INTERNATIONAL JOURNAL OF eBUSINESS AND eGOVERNMENT STUDIES
Vol 10, No 2, 2018 ISSN: 2146-0744 (Online)

MAKERSPACE CHILDREN UNIVERSITY: A CURRICULUM DEVELOPMENT PROJECT PROPOSAL

Demet Soylu
Ankara Yıldırım Beyazit University
E-mail: dsoylu@ybu.edu.tr

Tunç Durmuş Medeni
Ankara Yıldırım Beyazıt University
E-mail: tuncmedeni@ybu.edu.tr

─Abstract ─

As learning needs and behaviors of the students of the Z Generation have changed recently, new educational trends and learning environments emerged into the field of education. Makerspaces are one of the prevalent innovative educational hubs and centers which enable the learners to experience and experiment cooperative and participative learning through the use of various tools, equipment and materials within the frame of STEAM approach. They are creative knowledge production platforms where learners interact with each other and knowledge, itself. Throughout the world, there are various makerspace initiatives of universities, colleges, high school and secondary schools that have been influenced by the makerspace culture in their educational approaches. Many educational organizations have started to re-frame and re-shape their educational curriculums and incorporate maker culture in their educational programs. Turkey is one of the countries making attempts in re-structuring the curriculum with makerspace activities and incorporating non-formal tools in the educational programs and curriculum. This study aims to put forward the theoretical framework of the Curriculum Development Project Proposal of Ankara Yıldırım Beyazıt University entitled as “Children MakerSpace University Hub” and provide information about the curriculum and educational methods of the makerspace university hub to be established. In accordance with the given data within the scope of the study, it can be recommended that educational institutions in Turkey should take important steps in creating makerspaces, cooperating with each other and make partnerships with the other countries and provide exchange programs within the scope of makerspaces. Educational organizations can employ makerspace teachers who have expertise practical and theoretical knowledge relevant to the field. They can also work on developing special curriculums for disadvantaged groups and minorities to facilitate their learning and inclusion processes.

Key Words: *Makerspace, Maker culture, Curriculum Development*
JEL Classification: I29

1. INTRODUCTION

1.1. Concept of Makerspace

Since learning needs of Z generation and digital natives change and each day, learning behaviours and manners of individuals have evolved, as well. Post-modern educational era has witnessed the emergence of varying trends and creative learning approaches in educational implementations in such organizations as schools, museums and libraries. In new trends, it is getting prevalent to teach how to learn and design in creative knowledge management hubs and space for learners. These innovative spaces are attracting the attention of the learners as they have the characteristic to interact with the learners and providing them with the opportunity of expressing themselves, learning in a place where they feel more comfortable as they do at their homes. Makerspaces can be considered as the free acting stage of an individual where "making" and "creating" are prioritized. Based upon this, the term-makerspace- seems to have a high potential in occupying the educational literature pleasurably

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In literature, there are various definitions and synonyms. While the Institute of Museum and Library Services (2012) defines makerspaces as hands-on, mentor-led learning atmosphere to make and re-make the physical and digital worlds thereby fostering experimentation, invention, creation, exploration and STEAM learning, 2015 Horizon Report Library Edition identifies it as "community oriented workshops where tech enthusiastics meet regularly to share and explore electronic hardware, manufacturing and mechanical tools, and programming techniques". In literature, makerspaces are called with various names such as STEAM lab, Design Studio, FabLab, Tinker Tub, iLab, Workshop, Sandbox, Tech Center, which can be handled as transformative trends in innovative education (MindBridge Partners, 2016). It is also described as a space where a student can design, create using multiple tools, methods and materials with various purposes and commonly used by K2 schools and integrated into their curriculum. As miscellaneous materials they use high-tech 3-D Printers, laser cutter tools, electronics gear (MindBridge Partners, 2016)

2. LITERATURE REVIEW

Makerspaces are handled as strategic open-access learning units which enable the autonomous and social learning process of learners and students with divergent thinking manners (Liu and Schönwetter, 2004; Thompson and Lordan, 1999). They are different from the traditional educational settings and they are not prioritizing pre-defined assignments of students (Farritor, 2017). Rather than being an ordinary class atmosphere, they are as considered a mechanism for encouraging students to experiment and learn beyond the classroom environment and outside of the normal structure of their assignments. Students are encouraged to examine new means of creation and in doing so they strengthen and apply more (Burke, 2015). They enable the students to learn through gamified practices which will have a positive impact on permanent learning process and appeal to the multiple intelligences of learners. They are closely associated with the experiential learning (trial-and-error, learning-by-doing, student-centered) (Blackley et al, 2017) and are considered as “third-places” (Oldenburg, 1999) of individuals where they feel comfortable after their home and workplace (Moilanen, 2012). Cosy learning atmospheres are believed to contribute to the efficient learning process of learners.

