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Furnushing New Generations with Productive ICT Skills to Make Them the Maker of Their Own Future

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Abstract

Increasing awareness on children's using ICT tools interdisciplinary to solve the problems they observe is one of the priority issues in the pursuit of several countries. Today, because individuals want to use products by their own pleasure and wishes, "do it yourself" movement has started to become common and as a result of the facilities of technology, the culture of creation was born. This study aims to find out children's current views on production, to make implementations regarding 3D designs and to discover whether there is awareness in children's ideas regarding production after the 3D design and production activities. Exploratory case study, a qualitative method, was used to answer the questions regarding the use of Tinkercad program and children's examination of their 3D designs. A total of 22 children from the Child Council of Ankara Metropolitan Municipality participated in a one day 3D design and production activity with Tinkercad online design program presented by Autodesk. Several themes such as information technology use of children and their parents, children's 3D designs and their awareness levels were analyzed. Results show that even though children use information technologies for communication and fun, they are unaware of the productive aspects of ICT. Organizing activities allowing them to produce with computers and computerized machines help children to see the potential power of ICT.

Keywords: public spaces and computing, authoring tools, pedagogical issues, elementary education

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Yeni Nesillere Kendi Geleceklerini İnşa Etme Amacıyla Üretim Odaklı Bilişim Teknolojileri Becerilerinin Kazandırılması

Öz

Bilişim teknolojileri araçlarını çocukların gözlemledikleri problemleri çözmek için disiplinlerarası kullanmaları yönünde farkındalık yaratmak çeşitli ülkeler için öncelikli konulardan birisidir. Günümüzde, bireyler ürünleri kendi istekleri doğrultusunda kullanmak istedikleri için, 'kendin yap' akımı yaygınlaşmaya başlamış ve teknolojinin sağladığı olanaklar sonucunda buluş kültürü doğmuştur. Bu çalışma üç boyutlu tasarımlara ilişkin uygulamalar yapmak ve çocukların üç boyutlu tasarım ve üretim aktivitelerinden sonra bu süreçlere ilişkin farkındalık kazanıp kazanmadıklarını görebilmek için onların bilişimle üretim konusundaki güncel görüşlerini ortaya çıkarmayı amaçlamaktadır. Araştırmada, Tinkercad programının kullanımı ve çocukların 3D tasarımlarının incelenmesine yönelik soruların yanıtlanması amacıyla nitel bir yöntem olan keşfedici durum çalışması kullanılmıştır. Çalışma, Ankara Büyükşehir Belediyesi Çocuk Konseyinden toplam 22 çocuğun, Autodesk firmasına ait Tinkercad 3 boyutlu tasarım ve üretim etkinliğine bir gün katılmasıyla gerçekleştirilmiştir. Çocukların ve ebeveynlerin bilişim teknolojileri kullanım durumları, çocukların 3 boyutlu tasarımları ve farkındalık düzeyleri gibi çeşitli temalar çalışma kapsamında analiz edilmiştir. Araştırma sonuçları, çocukların bilişim teknolojilerini iletişim ve eğlence amacıyla kullanmalarına rağmen, bilişim teknolojilerinin üretim yönünün bilincinde olmadıklarını göstermektedir. Çocuklara bilgisayarlarla ve bilgisayarlaşmış cihazlarla üretim yapabilme olanağı sağlayan etkinlikler hazırlamak, bilişim teknolojilerinin potansiyel gücünü görebilmeleri açısından yararlı olacaktır.

