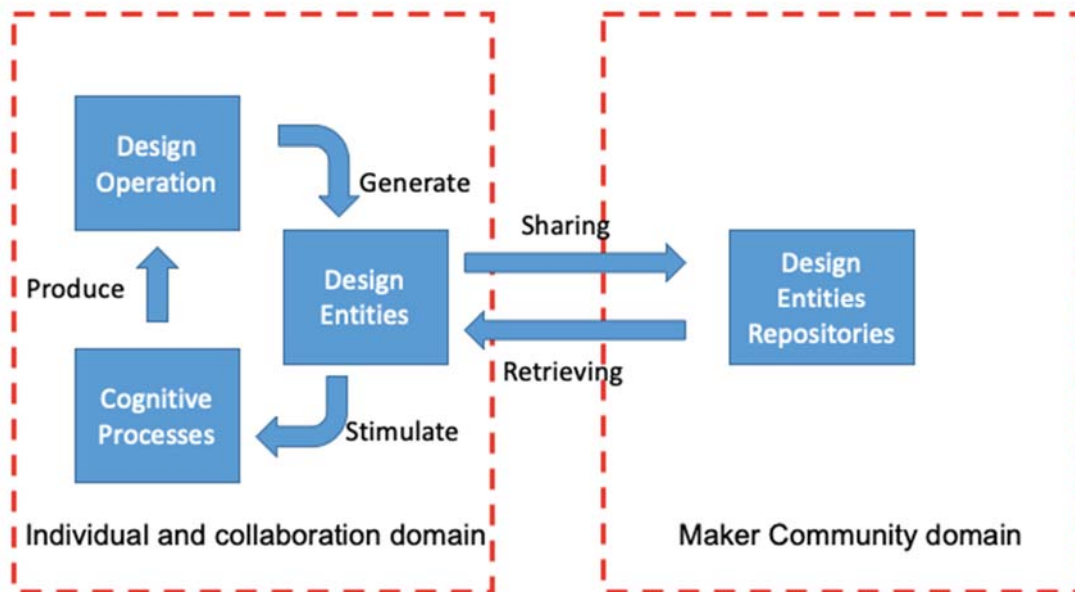


FIGURE 1. Sustainable process of online makerspace through retrieving and sharing from individual/collaboration domain and maker community domain.

The process can be divided into two domains which are individual and collaboration domain and Maker community domain. The first domain, individual and collaborative domain through a cognitive process(generate, stimulate and produce) are taken from [24] while individual and collaboration domain explains the process where the cognitive process played a part in idea generation resulting from the design entities and then through the cognitive process that will undergo design operation upon creating another design entities which resulting in the innovation. On the other hands, the maker community domain explains the design/ideas repositories that have been

shared through an online platform and growing bigger and bigger through time and act as an idea stimulant for designer and Maker. By supplying the design documentation, instruction and solution through an act of sharing and collaboration, the innovation will then keep on producing new solution for the given problem will later either will be used as an idea, inspiration for the next idea to come. The double arrow shows that the process is a sustainable process which promotes the dissemination of innovation and later the production of the innovation. Examples of this can be found on the website such as Instructables, Thingiverse and others. At the same time, the primary material is created by the community, which later can be used by another person to create its content. Since there is a lot of design solution currently in the repositories, it is a matter of reuse (re-appropriating) [26] the design solution to be implemented in the current problem. While the Thingiverse website caters the digital fabrication areas, Instructables serve the community with a wide range of topics ranging from traditional craft, cooking, sewing, digital fabrication, electronic circuit project through an open-ended project.

CONCLUSION

In general, this paper suggests that the education system should stimulate the ability of a student in creating more open design through online sharing and engaging in co-design creation through online makerspace platform thus will enhance an archive solution and re-appropriating the current design solution repositories for the current design problem. In addition, the openness in design and innovation will significantly influence the student ability upon solving a difficult problem and streamlining students' knowledge with the global design scene. Throughout this paper, we have highlighted the importance and the sustainability of online makerspace upon disseminating ideas and innovation that can be used by designers/student to stimulate new ideas and innovation through memory retrieval and idea transformation. This sustainable ecosystem can be used by students to enhance material and ideas upon completing a design task and act as a design catalyst. Technological advancement opens up the possibility for global design collaboration that cross the boundaries of culture and nation as it also provides the unique platform for strengthening education 3.0 which emphasizes the role of a student as a creator upon unleashing creativity and innovation.

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