Full STEAM ahead: Empowering and catalyzing creative thinking and social entrepreneurial skills of the community through library makerspace

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Abstract:

This research will highlight the 10-month STEAM (Science, Technology, Engineering, Arts, and Math) Upcycling makerspace program in a library that provided equal opportunity for participants to engage with diverse people and utilize technologies in a makerspace. It will discuss the accomplishments and challenges in establishing a serial program that led to the launching of the first maker fair in a library setting – showcasing the key projects of the STEAM Upcycling program.

Keywords: Makerspace, STEAM skills, Academic libraries

Background

Libraries are cognizant of their social role as enablers and providers of opportunities of development in their community. Hence, they do strive to adhere to the call of the United Nations' Sustainable Development Goals (SDG) where it is worth noting that libraries align themselves under Goal 4 — ensuring an inclusive and equitable quality education and promote lifelong learning opportunities for all. In the future, it is envisioned that there will be an increased access to vocational training and information and communications technology, technical, engineering, and scientific programs, in developed countries and other developing

countries (United Nations, 2015). Consequently, libraries carry on a continued commitment to create more inclusive, socially relevant and skill building programming that strengthens our reach in the community.

It is also worth noting that in the recently released Global Vision report of the International Federation of Library Associations (2018), it was revealed in the top ten highlights and opportunities that librarians and information professionals need to continue embracing digital innovation and be knowledgeable with ongoing technological shift and must embrace change. The vision also strongly asserts that librarians and information professionals can help enrich 21st century and the creative economy by using the right tools, and technology, infrastructure, and skills.

In addition, librarians and information professionals should not forget to target not only the active users but also the underserved communities or the so-called inactive library users. Understanding their respective needs would be a great impact for forging the library's commitment in valuing diversity and inclusion and the importance of providing a space for engagement.

Clearly, these global vision and sustainable development goals are meant to help libraries in redirecting the strategic goals of libraries and creating worthwhile skill programs that are aimed at bringing back the relevance of libraries in the 21st century society and creative economy.

In a country where the maker movement is starting to take off, libraries can seize these global visions and opportunities to provide a space that will enable its community to have access to information and equipment that can enhance the general public's skill sets and effectively contribute to the social, educational and economic development of the citizens where they belong. Hence, the establishment of creative and inclusive spaces in libraries or the so-called "makerspace" for all is indeed a need in today's society.

Makerspace and the Maker Movement

The historical background of the maker movement is deeply rooted in the maker culture that started during the 1970 in Europe and the United States of America. The so-called hacker communities through technology clubs and meetings introduced cultural and social movement in Silicon Valley. Software development, semiconductor design, and computer programming were the main interest of these hacker communities. Hence, these hacker communities opened doors to be mindful from the knowledge economy to the so-called creative economy era, where creative and critical thinking are the focal point for economic development. With this, key people in the society have paved the way to incorporate critical and creative thinking skills in various institutions (United Nations Conference on Trade and Development, 2018).

As defined by International Federation of Library Associations (2014), makerspace is a place where people with shared interests, especially in computing or technology, can gather to work on projects while sharing ideas, equipment, and knowledge. This space is equipped with 3D printers, laser cutters, various milling devices, and more. According to Dale Dougherty, the father of Do-It-Yourself maker movement in the United States of America, makerspace also known as hackerspace, creation station, Fab Labs, and Tech club, is a

physical space where makers can come together to create, hack, innovate, and develop creative projects.

On the other hand, some scholars in the United States of America defined the maker movement as an innate mind-set that values open-source and creative thinking in which students and teachers share expertise and information with one another. Through this mind-set, a lot of business organizations and educational institutions introduced Do-It-Yourself entrepreneurialism to their employees and staff to innovate, collaborate, and create for the institution's success (Fontichiaro, 2016; Good, 2013)

In the Philippines, the long history of maker culture is deeply influenced by the socio-cultural life of Filipino people. One of which is the famous Filipino characteristic called diskarte being defined as strategy or approach, which can be associated to problem-solving and the ability to go beyond situational limitations. Second, malikhain or being creative or commonly associated to inventiveness, and flexibility. Third, mapamaraan or being resourceful and the ability to find ways and solve various problems and situations. During the pre-colonial period, Filipino showed their inventiveness in various livelihood aspects which includes arts, craftsmanship, woodworking and metalworking. During the American period, Filipinos showed their resourcefulness by inventing the ubiquitous symbol of Philippine culture called Jeepneys. This were originally U.S. military vehicle that was converted into public transportation vehicle (Yacat, 2005; Morales, 2017; Bartolome, 1991)

