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Makerspace or Maker(-): Making Culture as an Alternative Society to Mass Consumption

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Abstract

We are in the midst of a never-ending paradigm shift of standards and insights in a technology-focused educational structure that is constantly developing. Because of the democratization of information with widespread use of the Internet, the organization of educational processes has loosened its effectiveness of existing hierarchical structures. Education once was a one-way communication between the teacher and the students, and has transformed into an experience-oriented structure with a multi-faceted communication. One of the most common implementation examples of today's experience-oriented education component is the Makerspace, which is rapidly becoming widely celebrated in educational societies [1]. Makerspace can be defined as common spaces where participants create practical projects that will reinforce their knowledge and skills based on their internal motivations. However, makerspaces can move away from the basic principles that led to their existence and become the consumers of life, not the producers of life. When it comes to the use of makerspace in educational content, some confrontational social and ethical responsibilities arise. In this article, the author discusses the necessary content components which would be required for an efficient use of Makerspaces based on the experiences in the VA455 Physical Computing course being given at Sabanci University. During this course, students are introduced several topics about how to integrate the use of computational systems by utilizing various physical sensors to create interactive art and design projects. In this paper, while the discussions focus on the nature of makerspaces, the author aims to illustrate emerging educational paradigms in the intersection of using technology as a socializing platform for various interest groups.

Keywords: Makerspace, Maker Culture, Mass Consumption, Physical Computing, Technology in Education

INTRODUCTION

Makerspaces have become attractive locations for creative, innovative and self-driven minds. The desire to create customized utilities with a certain set of specific features and functions have been fostered by these community meeting spots. These centers have been structured in various organizations and over time, different user case scenarios have flourished throughout their evolutions. Most commonly, an ordinary makerspace provides its members with a variety of equipment including laser cutters, CNC machines, 3D printers, whipsaws, circuit components, and hand tools. Since the maker practice is structured on a peripheral of different resources, these venues are usually filled with sets of equipment for cultivating skills. Attendees of these makerspaces do not only share tools and spaces but also ideas and experiences. According to Burke and Ellyssa [2], makerspaces spur practical and artistic creations that can provide economic, educational and social rewards. In an era where consumers have been more aware of their demands, the market has been struggling to serve for personalized inquiries. People are trying to explore new methods to become self-sufficient in fulfilling their supply of commodities. Moreover, it has been observed that the people who seek new approaches to innovation and co-creation have used makerspaces as incubation platforms for their prototype developments.

Fleming [3] states that makerspaces have become the places where people appreciate the opportunity to explore their own interests while learning how to use new tools and materials, both physical and virtual. On a similar note, websites such as “instructables.com”, “thingiverse.com” and “hackaday.com” have been extensively visited by interested groups and similar projects have been submitted to these recourses to provide more refined content to the communities. At the core of the maker culture, there exits the notion of moving from passive consumption to become an active creator of projects and ideas. According to Leavitt [4] in the early 2000s people demanded the need to explore their own projects rather than complying with the products available in the market for consumption. Widespread use of internet contributed to the development of shared experience platforms and as a result, connected users were able to improve their skills with intrinsic motivations. However, the connectedness also facilitated such physical environments where talented people get together to accomplish inspiring projects. Different than the individual isolated garage workshops, makerspaces were built in public spaces not only for sharing the specific equipment but also the information maintained with the experience of making it. So, a new sharing culture was organizing around the way in which people produce artifacts and products for the common use.

But then what makes the difference between a makerspace and a vocational school? Vocational schools are traditionally designed to educate people to perform the tasks of a particular job with specific definitions. In the face of technological revolutions, vocational education has become a key figure in providing qualified human resources for highly competitive markets. Their main goal is to provide an adequate amount of workforce for the demanding industries. However, in makerspaces the education is mainly voluntarily associated, and the tasks are configured by the learners' inquiries. The participants' backgrounds may come from different disciplines such as engineering, arts, design, natural sciences etc. Another significant difference is that makerspaces mainly have started outside the established education system as a technology-based extension of Do-

It-Yourself (DIY) culture [5]. Now it is becoming more commonplace to observe that in order to benefit their services, universities are hosting makerspaces in their campus and trying to build curricula teaching hands-on approaches for rapid prototyping and new courses have been opened to promote innovative thinking.