Maker-culture is essentially based upon the art of making in a participatory and collaborative atmosphere. Papert’s theory of constructionism puts forward the idea that “construction of knowledge happens remarkably well when students build, make and publicly share objects “(Blikstein, 2013; Wong and Partridge, 2016). Knowledge is created through the cooperative making and sharing process of learners with a psychological constructivist approach which is closely associated with makerspace concept and maker-culture. It is a kind of theory which asserts that conceptual knowledge is dependent on the developmental stage of the learner and active participation of the learner in the learning process. Learners are handled as active meaning –makers and interpreting experience with cognitive structures. In each level of maturationism, person develops different skills and gains new competencies (Mahoney and Granvold, 2005). Makerspaces have a relation with the well-being of the society, they serve in order to meet the demands and social needs of the society and reach out excluded people (Hussain and Nisha, 2017).Namely, they aim to create positive emotions in the behavior of learners and they transform the learning experience into playful manner and game-context. Learners can easily adapt themselves to the atmosphere and they can tinker, construct and build with engineering thinking manners. Furthermore, "the maker educational environment is characterized by a blend of project-based pedagogical practices alongside informal "ways of seeing, valuing, thinking, and doing found in participatory cultures," which contributes to participant reports of makerspaces "feeling like a family or a group of friends" (Sheridan et al., 2014, pp. 527-528). Makerspace theorists argue that makers should be exploring digital competency, self-expression, and community formation through the creation of artifacts.

The maker movement was borne out of the increasing number of people who creatively engage in both physical (or tangible) and digital fabrication to solve an existing problem or need and to share their design and making with a community of like-minded innovators (Halverson and Sheridan, 2014). Moreover, it is closely related with the Do-it-Yourself Paradigm, which has recently re-emerged as a creative expression (Buecley et al., 2013), self-directed learning (Martinez and Stager, 2013) and "maker" concept involves the hands-on creation of material things that are blend of both physical manufacturing and technical digital skills (Hughes, 2012). It enables online and offline, interactive and reflective peer production, resource sharing, collectively organized makerspaces (Anderson, 2012). It is a mixed ability maker culture which means collaborative culture within which people with and without disabilities can co-exist and co-create as they work to maximize and develop their skills (Alper, 2013; Connor and Gabel, 2013). Maker space learning atmosphere is based upon the use of knowledge or skills within a particular context. It considers the learning activity as a social activity enabling, entailing and requiring the participation of the members of the community and embedded with the idea that learners must work together to achieve the desired outcome and impact (Adrianus de Kock, et al, 2000; Fardanesh, 2006). Maker movement is based upon a constructivist approach to education, regarded as a movement which allows students to be creative, innovative, independent and technologically literate, (Stager, 2014). According to the theory of constructionism, idea of –making- is more prioritized than –getting- , as making entails knowledge production (Kafai & Resnick, 1996; Litts, 2015;). Learners become active makers of ideas and knowledge. Knowledge and learners interact with each other in a reflective making manner, which is considered as "an iterative process of creating and revealing knowledge through constructing external artifacts". Cognition is asserted to be both in the mind and world and they become united with the act of making; namely, constructionism (Papert, 1993).According to this concept, learner is regarded as an interactive maker and tinkerer in an incubator-like learning atmosphere where they can explore, construct with the external materials they find. The tools they find in their surroundings help them to be "bricoleur" which means a builder (Papert, 1980,1991; Litts, 2015). "In this bricolage style of working, creating becomes a conversation between the bricoleur and the environment in which constructing is happening; bricoleurs play with a range of tools that happen to be accessible around them and, as a result, create new tools that go back into the environment joining the repository of future resources of making " (Litts, 2015). Makerspace activities have a wide range of activities such as electronic textiles center, coding, 3-D printing, metal work, wood work, digital tools.