Today, with the technological advancement happening in various institutions, the maker movement has been promulgated in technology companies and in educational institutions. Few companies like Google and Microsoft have innovated to incorporate state of the art technologies to promote creative thinking, and entrepreneurial skills. These institutions have made efforts to introduce and advertise the maker movement, start-up competitions, and creative thinking through maker fairs, fora and exhibitions (Ortiguer, 2017).

In Philippine educational institution, the Department of Education has made an effort to create a learning environment conducive to 21st century students through the K to 12 system. This program plan of the national government started in 2014 to introduce interdisciplinary studies in the basic education curriculum, which includes (1) STEM (Science, Technology, Engineering, and Mathematics) strand and (2) Technical-Vocational Livelihood Track focusing on Information and Communications Technology (ICT), Creative Arts, Coding and Robotic Technology (Official Gazette of the Philippines, 2016).

Although there are development and advancement in promoting the maker movement and creative thinking in the Philippines, however, there is still dearth of knowledge on programs and activities happening schools and other educational institutions particularly in libraries and information centers. With this, this research would like to introduce a library program specifically conducted in order to promote creative thinking and entrepreneurial skills through the use of a library makerspace concept.

Methodology

Objective

The primary objective of this research is to describe the 10-month STEAM (Science, Technology, Engineering, Arts, and Math) Upcycling makerspace program conducted in a library that created opportunities for library users to engage with diverse people and utilize available technologies in a makerspace. The paper focused the journey of the STEAM Upcycling participants as they employ STEAM skills, including design thinking skills, robotic arts skills and social entrepreneurial skills.

Methods

This research used a qualitative approach to reveal and evaluate the 10-month STEAM upcycling makerspace program that was held in American Corner, De La Salle University Libraries. A survey was conducted and the instrument was not designed to be exhaustive. It is inclined to be more exploratory about the perspective of the library as the program implementer and perspective of the participants in joining the said program.

The STEAM Upcycling Program

The maker movement has been creating a buzz but most libraries in the Philippines are still unaware on how to either implement or start a maker program in their respective schools. This program, however, was born out of the combined efforts of the local maker community and the professional librarians in the Philippines. This group of people showed commitment in providing access to innovation and participation to skills building particularly to highlight the importance of creative thinking skills in schools and libraries. Correspondences and meetings for planning started as early as October 2016 and the rest paved way to the creation of the first serial maker program in the Philippines.

The De La Salle University Libraries, the U.S. Embassy's American Spaces in the Philippines, and the Makerspace Manila, initiated the STEAM Upcycling Program in 2017, this program highlighted STEAM (Science, Technology, Engineering, Arts, and Math) skills to repurpose and reuse discarded, unwanted and/or unused materials that can be seen in our environment into something functional than its present quality, monetary value, or function. The program was designed to: (1) introduce Filipinos to the global maker movement and the positive impact it brings to education (STEAM and non-STEAM), business, and society (2) educate Filipinos on becoming makers and utilizing makerspaces (3) promote entrepreneurship and environmental protection using platform and tools available from makerspaces (4) celebrate Filipino ingenuity through tinkering and making (5) support various opportunities for a better quality of life, borne out of upcycling (6) bring together local makers and makerspace organizations, non-government entrepreneurship and environmental organizations, Philippine and US government agencies, upcycling experts in the Philippines and the U.S., and alumni of U.S. government exchange programs; and 7) deliver different in-person and/or virtual makerspace learning workshops and activities that promote upcycling as a way to protect the environment and as a viable and sustainable source of livelihood.

The program officially started in **March 17, 2017** with **25 participants**, a mixed group of students and faculty, from different Colleges within the University, as well as public school teachers from *Access* schools, an English Access Microscholarship Program from the U.S. Embassy. The program covered design thinking, 2D/3D design, robotics, programming and electronics. To deliver the sessions, facilitators come from **Makerspace Manila**, a fabrication lab and activity center established in May 2015. It was inspired by the global maker movement that holds regular maker-themed workshop in the South of Manila.