When the educational dimensions are considered, it is observed that the traditional learning methodologies have been acknowledged to a limited degree of affirmation, thus enabling the educator to withdraw as the main figure cruising the directed guidance in the learning process. Kurti et al [6] describe this emerging philosophy of learning as an inquiry-based approach in the development of knowledge and thinking process. It is expected that the learner initiates learning with intrinsic motivations. In this paradigm, the line between the learner and the instructor becomes obscure and both parties are involved in the learning process actively. Also, as the students start to collaborate on certain tasks while solving the challenges that they face upon, they become actively engaged in the learning process and the instructor's previous patronizing role shifts into being a facilitator while students enhance their intrinsic motivations for further affordances of learning situations.

VA455 Physical Computing course has been opened in Spring 2008-2009 semester at Sabanci University, Istanbul. Sabanci University's education philosophy relies on the following concerns: student focused, participatory, interdisciplinary, application-oriented, self-sufficient, teamwork oriented and learning to learn. Similarly, the course has been outlined to integrate such issues under the umbrella of a certain discipline named Physical Computing. Physical Computing is a field of study that explores establishing communication between the physical world and the virtual world of the computational systems [7]. It entails the design and actualization of interactive systems and allows people to create tangible products with their own commitments [8]. As a consequence, makerspaces become common spaces where participants create practical projects that will reinforce their knowledge and skills based on their internal motivations. During this course, students are introduced to various methods and design systems for the purpose of collaboratively applying physical computing while building interactive physical environments. Essentials of building circuitry and creating basic software to accomplish communication with microcontrollers and computers have also been introduced.

MATERIALS AND METHODS

Students enrolled in Sabanci University Undergraduate Programs are allowed to declare their majors at the end of the second year of their studies. As a consequence, it permits the flexibility for the students to consider their options while still being introduced to the fields of studies. This student focused education architecture facilitates an interdisciplinary environment in which students are guided to carry out planning their own agenda of curricula. To a considerable extent, being enrolled to a specific program does not necessarily limit a student's choice for attending other courses than their assigned program requirements. Especially for elective courses, there is a substantial demand for the interdisciplinary courses which are based on integrating multiple disciplines together with the utilization of skills and information on different areas. The course aims to optimize the flexibility of the course content while introducing essential issues about the technical details. In VA455 Physical Computing, backgrounds of the students are frequently dispersed in various interests such as engineering, natural sciences, administrative sciences, arts, design etc. This interdisciplinary environment is a cultivating setting for the use of makerspaces as well. Rather than being confined to a certain academic discipline specifically, the participants of such venues establish interactions with people coming from other disciplines smoothly [9, 10].

Table 1. VA455 Physical Computing course enrollment with majors*

Semester (Spring)	VAVCD	CS	EE	ME	MS	N/A
2008/09	7	-	-	-	-	-
2009/10	5	-	-	-	-	-
2010/11	1	5	1	-	-	-
2013/14	5	1	-	-	-	-
2014/15	8	1	2	-	-	-
2016/17	6	3	1	3	-	-
2017/18	11	5	-	2	1	1

*VAVCD: Visual Arts and Visual Communication Design, CS: Computer Science, EE: Electrical Engineering, Mechatronics Engineering, MS: Manufacturing Systems, N/A: Undeclared yet, BA: Bachelor of Arts, BS: Bachelor of Science