Anahtar Sözcükler: kamusal alan ve bilişim, yazarlık araçları, eğitimsel konular, ilköğretim

Introduction

The Harvard Professor Howard Gardner (2006) stated that from now on we need to equip our children with information and skills to be able to do things that "machines cannot", because it is estimated that 47% of the jobs of employment in USA existing today, is in the high risk category in next 20 years (Frey and Osborne, 2013). Similarly, in United Kingdom, about 35% of the current jobs are at high risk of computerization in next 20 years (BBC, 2015). In addition, Davidson (2012), a Professor on Duke University estimates "that 65% of children entering grade school this year (2011) will end up working in careers that haven't even been invented yet".On the other hand, scientists such as Bergson defines human beings as homo faber (maker) rather than as homo sapiens (1911). Bergson, in his famous study Creative Evolution (1911) states that history of human-being starts with its tool making abilities. The problem is that although human being is a human being as long as s/he can make, the era we are living in separates us from producing due to computerized machines, internet of things, big data, artificial intelligence, etc. So, today's educators face a new challenge to prepare new generations in order to make them maker of their own future.

Increasing awareness of children's using ICT tools interdisciplinary to solve problems they observe is one of the underlying issues in the pursuit of several countries. Human beings have turned into consumers more than ever thanks to information era and technology. Therefore, societies need to increase their productive potentials to survive in the global economic competition environment. If the Far East Asian countries that missed the Industrial Revolution are considered, it is seen that within the last 30 and 40 years they have closed the 100- year- gap between themselves and the developed countries like Europe and USA. This shows us the fact that technology and science is a significant tool for societies to advance.

Since this is an accepted reality, the societies desiring to prosper economically while consuming information rapidly have to be the producer of information by using technology and scientific developments. For this reason, the need for individuals designing and producing technologies which are essential for production process increased more than ever. It is also possible to observe the same effects of this cultural transformation in small business environments and educational institutions. In business environments, individuals who can produce new information, create and take initiative are demanded instead of employers who use stable information (Plemmons, 2014; Levy & Murnane, 2004). When the fact that education should develop in line with the need of a society is taken into consideration, it can be concluded that this change in the society and workplace has also affected the approaches in education. Together with a similar change in the education environment gaining skills such as questioning, interpreting and experiencing information and applying it to different areas and producing new things with the available information instead of memorizing the stable information and applying it to an area of which borders are clear have become some of the significant aims (Blikstein, 2013).

In the Strategic Framework for European Cooperation in Education and Training" notice published in May, 2009 by the European Union Council (2009) it was stated that in order to realize the "Improving the quality and efficiency of education and training" strategic target on a sustainable basis, learners' basic skills regarding mathematics, science and technology should be developed until 2020 (C 119/3). Also, in order to guarantee these "strategic objectives" defined in 2009, 6 new, primary areas regarding Education and Training 2020 (ET 2020) were introduces in the draft report published by the Council on September 1, 2015. (ET 2020 New Priorities, 2015). One of these areas is "Open and innovative education and training, including by fully embracing the digital era". Accordingly, together with increasing demand for digital skills and qualifications as a result of the digital evolution, it has become a requirement for education and training to satisfy the need (European Commission, 2015). The draft report is expected to be accepted by the council by 2016.

Education systems of developed countries try to create education environments in which students can become self-confident, productive and creative and have decision-making skills. Barack Obama, President of the USA, who emphasizes the necessity of science, technology, engineering and mathematics education and gives them highest priority with regarding their potential which is used in making significant and innovative contributions to the country's economy utters the expectations of the 21st century economics from the students in "Hour of Code" program in 2013 "Don't just buy e new video game, make one. Don't just download the latest app, help design it. Don't just play on your phone, program it. No one is born a computer scientist, but with a little hard work and some math and science anyone can become one." (Obama, November, 2009; March, 2014). Similarly, The European Union sent a letter to the member countries' Ministers of Education on July, 2014 and referred to the importance of adding coding lessons to the curricula of the possible earliest levels. The motive behind this was reported as the increasing competitive capacity of Europe with the USA and the Far East and it was also stated that unless this was realized, they would lose their competitive power within 20-25 years (European Commission, 2014). It can be realized that the expectations of the 21st century have been chancing and students are expected to keep up with these changes.