The program was conducted in the following sequence: Phase 1 - Skills Building; Phase 2 - Design Challenges; Phase 3 - STEAM Upcycling Project Fabrication; Phase 4 - Maker Fair.

During Phase 1, rote-learning in a classroom setting took place where an introduction to the design thinking approach, invention cycle and fabrication techniques were discussed. On through Phase 2, maker challenges start to emerge where they must build solutions to answer the challenges. Intensive hands on exercises using *Arduino*, *littleBits* and *3D printers*. Site visits to the U.S. Embassy's American Center and Makerspace Manila, the program facilitator's space at Nuvali, Sta. Rosa, Laguna enabled ample exposure to the participants on the various technologies and programming available at both spaces. It was also during this phase that participants were grouped into five (5) teams: *Team Hanna*, *Team Sagip*, *Team Undergrads*, *Team Petchay* and *Team PLA*. These teams collaborated and proposed their team projects to their mentors which will then be showcased at the *Maker Fair* initially scheduled on September 2017.

During Phase 3, building on the teams' big upcycling project was the main goal. Team conceptualization meetings with the facilitators were scheduled through *Slack*, a team messaging and workflow application, where team leaders and its members update remotely on the details and progress of their projects. In person brainstorming with the facilitators were also scheduled and teams can continue with their fabrications at the makerspace or during their most convenient time. However, due to the stringent policies in the budget and unforeseen additional processes, the sessions were extended. Both the teams and facilitators adjusted and the maker fair was moved to the last month of the year. With this, time and commitment started to be factor for success as some participants (both professionals and students) had a bit of difficulty committing to the weekly sessions at one point or another. But despite that, a good turnout in attendance is still evident. Additional sessions were then dedicated to improving their project proposals and fabrication. On the other hand, as observed by the facilitators, the more unique the project, there is a difficulty in acquiring materials. However, this is where the extended time helped as they tweak and fabricate their projects.

At the last phase, the teams showcased their makerspace projects at *"Invention Stories: A maker's journey to innovation"*, the first-ever maker fair in an academic library, held on December 7, 2017, at the DLSU Learning Commons. The teams' hard work was recognized at this culminating activity of the 10-month program, where they were challenged to learn new skills and build their creative confidence. Also present during the maker fair were exhibitors of software and hardware solutions as well as business and project management tools.

Likewise, the University also participated by showcasing its innovative creations through its *Eco Car,* a fuel-efficient and eco-friendly vehicle and the *Agapay Exoskeleton,* a
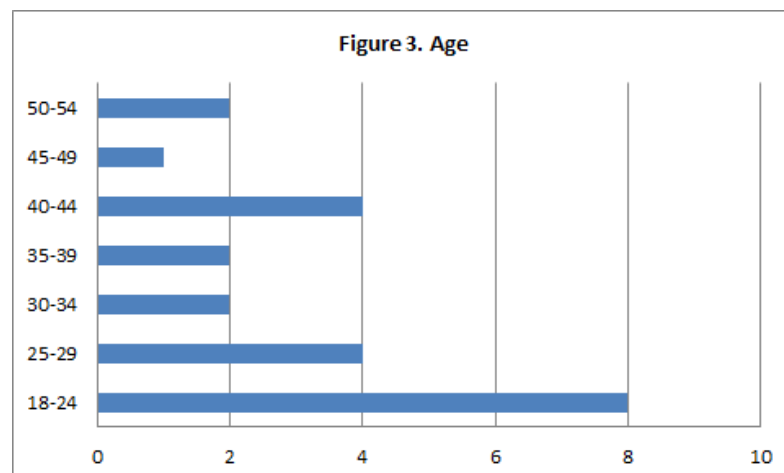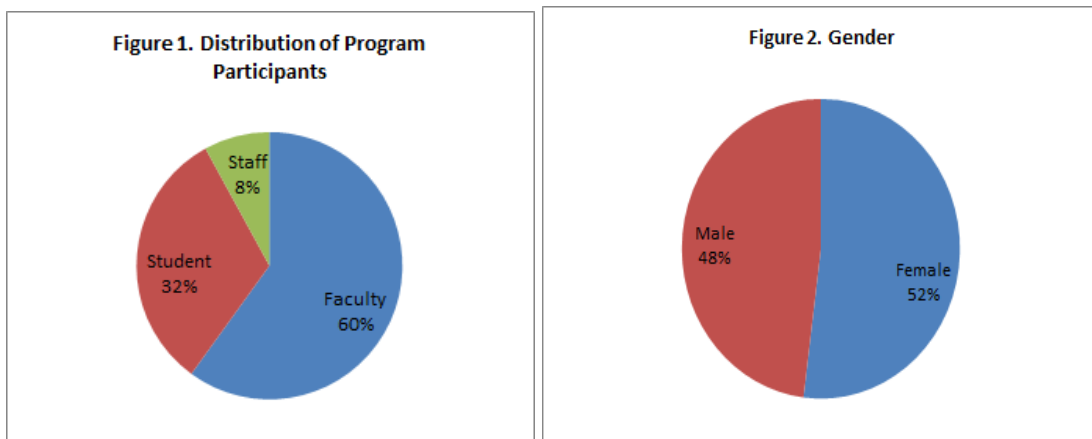
3D-printed wearable robot. Maker enthusiasts came together under one "playground" to ideate and collaborate. (Navarro, 2018; De La Salle University, 2012)