Many organizations including universities, colleges, museums and libraries use maker space learning areas and identify it with various names. For instance, University of California uses Super Node, while University of Polytechnic State University uses Innovation Sandbox. Darthmouth College uses calls it as Unified Projects Laboratory; Carneige University as IDeATe, Drexel University as ExCITe center, Harvard University as Guerilla Maker Space, North Carolina State University as Hunt Library Makerspace, Purdue University as BoilerMaker Lab, Washington State University as Fab Labs (Barret et al, 2015). In addition to these examples, California Community Schools (CCST, 2016), Brooklyn Public Library which provides STEM-themed activities for children, organizes HOMAGO activities (Hanging out, messing out and geeking out), Coder-Dojo activities (coding training), Bric (Media and Production) Education (Urban Libraries Council, 2018a), Cleveland Public Library which has Hands-on MakerLab Programming, fabrication and production space (Urban Libraries Council, 2018b), Chicago Public Library which carries out activities from origami to Arduino powered robotic knitting (Urban Libraries Council, 2018c), Gwinnet Public Library which gives training on 3D Design Software Applications, fundamentals of 3D dimensional printing, use of MakerBot Replicator 2 Printer (Urban Libraries Council, 2018d), Lexington Public Library (Urban Libraries Council, 2018e), Yale University, Stanford University, Georgia Institute of Technology (Wilczynski,2017), University of South Wales, University of Newcastle, The University of Queensland, The University of Syndey (Wong and Partridge, 2016) are among the other organizations providing makerspace services worldwide. St Petersburg College has established an Innovation Lab, offering educational opportunities for robotics, coding, 3D design and printing, circuitry/electronics, virtual reality, drone, holographic enhanced learning. Furthermore, Palm Harbor Library has created a zero-tech and art-themed makerspace for kids. Rijeka City Library has established 3D Printing Incubator for Children and Youth and providing a training on 3D design, modeling software and operating the printer, it holds out annual Maker Festival Apart from these, museums are also engaged in makerspace activities. Children's Museum of Pittsburgh initiated building a "field-wide understanding of making in museums and libraries. Oregon Museum of Science and Industry (Institute of Museum and Library Services, 2014). In literature, miscellaneous studies and researches have underlined the importance of makerspace activities (Litts, 2015; Wong and Partridge, 2016; Taylor et al, 2016; Burke, 2015); Tomko et al, 2017; Blackley et al, 2018).

3. MAKERSPACE TOOLS, MATERIALS AND PRODUCTS

Makerspace activities are performed with various tools, materials and products, which enable the learners to be easily included within the activity and to improve their skills. In accordance with that, this section of the study lists makerspace tools, materials, products used worldwide in makerspace activities. These tools can be used in science, technology, artistic (painting, drawing and wooden work etc.) and textile-related outputs. Makerspace workshops are embedded with common technologies and activities as computer stations, photo editing, 3D Printers, creating a website or online portfolio, video editing, scanning photos to digital, digital music recording, animation, high-quality scanner, creating apps, game creation, prototyping, VHS conversion equipment, electronic music programming (Burke, 2015). All these are significant components of makerspace education programs.

Detailed list of the makerspace tools, materials and products relevant to these components have been shared in the list below (Table 1):

dowel	plywood	popsickle stick	machine screw
pry bar,	putty knife	spring clamp	hot glue gun,
3D Printers	laser-cutters	orbital sanders	digital multi-meter
tin snips	needle nose	mallet	Lilypad (sewable electronic kit)
solder sucker	crimper tool	diagonal cutter	slip joint pliers
pull saw	rotary tool	miter box	hacker saw
Vernier caliper,	paint brush,	staple gun,	white glue
wood glue	super glue	masking tape	electrical tape,
lumber	foam board	zip tie assortment	jig saw
circular saw,	welding clamp	wood chisel set	belt sander
T-connector	9V Battery Snaps	buzzer	switcher
lubricant	Plastic tubing	Makey Makey	littleBits
toothpick	Scoth tape	PVC cement	Circuit Stickers
router	sharpening stone	Drill vise	anvil
wire	LED	battery	Jumper wire
spray adhesive	epoxy	duct tape	staples
super glue remover	pen	pencil	marker assortment
Sphero	LEGOs	Squishy Circuits	Goldie Blox
Doth & Dash	Lego Mindstorms	Raspberry Pi	Arduino
Engino	VEX Robotics	Ozobot	Bee-bot
Ardusat	Humming Bird Robotics	Makedo	Hyper Duino
Kinetic Sand	Maxformers	Circuit Scribe	Electric Paint
Do Ink	Sugru	Finch Robot	3D Printing Pens
Bare conductive	Go Pro Camera	Open Rov	Vinyl Printer
Giant Jenga	Rainbow Loom	Paperboard	Bar clamp
Bradawl	Swivel casters	Jeweler’s saw	Butane
Cutoff disk	cupbrush	Piezo buzzer	Steam iron
Sewing awl	Snap setter	Fabric marking pen	Fabric glue
Hook and loop fastener	Digital camera	Plastic filament	PVA (water soluble) filament

Table-1: Makerspace Tools, Materials and Products (Maker Media, 2012; 2013; Makerspace, 2018; The Art of Education, 2016)

4. ANKARA YILDIRIM BEYAZIT UNIVERSITY (AYBU) MAKERSPACE UNIVERSITY

This section of the study will provide information about the EU Project Proposal on Establishing AYBU MakerSpace University. The project is based upon the Magical Wish Box Children Makerspace Festival Social Responsibility Project supported by Ankara Development Agency and coordinated by AYBU. Now, it is currently being designed as an Erasmus Plus Strategic Partnership Project.