Similar with the global effort, there is a great effort in Turkey about ICT use in K12 level. MONE (Ministry of National Education) carries out the biggest project in the world in K12 level called "FATİH". In an educational system that have 17 million K12 students, 1 million android-based tablets were distributed to students, 370.000 classrooms are equipped with LCD smart boards and thousands of schools got fiber internet connection. In addition to these, for all courses in K12 level, digital educational contents are published via http://eba.gov.tr website. "FATİH" project is still on progress and efforts such as tablet computer distribution, internet connection and digital instructional content development continue all over the country (http://fatihprojesi.meb.gov.tr).

In order to put forth the characteristics of the 21st century, different ideas in theoretical frameworks published by different countries and international organizations were gathered under one single roof in a study conducted by Voogt and Roblin (2010). The 5 theoretical frameworks in the literature, namely Partnership for 21st century skills (P21), En Gauge, Assessment and Teaching of 21st Century Skills (ATCS), National Educational Technology Standards (NETS/ISTE), and National Assessment of Educational Progress (NAEP) were examined within this context. Also, international studies and reports by the EU, OECD and UNESCO regarding the need for 21st century skills and how these skills can be applied to education were analyzed. The common 21st century skills mentioned in all the reports are as follows: collaboration, communication, information and communication technologies (ICT) literacy, digital citizenship, creativity, critical thinking and problem solving. In his book “The Global Achievement Gap” Wagner (2008), claims that what we are living at the moment is a globalachievementgap as a result of the fact that the schools are behind this change while accelerating change in all fields. Educational experts believed that the increase of discrepancy between the expectations of the “New World” working conditions and what is taught to students in “Old World” schools is the basic reason of this deficiency. In order to be able to cope with the global success deficiency, the students have to be trained with a different understanding and gain vital skills that they will need in the 21st century. These skills are as follows:

- Critical thinking and problem solving
- Leadership with cooperation and influence
- Promptness and adaptation
- Taking initiatives and entrepreneurship
- Effective oral and written communication
- Access to and analyzing information
- Curiosity and imagination (Wagner, 2008, p.14).

Automation brought by the industrial revolution is slowly dispossess piecework jobs. Fossil fuels used in factories in the Industrial Era are elite energies because they are located in rare regions (Rifkin, 2011). In order to ensure the usability of these energies, continuous geopolitical management and investment are required. Moreover, in order for them to reach the end user from underground, a top-down inspection system and intense capital are required. These rationally structured, great and centered bureaucracies combined with mass production enabled with coal and steam power and ensured to conduct complex commercial relationships in today's factories. As a result of printed communication becoming close with coal and steam power, distances shortened and the time problem disappeared and economy has accelerated. A vertical-scale new economy emerged together with low process prices accompanying commercial flow speed (Rifkin, 2011, p. 154). Because of the expertise, equipment and cost, production is monopolized by big, centralized corporations. Today, as production has become more digitalized, this situation signals change concretely.

In the 21st century everything has digitalized, virtualized and automatized, and business processes have become ordinary by retrenching time and cost to a great extent. Together with the democratization of new technological tools which makes a lot of people increasing access to them, the efficiency levels of countries, corporations and individuals using these tools will also start to increase significantly. In every field top-down businesses have already started to transform into more cooperative and horizontal structures.

Cooperative era will possibly end working on a salary basis just like the Industrial era ended slavery. The characteristics of the third Industrial Revolution will be that instead of workers working with machine, they will use high technology and program and observe smart technologies. All these situations bring forth the question how millions of people will be employed years later. The third Industrial Revolution stands as our last opportunity to create on-salary, traditional job opportunities. (Rifkin, 2012). For this, humanity should be prepared to step into the third Industrial Revolution composed of cooperation, renewable energy systems and fabrication means of production.

In order to gain these skills and most importantly to provide real learning, various learning approaches have been proposed. Project-based and constructivist learning approaches stand out in learning environments which can gain the 21st century skills (Blikstein, 2013). In the constructivist learning theory students construct information and skills via various experiences. According to this theory, which was emphasized by John Dewey in the 1920s and remained on the agenda in the 1990s, the student should be the active role taker instead of passive listener during the learning process. This approach emphasizes various acquisitions such as student taking responsibility and being productive during the learning phase (Taylor, Fraser & Fisher, 1997).