After the series of immersive sessions, the teams were able to produce their STEAM inspired projects. The team projects that were showcased during the Maker Fair were as follows:
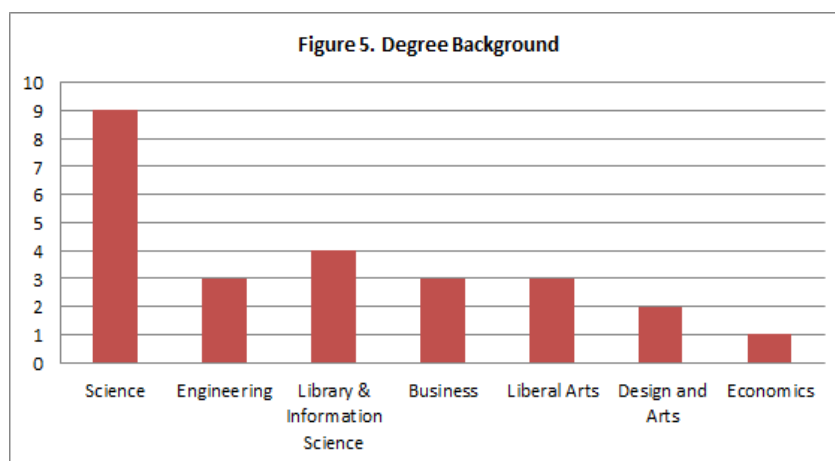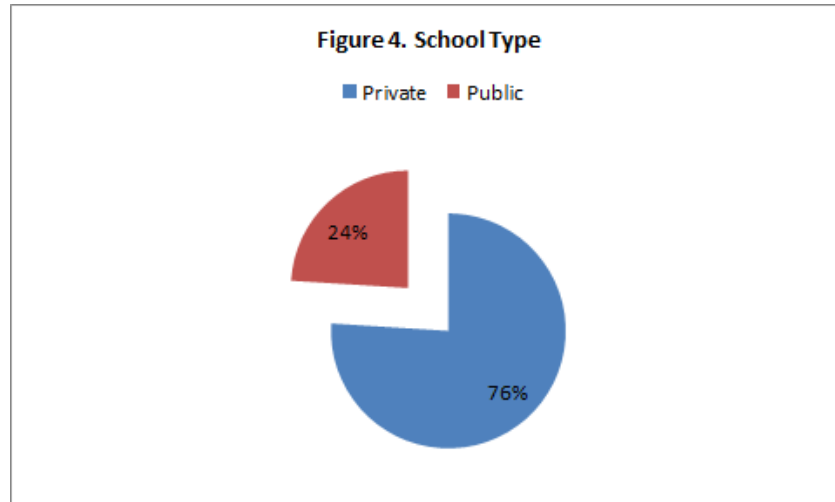
- EdukFan, solar powered electric fan (*Team Hanna*)
- Mini Farm, indoor prototype of an urban garden (*Team Sagip*)
- Hybrid Bicycle, bicycle that charges gadgets (*Team Undergrads*)
- STEAM Pak, an upcycled bag powered by solar panel (*Team Petchay*)
- #Dunk-it-plastics, a plastic shredder (*Team PLA*)