Figure 1: Photo from Magical Wish Box Social Responsibility Project (Source: Coauthors Archive)

Curriculum is designed based upon the courses given by Ministry of Education, among others. These are not particularly dedicated makerspace sources, however the coauthors try to adapt these into the suggested makerspace curriculum. AYBU Makerspace Children University Curriculum aims to gamify courses for children who are over 9 and enable the children to gain recognition, skills, competency and knowledge through gamified methods and approaches with the cooperation of different organizations who have expert knowledge and competency in the relevant field. The relevant curriculum will be supported the use of above-mentioned tools, materials and products during implementation phase. Prepared courses of the makerspace university have been shared in detail in the following section.

4.1 Curriculum of the AYBU Makerspace University

4.1.1 Science and Technology Course

The course aims to enable the students to have science and technology literacy through critical thinking, problem-solving skills, and improving decision-making mechanism, be life-long learners and sustainably question the world, comprehend the interaction between society and environment, to use scientific methods while contemplating. Science and Technology Literacy course has seven dimensions such as sciences and technology, fundamental science concepts, scientific process skills, science-technology-society-environment relationship, core values of the science, values of science. These seven dimensions of the course are taken into consideration to improve the science and technology literacy skills of the students. The course improves the competency of the students as includes experimental criteria, rational reasoning and thinking, continual questioning, scientific methods, observation, formulating a hypothesis, testing, collecting data, interpreting data and presenting the findings. It enables the improvement of creative, imaginative and objective skills of the students and foster them to learn the natural world through, learn how to learn, use scientific methods and principles in problem-solving processes. Science and Technology literacy course reflects the "constructivist" learning which fosters the student to structure the knowledge he gains in the cognitive mental processes. Computer and other information and communication technologies facilitate the development, implementation of scientific thought and scientific learning. (Ministry of Education, 2006a).

4.1.2 Visual Arts

Visual Arts program has been prepared in order to enable the students to discover themselves, be emotionally, cognitively, culturally and socially equipped and gain qualified habits, to conceive and appreciate art, criticize the artistic elements and components, to grasp the subtle dimensions of artistic works, grasp and discover the meaning of art, follow the contemporary artistic developments, news and trends, analyze them critically. The course aims to enable the student to observe the nature, have critical and analytical thinking skills (analysis, synthesis, selection, elimination, combination, organization and re-organization), have self-expression capacity with visual designing, to feed the interest of the student with miscellaneous artistic sources such as museum, gallery, historical artifacts, to recognize the national and universal artistic works, to appreciate the cultural heritage works and understand the value in them, to have a better perception and imagination power, to transform the self-subjective perceptions into artistic expressions with visual perception, transform knowledge and accumulation into ability, to have aesthetical assessment and evaluation skill, to be aware of the enriched expression and narration types with different methods, to have the competency to choose the appropriate material in accordance with the objective of the given task, to grasp meaning from the harmony of the materials. Within the scope of this course, students have visual relationships with different materials and substances, share their critical impressions of nature, synthesize different types of materials and create harmony with the use of them, create new meanings for objects, enable items to have subjective meaning, create extraordinary stuff reflecting the subtle points of the heart and brain (Ministry of Education, 2006b)

4.1.3 IT-Based Design Course

The program aims to foster students to question the world, make observations and make research, to evaluate the relationship between the case and places critically, to produce original solutions for the problems they face, to make original designs and make speculations, actively participate in the learning process, assess the decisions they make with a critical point of view, express their emotions and thoughts in different ways, have self-confidence in technology and design, learn about the biographies and activities of the scientist. The program allows students to make their own designs through meta-literacy skills, identify the design methods appropriate for their work, structure organization, rhythm, harmony, geometrical shapes, color, reflect cognitive and mental processes, learn how to design and think (Ministry of Education, 2006c).