As it is observed in the above table, VA455 Physical Computing Course brings students from multiple disciplines together. Although there is general uncertainty about the meaning of the term interdisciplinarity [11], it can be defined as the integration of two or more academic disciplines into one structure. Considering the number of attendees coming from distinct fields of study, an interdisciplinary participation ratio could be calculated as below;

$$IPR = \frac{\min\left(f(d), f'(d)\right)}{\max\left(f(d), f'(d)\right)}$$

where IPR: interdisciplinarity participation ratio,

$f(d)$*: number of attendees when* $d \in$ *major(d),*

$f'(d)$*: number of attendees when* $d \notin$ *major(d)*

According to the proposed equation, if we take the Spring 2016 - 2017 Semester in consideration, IPR value is calculated to be 85.71 % whereas Spring 2010 - 2011 Semester's IPR value would be 16 %. Thus, in a perfect situation given that the number of VAVCD students and non-VAVCD students will be equal, the value becomes 100%. Interdisciplinary participation ratio does not necessarily favor the likelihood of having a dominant number of non-disciplinary participations, instead it emphasizes an equal distribution.

In order to structure a course content with promoting curiosity towards a certain problem to focus on, the final project topic is specifically selected to be based upon a particular theme. The final project of the course aims to integrate fields of interests to enhance the cross-fertilization of the learned skills and knowledge on a given task. For example, in 2010-2011 Spring Semester, the course focused on the subject area of assistive technologies for special needs. The students were asked to collaborate with a special school for kids who have a condition of Cerebral Palsy (CP). CP is ‘a disorder of movement and posture due to a defect or lesion of the immature brain [12]. The kids with CP attending this school are going through a special education tailored for their special conditions. After having spent adequate time discussing with their mentors and other professionals in the field, VA455 Physical Computing students have tried to design interactive systems for establishing assistive technological solutions. In one of the projects, a student tried to build a custom game controller for a computer game instead of commercially available version so that the kids with CP conditions would be allowed to interact with the system on a custom setup for his condition.

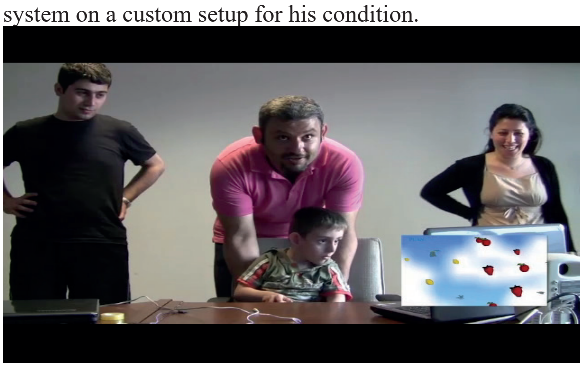

Figure 1. A kid with a Cerebral Palsy condition interacting with a custom build game controller

In this modeled game, the players are asked to collect various kinds of fruits floating in the air as much as possible on a computer screen. To change the altitude of the main character, the handler was designed to have a replaceable spherical body that moves in clockwise and counterclockwise directions. Such rotational movements helped the player to prevent further muscle deteriorations. In this interdisciplinary project, we are observing a synthesis of implementations from the fields of game design, physical interaction design, ergonomics, and psychology. Having an experience in these fields not only demonstrates a student to be introduced to unfamiliar disciplines but also to confront real-life challenges while embracing essential human values.

In 2013 – 2014 Semester, students were given the task of focusing on the theme of introducing colors in their design to motivate, educate, entertain and familiarize kids within an age group of 3 to 4 years old. Among the several projects which successfully accomplished the task, in a project named RGB Toddler, the student tried to design a transparent ball with a light system in it that looked like an egg with facial features. When a person interacts with the toy by interfering it with a physical contact, the toy was changing to display different colors. For the final presentation of the designed system, a three-years-old boy was invited to class to interact with the game.

Figure 2. A three-years-old kid playing with an interactive game

However, it was not expected to see the boy not interacting with the project not even touching it at all. Later on, when the boy was asked about his behavior for not hitting the ball, it was astonishing to hear that he avoided it because it looked like an egg which might break. Similar to the previous project, this project also included issues of toy design, physical interaction design, ergonomics, and psychology issues. Both focus topics have aimed to accumulate students around a certain issue that might help them to emphasize their intellectual growth and self-development.