Results and Discussion

The study gathered feedback from the program participants composed of faculty, student and staff with percentages of 60 %, 32 % and 8 % respectively. Majority of the respondents were the faculty with the highest percentage as seen in Figure 1. They were majority from private school (76 %) females (52 %) with ages 18-24 (34 %). Please see Figures 2 and 3.

Figure 1. Distribution of Program Participants
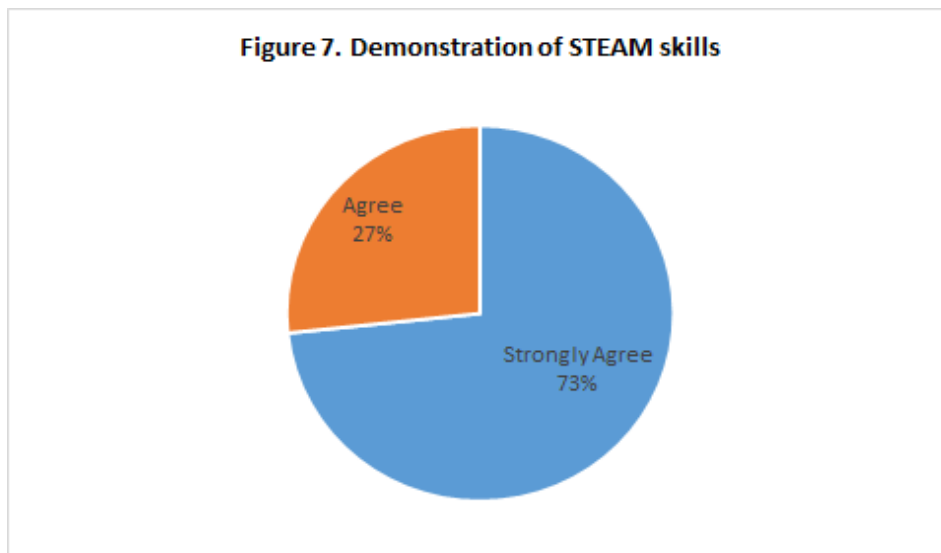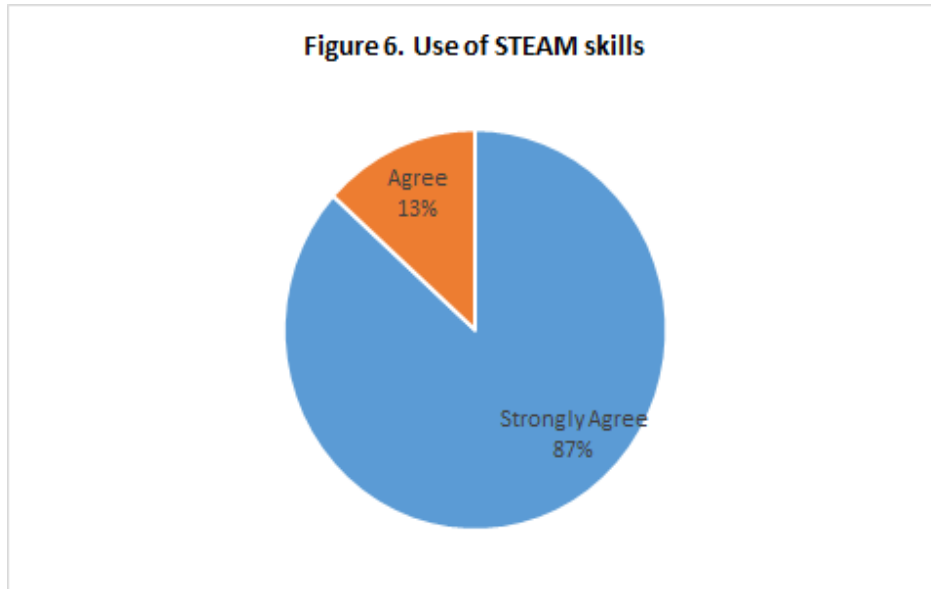

Figure 2. Gender

Figure 3. Age

The program participants were both from public (24 %) and private schools (76 %) coming from the different subject disciplines but the majority came from the Sciences (24 %). Please see Figures 4 & 5.