Constructivism does not aim to meet the concept productivity clearly and it points out the cognitive construction of information. Recently, “Constructionism” learning approach has been suggested upon physical production gaining importance (Papert, 1991). According to Papert, one of the pioneers of this view, during the learning process the student must create a concrete thing or an idea (Blikstein, 2013). In Constructionism, constructions are as important as the constructionism process which these constructions create by interacting with the concrete constructions in the real world. Therefore, in terms of the word structure “Constructionism” has been preferred to be used (Şimşek, 2004). According to Papert (1991) although constructivism focuses on the fact that information is constructed by the learner not by the teacher, constructionism focuses on the role of the objects and constructions in the real world that will support this process. Based on the idea of the student producing a physical or digital object (Vossoughi & Bevan, 2014), this approach might support to satisfy the need for production in the society and enable student to realize a more permanent learning (Papert & Harel, 1991). In a typical constructionist learning environment, a fixed curriculum is rarely seen. Students use technology for their projects and teachers support students in this environment (Blikstein, 2013).

Piaget's constructivist learning theory and Papert's constructionist theory have set ground for the maker movement in time and it has been a much controversial issue (Martinez & Stager, 2013; Sheridan, Halverson, Litts, Brahms, Jacobs-Priebe & Owens, 2014). Maker movement is defined as producing rapid and small-scale first sample (Vossoughi & Bevan, 2014). Constructionist learning environmentsare confused with project-based learning. However, they are different in that in project-based learning environments teachers want to direct certain process in certain times and around certain topics but in maker environments, each student observe various process and use different tools (Barniskis, 2014). In these environments real tasks, trial and error, and experiencing in different environments and times are rather important in constructing information (Martinez and Stager, 2013). Maker movement includes people involving in the production process creatively and sharing their products and thus students become producers instead of consumers. According to Dougherty (2012), one of the pioneers of this movement, every human being is an inborn maker; it is a natural characteristic and people gain self-confidence when they satisfy this need. Dougherty (2012), advocates that the main difference in the maker movement is that people are active producers rather than passive consumers. People prefer to produce and share what they produce instead of being competitive. In education experiences and productivity have replaced memorization (Halverson & Sheridan, 2014).

Because the third Industrial Revolution has enabled dispersed entrepreneurship, top-down innovativeness while giving the chance of dominance over means of production to ordinary people, everybody has the ability of creating and designing a new product thanks to this technology. You do not have to invest in enormous facilities or employ a labor power to carry your idea into the production phase. The democratization in the digital means of production is getting ready to become the factory model of the third Industrial Revolution (Rifkin, 2012).

It is very important that education which is supposed to gain the 21st century skills should be designed in a way that enables students to find creative solutions to real world problems and to transfer their solutions to other individuals by cooperating. One of the education approaches that provide many opportunities to gain the 21st century skills is STEM disciplines. Students can develop 21st century skills such as adaptation, complex communication, social skills, problem solving, self-management and self-development and systematic thinking via STEM disciplines (NRC, 2010). Maker movement and constructionist learning method are considered very important in applying curricula using STEM approach (Martin, 2015; Schweikardt & Gross, 2006). STEM is a method that focuses on the idea that science, technology, engineering and math cannot be learnt separately and they can make sense in a trial and error environment (Resnick & Rosenbaum, 2013). With STEM approach students give meaning to abstract concepts such as friction and balance by using and applying their engineering, science and technology knowledge. (Blikstein, 2013). According to Papert; engineering, design, programming and production should be included in education and interact with each other (Blikstein, 2013). Accordingly, although the effort to teach the 21st century skills via STEM discipline has been considered as important in terms of societies' technological and scientific development within the last half century (Subotnik, Edmiston and

Rayhack, 2007), it is accepted to have deficiencies in some dimensions. Maker movement has the means of production with the capacity of meeting this deficiency.