Collaboration Space was built at Sabanci University in 2017 to be used as a makerspace for hosting innovative and collaborative hands-on learning experiences. The facility provides resources like 3D printers, 3D scanners, electronic peripherals, and various other hardware and software applications for the common use of the University members. After its initial opening, VA455 Physical Computing class was moved to Collaboration Space for the 2017 – 2018 semester. As it was previously held, a theme was provided to students for a final project challenge. Students were asked to focus on building physically interactive table games for various age groups.

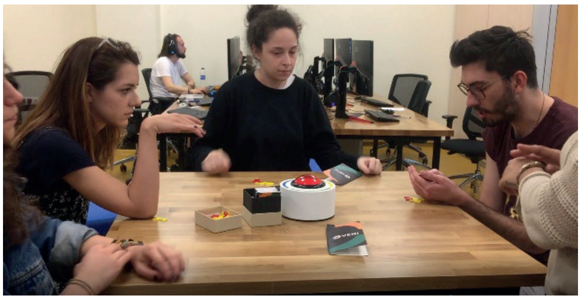

Figure 3. Students testing the board games at the makerspace

Different than the previous course experiences, 3D Printing was included as a new topic to be implemented. Students were trained to have experience in 3D modeling and accurate prototyping as an introductory level and further detailed tasks were brought about during the project implementations.

3D Printing is considered to be a revolutionary technology that is likely to manipulate existing business models, enabling fabrication of custom products with home-based manufacturing systems [13]. With the availability of open communities such as Thingiverse, people are able to download replacement parts for their malfunctioned equipment and fix it with their own means. As a consequence, such technological reuse and upcycling opportunities become a norm in the maker culture, making it to be an opponent to the mass consumption culture.

With the addition of 3D Printing skills and integrating it with basic electronic circuit designs, the participants’ curiosity to create new table game designs were enriched to a greater extent. One key element in this class is that students are required to make their own circuit boards from basic electronic components instead of buying predesigned commercial control systems such as Arduinos, Tinker kits or Makey Makeys. As a consequence, the makerspace was used as an effective idea actualization space rather than being a consumer to existing market supplies such as electronic kits, shields and sensor kits.

Students coming from various interest groups have collaborated together to realize tangible projects based on their creative thinking. Because of the fact that the course was held at a common space which is shared publicly, any enthusiastic visitor was allowed to participate in the class without any course enrollment concerns. Consequently, the open and flexible environment in the makerspace has let the students' motivation to be high throughout the course. Their curiosity and eagerness to achieve given goals have enabled them to explore and learn further details of the content fueled by their self-motivation. The conventional curriculum-based teaching methods with rigid boundaries were abandoned, as a response, the students have developed their peer-learning and intrinsic learning skills that are customized for their requirements.

RESULTS AND DISCUSSION

Although the makerspaces have originated from non-academic community based independent organizations, their widespread recognition permitted the educational makerspaces to be established in the institutional levels as well. Rather than investing in a space with expensive technological equipment for building adult playgrounds, institutions need to consider designing appropriate uses for these community meeting points. Courses configured on the use of such makerspaces need to focus on formalizing occasions to encourage students to gain self-driven deeper learning skills with purposeful tasks. The teacher's role evolves into a responsibility of configuring challenging tasks for the students and curating a strategy to empower students' level in developing skills and gaining knowledge while enlightening humane values such as responsibility for others, ethical thinking, feeling of empathy. It is inevitable to say that makerspaces need to encourage students to establish a collaboration to support student confidence in accomplishing a shared goal.

With the experiences gained on teaching VA455 Physical Computing course, it could be stated that when students are exposed to real-life challenges with a certain set of expected outcomes, their learning results become more efficient and sustainable as a consequence. Makerspaces are inspiring environments to rethink about traditional educational paradigms due to their revolutionary and effective success in inquiry-based personal development. In this study, we are observing a series of educational schemes that aim to contribute to enhancing the self-intrinsic motivational endeavors for constructive learning environments. With the inclusion of makerspaces in the curriculum of new educational configurations, it is observed that the students have significant improvements in their self-driven learning impetus. Nevertheless, it should be noted that the makerspaces need to be involved with purposeful discourses, thus avoiding the unaccountable efforts to construct hollow outcomes.

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