Figure 4. School Type

■ Private   ■ Public

24%

76%

Figure 5. Degree Background

When asked about if the program has provided additional knowledge in employing STEAM skills (87%) strongly agree with the statement. Meanwhile (73%) strongly agrees that the program was able to help them demonstrate STEAM skills. Please see Figures 6 & 7.

One participant also noted that the topics in the said workshop can also be applied in daily routines in life like upcycling, a life-skill that everyone should be learning in school that instead throwing unwanted materials, we can possibly convert this into useful and help solve environmental problems in our community

Majority of the participants noted that the application of design thinking methodology in creating innovative products and the basics of Arduino were one of the useful sessions for them (Personal Communication, May 24, 2018).
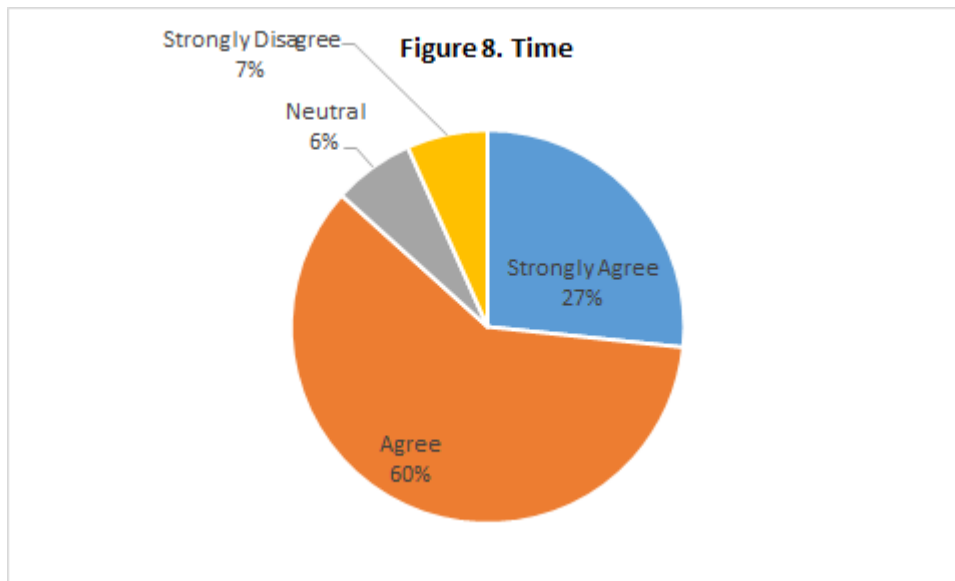
Figure 6. Use of STEAM skills

Agree 13%

Strongly Agree 87%

Figure 7. Demonstration of STEAM skills

Agree 27%

Strongly Agree 73%

However, when it comes to the adequacy of time alloted in the session, (27%) strongly agrees and (67%) agrees to its sufficiency while (7%) strongly disagrees. Please see Figure 8.