STEM has been a recently-emphasized approach, and by adding art to this approach STEAM has stood out. Because digital technology is more easily accessible, art and science have been mentioned together (Kim & Park, 2012). Maker movement has provided a correct approach to implement this approach and gives the students an environment where they can be productive and active and where they can work in an interdisciplinary way. According to the researchers studying STEM, maker movement enables student to keep interested within the STEM curriculum. Briefly, maker movement has been an important step to implement the STEM approach (Morrison, 2006). For instance, while students design and produce furniture to use in their classrooms, they make use of geometry and math and this environment will implement maker approach within the STEM curriculum.

Within the last century, people have been directed to live a consumer life and maker movement is believed to be a vital step in order for us to be a productive society again (Vossoughi & Bevan, 2014). Papert believes that technology is the strongest and most liberating tool to increase students' productivity (Halverson & Sheridan, 2014). According to Papert, technology supports the culture of creation. With new technologies, designing, constructing and making have become easily accessible skills for each individual (Blikstein, 2013). Today, because individuals want to use products by their own pleasure and wishes, "do it yourself" movement has started to become common and as a result of the facilities of technology, the culture of creation was born (Anderson, 2010). People started to produce products to meet their daily needs and solve their problems in which color and model they want.

There are some significant studies about 3D modeling and its effect on students' spatial knowledge or their achievements. Concrete modeling is important in terms of developing students' spatial thinking skills and their achievement of geometry courses (Clements & McMillen, 1996). Similarly learning environments designed with concrete materials are more effective on students' achievement in geometry courses (Clements, 1999). Bulut and Köroğlu (2000) determined in their study that there is a significant relationship and positive correlation between spatial skills and problem solving. 3D design and production is also important that it gives the students the excitement of being productive, it is complimentary to STEM curriculum, gives easy access to course materials previously difficult to access and supports problem solving (Planchard, 2007). For example, students can examine the 3D form of molecules for Chemistry lesson and learn cells and organs by producing their 3D forms. Also, 3D design supports spatial intelligence, the intelligence type that can enable to draw 3D drawings by looking at objects and thinking. Students design by taking into consideration the relationship of the shape and its sizes with other objects and in this process there are views that assert that during this process student develop their spatial intelligence by using math and geometry skills (Planchard, 2007). Studies carried out with students in the process of 3D design and production show that these activities increase students' self-confidence, gain them a new way of thinking and attendance to classes (Peppler & Bender, 2013).

Researchers who discussed what and how students could produce and what the necessary skills were to produce a product suggested that this can only be possible by using technology and by being interdisciplinary (Roque, 2015). Here 3D design tools and printers are considered to be significant tools for maker movement to become common. 3D design and production activities are considered to be rather beneficial in terms of enabling students to concretize concepts and to learn visuals easily. However, awareness regarding this issue in our country has just started to be formed. Informatics Technology course, one of the important mediators of this awareness, is criticized. When the curriculum of this course is examined, it is criticized because the course content includes what students already know and it is not a solution to gain 21st century skills (Akpınar & Altun, 2014).

The aim of this study is to find out students' current views on production, to make implementations regarding 3D designs and to discover whether there is awareness in students' ideas regarding production after the activities. By doing so, students gain informatics and production concept and the skills that this concept includes. It is predicted that the inclusion of training and the tools used in the study in school curricula will contribute to students' gaining 21st century skills and informatics and production approach. In this context, the following questions are tried to be answered;

- How much the children participated in the study and their parents use information technologies in their daily life?
- At the end of the activity, what are the results of children's 3D design evaluations?
- What do children think about 3D design and production after the activity?

Method

Research Design

Exploratory case study, a qualitative method, was used to answer the questions regarding the use of Tinkercad program and children's examination of their 3D designs. Exploratory case study is used in pilot studies in which the effect of a case is tried to be determined in times when the integration of technology is used especially in educational researches (Berg, 2009). It was also stated that exploratory case studies were useful for pilot studies carried out before a more extensively planned and done quantitative studies in Social Sciences (Swanson & Holton, 2005). The independent variable of the study is 3D design activity and the dependent variable of the study is awareness regarding production with information technologies.