4.1.4 Informatics-based Music Course Teaching Program

The course has been designed to enable the student to use information technologies, music software, educational technologies, identify the position of music in electronic and computer world, get to know the computer software for electronic music, terms and phenomena used in electronic music, gain the musical and digital competency to record vice in computer, develop their skill of expression through music, skills in music notation. Students improve their digital and computer literacy skills, adjust musical tone, beat and meter the song through using critical skills (Ministry of Education, 2006d).

4.1.5 Information Technologies and Software Course

The course aims to stimulate student to gain technical capability in six dimensions such as retrieval, management, integration, assessment formation and communication, considered as fundamental competencies of information technologies. Within the scope of the course, students improve themselves inn literacy, collaboration, efficient decision-making, integration, training programs, create materials using technology, use and adapt technology and technological tools to interdisciplinary fields, assess the universal impact of technology, create, retrieve, transform, assess, share information as required in meta-literacy concept (Ministry of Education, 2012).

4.1.6 Media Literacy Course

The course aims to enable the students to follow the developments in media technologies, to retrieve messages (visual, audial, printed etc.), read the media content and analyze, interpret the content critically through creative and analytical thinking skills, and produce their own media content, share it with other individuals in community platforms or social media, interact with the other individuals, discuss the content and make brainstorming in accordance with meta-literacy concepts. (Ministry of Education, 2013).

4.1.7 Graphic Design Course

Graphic design is an art of visual communication. The first function of the graphic design is to convey a message, introduce a product or service. Design means resolving a problem. Designer presents up-to-date information with contemporary tools and materials within the frame of contemporary sense of appreciation. The course improves the contemporary intellectual knowledge level of students, skill of students to interpret contemporary art, enables creativity and follow the recent developments in the field of art, television and gain competencies in computer-supported design, multiple-dimension designs, media planning, communication design, virtual reality implementations, design of visual images in printed media, online media, mass media (Ministry of Education, 2006e).

In addition to these courses that are based upon the offerings of Ministry of Education, the below courses are suggested for the Makerspace Curriculum.

4.1.8 Film-making and Animation Studio Course

The main purpose of the course is to provide the students with the unique chance of experimenting and experiencing film making and animation studio, gaining practical and theoretical information about film-making and animation software and applications, making their own films and improving their creative skills (Istanbul Aydin Children University, 2017)

4.1.9 Art Course

The art course has the purpose of augmenting the artistic skills of students through painting, drawing activities, wooden, metal workshop, sewing (textile) workshop. Thanks to the art course, students are expected to improve their artistic design skills (Anadolu University Children Education Training and Research Center, 2017).

4.1.10 Coding and Programming Skills Course

The overarching aim of the course is to equip the students with the skills of programming and coding, gain recognition about the importance of coding in the programs and games. Special gamified software programs will be used in order to teach the course (İstanbul Aydın Children University, 2017).

5. CONCLUSION AND RECOMMENDATIONS

As part of innovative learning environments, makerspaces are one of the effective learner-centered reflective and refractive platforms where learners can act, make and perform in a cooperative and participative way in accordance with the given instructions. In literature, it was proved that they have a positive impact on children's learning habits, behaviors and they established an emotional bond between the good emotions of maker-act and learners thanks to the gameful design. In order to provide gamified curriculum for children and support the formal educational processes of students, project-based study group of Ankara Yıldırım Beyazıt University made first initiatives to establish a Makerspace Children University. Curriculum development activities are still on-going. It aims to provide free access courses for children aged between 9-16. The courses have the purpose of improving the analytical, critical thinking, meta-literacy, media literacy, information literacy, computer-digital literacy and artistic skills of children through gamification and non-formal methods. Children will be included in social, cultural and educational life via makerspaces.

Makerspace activities are getting popular and common throughout the world. This work has aimed to bring together different pieces of information on this trendy topic and use these to suggest a curriculum development project proposal for possible funding by European Union agencies or other relevant international and national institutions. For Turkey, it is also recommended to increase the quantity and quality of makerspaces, for which this work be useful, as the coauthors hope. Educational organizations can search for necessary funds and opportunities to build İlab, innovation hubs and provide makerspace tools, equipment and materials for their learning platforms. Special makerspace teachers can be employed. Furthermore, teachers and librarians can attend makerspace training and improve their skills to instruct the courses. In universities, in K12 educational organizations, makerspace study groups can be created and they can be motivated to focus on design creative and reflective learning atmospheres for learners. As for future work, it can also be recommended to tailor the suggested curriculum for the needs of specific target groups such as disadvantaged learners.

ACKNOWLEDGEMENT

This work is adapted from and improved our the Special Session on Project Development and Poster Exhibition as part of ICEBEG2018 held in Ankara, Turkey on 23.11.2017.

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