This variation in the feedback might be attributed to the long stretch of the program being held in a series of session. It might be worth noting that some remarked how they thought of it as a weakness:
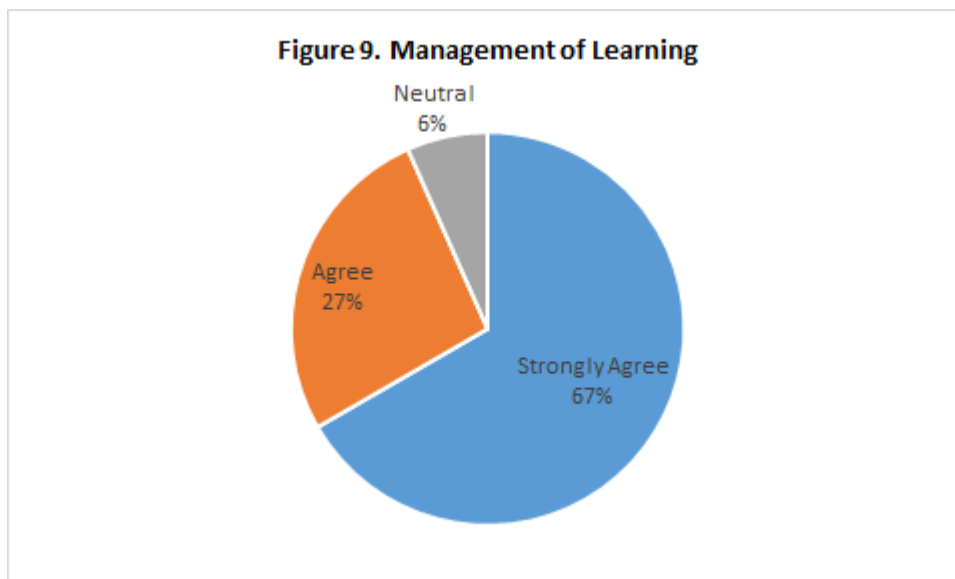
> *Weakness of the program is the schedule's vulnerability to external influences. The 6 month program stretched to a year creating so many issues (Personal Communication, May 24, 2018).*

> *I wished we had more hands on projects that weren't related to the capstone project like more robotics projects and more design thinking exercises -- forcing the two together for our capstone was rather difficult (Personal Communication, May 25, 2018).*
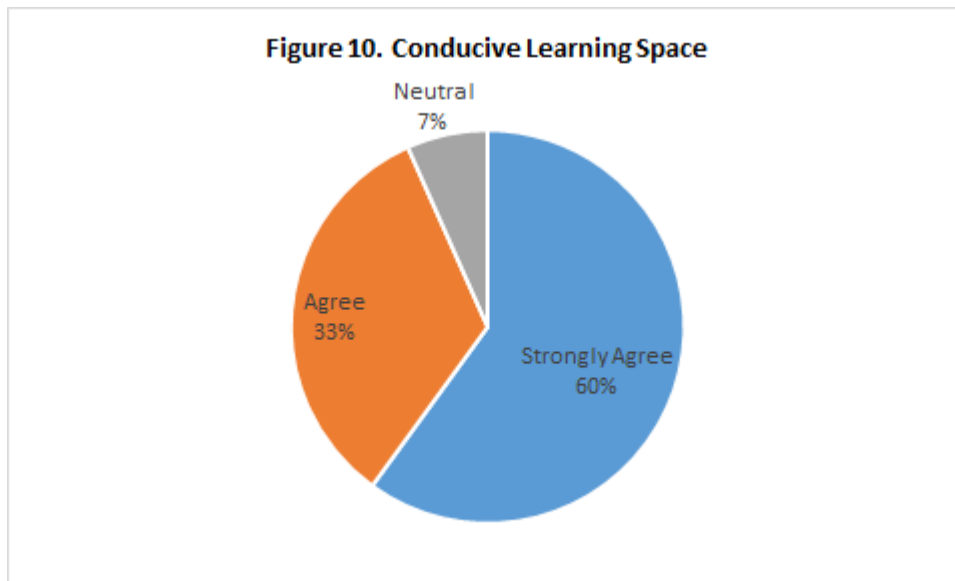
Figure 8. Time

On the other hand, (67%) strongly agrees that the program enables opportunities to ask questions and raise clarifications. Please see Figure 9. It created an atmosphere that is conducive to a participative and collaborative environment. One even remarked,