This study is pioneer one in terms of investigated distinct phenomena. There is no detailed preliminary researches for the age group being studied. That's why, most of other research methodologies might restict the acquisition of the study. Exploratory case study is crucial for studies like pilot studies and it is hard to identify strict variables before research. This study's most general research design specifies the independent variable as 3D design activity and the dependent variable as awareness regarding production with information technologies. However, besides these variables, it is even more important to discover new variables that were not previously thought of. The studied case of this research is 22 voluntary children is experiencing 3d design activity as the first time and the study tries to share first impressions in such a natural environment.

Participants

The research was carried out in Child Council of Ankara Metropolitan Municipality. The Child Council periodically carries out various educational, social, cultural, sportive and artistic activities for children living in Ankara province to express their problems and demands freely, to have a saying in the decisions made regarding their city and figure out solutions (http://cocukmeclisi.ankara.bel.tr). A total of 22 children, 8 boys and 14 girls, participated in the study. It can be said that this was both convenience and quota sampling. Because of the reason that research was conducted in Child Council, there were no chance to select participants. Children registered for the Council were announced to attend the activity. Also the number of participants were limited because of the capacity of the activity environment. The Child Council is composed of children from various schools and age groups; thus, the participants are heterogeneous. All the participants attend to public schools. Age and classroom distribution of the participants can be seen in Table 1, which shows that the children are aged between 9 and 13.

Table 1

Age and Class Averages of the Participants

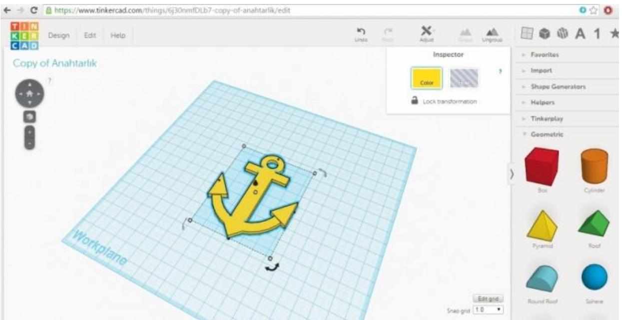
Age	n	Class	n
9	2	**4**	12
10	10	**5**	3
11	2	**6**	2
12	4	**7**	4
13	4	**8**	1

Activity

The activity environment is composed of computers located around an administrator computer and an overhead projector administered by one of the researchers. In order to trigger their curiosity and draw their attention, children watched an attractive video of front leg prosthetics designed in 3D design environment and printed out from a 3D printer which was implanted to a dog without front legs. After the introduction and video activities the children started to use computers to make a 3D design. Children used computers one-to-one. During the activity children designed an anchor-shaped key holder together with the researcher’s instructions. Children used Tinkercad, presented by Autodesk for online use as a design program (www.tinkercad.com). The key holder 3D design and the interface screen of Tinkercad is given in Figure 1.

Figure 1

Design Screen Shot



While one researcher was giving the instructions via the overhead projector, the other researchers were walking around and providing guidance whenever necessary. After the activity ended, the key holders designed by the children were printed out from 3D printer and given to them. The activity lasted for 6 hours in total. Study and interviews were conducted in the same place. Children use this place to use computers, play games and do free activities when they come to Child Council. So it was a natural research environment, not an artificial laboratory environment designed for this study. An image of the activity environment can be seen in Figure 2.

Figure 2

Activity Environment

Data Collection and Data Analysis

As the first data collection tool, information form was used to collect the demographic information and information technology ownership of children and their parents. There were questions about their gender, age, grade, which technologies they own and their parents own in this information form. Also there was an open ended question in the form, “what do you think first when you hear about 3D?” in order to determine whether they know something about 3D, 3D design or else.

The 3D products designed by the participants were evaluated via the second data collection tool; “Graded Product Evaluation Key” developed by the researchers. According to Kan (2007) a rubric can be defined as a scoring guideline that describes the characteristics of different levels of performance or criteria and judging a performance through the performance of a task. Because the rubric is used for product evaluation, in the horizontal column are the criteria that the product should have and on the vertical column are the levels of the scale, namely bad, average and good. For each cell where product criterion and level axis meet, separate definitions were made and each criterion was graded as bad 1, average 2 and good 3. The highest score one can get from the rubric is 24 and the lowest score is 8. Since the products within the scope of this research have to be evaluated by more than one criterion, an analytical rubric was used. Analytic rubric requires separate scoring of separate criteria of the dimensions (components) (Mertler, 2001). The rubric prepared accordingly has 4 main and sub-main dimensions: namely Dimensions (measure, ratio), Visuality (Geometric shape (form), edge and corners, perspective), Functionality and Shape Transformation. After the criteria regarding product evaluation were determined, definitions were made for each level and expert views were obtained. In line with the feedback obtained from the experts, necessary corrections were made and it was tested on a student group different than the target group and finalized.

Semi-structured interviews were conducted with 11 students. Questions were prepared by researchers and sent two experts for review. After the revisions, two main and two sub-questions were determined and asked to the children and the interviews were recorded with their permission. One interview with a child took about 5-10 minutes. Two researchers interviewed with children separately and it took about 1 hour in total. Questions are written below;

- Do you like this activity? Why?
- Have your ideas about what you can do related to information technologies changed after the activity? What else can you do?

Data analysis in qualitative studies is a “messy” process (Hatch, 2002). For this reason, the data collected from different data collection tools were analyzed clearly and carefully. Demographic information about children and children’s and parents’ information technology ownership were analyzed with tables. Answers for the open ended question were analyzed witn content analysis and main themes were created according to the responses. The answers obtained in the interviews were recorded and analyzed with content analysis method. 3D designs of children were also analyzed with the rubric. Quantitative results of 3D designs and qualitative data of interviews are used to prove each other for data saturation and the trustworthiness of the study.

Participants as data resources of the research have to be clearly defined in qualitative studies (Yıldırım & Şimşek, 2006). In current study, age ranges of participants, technologies they use and their grade levels were defined in detail in order to improve the reliability. A safe interview environment was provided to children to make them feel comfortable and data were collected in the same environment in order to ensure consistency. In addition to this, only volunteer children participated to the study and interviews. Validity of the study was improved with expert views. 3 subject area experts helped to determine the mutual themes from the coded data.

Content analysis method was employed to analyze the children views. Themes were determined with an induction approach (Yin, 2011). All interview records analyzed in detail and coding for content analysis were conducted with the relations of the whole data. The obtained categories and themes were clarified with the support of direct quotations from the interviews.

Findings and Discussion

Use of Information Technologies by Children and Their Parents

Table 2 shows the technologies children possess. When the Table is examined, it is seen that use of technology is common in children and that 10 of the 22 children have all three of computer, tablet and smart phone. Only one child stated not to have any of these technologies. In terms of Internet use 4 children stated to have connection via smart phone/tablet, 8 children stated to have connection at home and 7 children stated to have both. 3 children stated not to have Internet connection.

Table 2

Technologies Children Possess

Technologies Possessed	**n**
Computer (Desktop/Laptop)	5
Tablet	1
Smart Phone	1
Computer + Smart Phone	3
Tablet + Smart Phone	1
Computer + Tablet + Smart Phone	10
3DPrinter	0
None	1

Parents of the children have at least either computer (desktop/laptop), smart phone, or tablet and it is seen that most of them have more than one of these. Only one of the parents did not possess any of these technologies. It was also found that use of information technologies is also common among the parents. The information regarding the children's purpose of computer and internet use can be seen in Table 3.