The program was well designed and the facilitators/organizers and trainers demonstrated a genuine willingness to help the participants complete the program (Personal Communication, June 2, 2018).
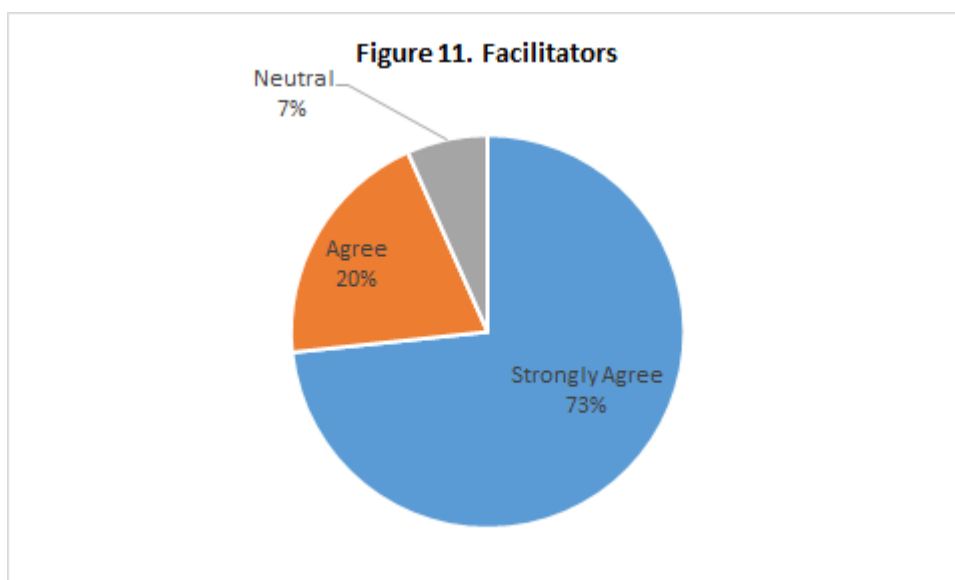

Figure 9. Management of Learning

On the learning space provided, (60%) strongly agree that the space helped in facilitating learning. Please see Figure 10. It was noted as one of the top strength of the program,

The resource person, library support and facilities were major strengths ` (Personal Communication, May 25, 2018).

Figure 10. Conducive Learning Space

Neutral 7%

Agree 33%

Strongly Agree 60%

On the part of the facilitators, (73%) strongly agree that as students they were challenged to think critically, analytically and creatively. Please see Figure 11. They even thought of this as part of their best takeaways in the program as they remarked,

I would just emphasize its strength because this program really built my creative aspects. The method of creating and selecting solutions. You get crazy as hell then you get realistic and combine them. Sounds absurd but it works (Personal Communication, May 24, 2018).

Figure 11. Facilitators

Neutral 7%

Agree 20%

Strongly Agree 73%

The program can be considered a success as (100%) of the participants recommends to have another run of the program that highlights multidisciplinary techniques that supports collaboration. As noted by the students,

It creates an opportunity for non-engineering students and faculty to diversify their skill sets. I realized how empathy can be a tool to develop or improve a design of a product and even in finding solutions to a problem (Personal Communication, May 24, 2018).

I learned a lot in electronics, innovation and design thinking. This program encouraged the participation of people from different fields. I learned a lot from the people I worked with and from the mentors. I always cherish the memories of being part of this program. (Personal Communication, May 25, 2018).

Conclusion

The STEAM Upcycling program helped address the needs of both faculty and students to equip them with STEAM skills. The program proved to be an alternative way and a good opportunity to learn new skills and concepts even for those who do not have any background on the hard sciences. As they were able to create a new material out of something, they were able to harness their creative skills which enables them to be future entrepreneurs should they continue making. Although it proved to be beneficial, several concerns are still present — internal policies, budget constraints and availability of the participants is a factor that librarians must consider if they are to consider a serial maker program. As mentioned, the program was offered as a full package - even extending to several months, requiring one to go through all the phases. Since time is also an important factor to be considered, organizers might offer the phases in separate learning sessions where students sign up to classes that they are interested to.

Moreover, The program was well recommended by the participants. It is also good to note that majority of the faculty and teachers who have joined the program said that the sessions are indeed meaningful and relevant in the increasingly changing landscape of education which includes the early curriculum developmental years of the K to 12 system in the Philippines. Majority of the participants said that the program is relevant to what they have been doing both in school and in their personal life and what our educational system needs for us to cope in the fast-changing technology.

In addition, most of the participants said that the program opened doors of opportunities to venture on social entrepreneurship and ignited their passion to help solve environmental and social problems in the Philippines.

Overall, the program is a great enabler for libraries to increase their social value by establishing and transforming places that promotes a conducive and inclusive space for the library users to make, create and collaborate. Hence, it is a worthwhile endeavor for libraries to consider creating programs that will help support the critical, creative and innovative skill sets of its community.

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