Table 3

Purposes of the Computer and Internet Use

Purpose of Use	**n**	**Purpose of Use**	**n**
Education (course videos, educationalsoftware, doing homework, following the lessons)	22	Office programs (writing, creating a table etc.)	10
Social Media (Facebook, Twitter etc.)	20	Information sharing on forum websites	9
Surfing, reading newspaper, watching videos, playing games)	19	Designing web sites, coding, creating animations	7
E-mailing, communication, chatting	17	Interactive processes (banking, shoppingetc.)	1
Visual design, drawing (Photoshop etc)	11		

Table 3 shows for what purposes children use the Internet and computer. All of the children stated to use information technologies for educational purposes. Again, most of them stated to spend time on social media. Some of the children have ideas about visual design, drawing programs, web design and programming. All this data show that children use technology prevalently and are aware of 3D design and production activity.

Evaluation of Children's 3D design products

Product evaluation was scored using the 3D design graded product evaluation key. The highest score one can get from the score is 24. 14 of 22 children were evaluated regarding design products. 3D design products were evaluated by 3 different experts (E1, E2, E3) and with their evaluations, average scores are given in Table 4.

Table 4

Children's 3D Design Scores

	User	Score (E1)	Score (E2)	Score (E3)	Final Score (Average)
1	User01	22	20	21	21
2	User02	23	20	23	22
3	User03	22	19	22	21
4	User04	17	17	18	17,33
5	User05	17	16	18	17
6	User06	21	20	20	20,33
7	User07	21	21	22	21,33
8	User08	22	20	22	21,33
9	User09	21	20	20	20,33
10	User10	22	19	21	20,66
11	User11	18	20	19	19
12	User12	19	20	19	19,33
13	User13	21	21	20	20,66
14	User14	21	20	20	20,33
				Average	**20,12**

4 children scored a little lower than 20 and 10 children scored above 20. The average score is 20,12. These results show that the children completed their 3D designs at the expected level at the end of the one-day activity.

Children's views on 3D design and production

Children's views on 3D before the activity

This was the open-ended question in information form. The answers were analyzed via content analysis method. Content analysis aims to reach concepts and terms that will explain the collected data (Yildirim &Simsek, 2006). In this study a pre-classification was not done during the content analysis and themes were identified by coding the concepts and the answers were classified under 5 separate themes: 3D movies and glasses, reality, game and virtual, all sides, object-thing. The answers to the mentioned themes are presented in Table 5.

Table 5

Findings the Views of Children on 3D

Theme	Answers
3D movie	- Movie glasses
	- Glasses, film
	- Cinema 4d
	- Glasses
Reality	- Real form of a drawing
	- The same printout with the 3D shape
	- Things I did becoming real
	- Everything seeming more lively
	- Seeing animated or unanimated things as if they are real on TV or the Internet
	- Reality, design
	- Very image of the real
	- Real, realistic objects
Game and	- Virtual real and game
Virtual	- Virtual real, game
All perspectives	- Seeing from every side
	- Filled objects with width, length, height,
	- 3 axis
	- Shapes that look the same size from every perspective
Object-thing	- Concrete objects
	- A printout pattern coming out concretely like an object or thing
	- 3D thing
	- Things looking strange

The answers show that children are familiar with the concept 3D. However, there are different themes in the minds of some children. While the children who knew 3D in terms of the visuals mentioned 3D movie and glasses, children interested in games spoke of virtual reality and games. The theme reality includes the answers of children who consider 3D as a concept that reflects reality as is. The objects and things were also referred to. One of the striking themes is "All perspectives". It is possible to say that the answers such as 3axes, width, filled objects with width, length, height and seeing from all perspectives create a theme more similar to the real meaning of 3D concept in the minds of the children.

Children's views on 3D design and production

The first question in interview was related to whether they liked the activity or not. All the children stated that they liked designing and producing a key holder activity. Because the interviews were carried out after the key holders were printed out, children mentioned their excitement.

The interviews were semi-structured and thus children were asked “Why did you like this activity?” 4 separate themes were identified after coding the answers: making concrete, production, ability and excitement. The answers to the mentioned themes are presented in Table 6.

Table 6

The Views of Children on Why They Liked the Activity

Theme	Answers
Making concrete	- Designs are printed out as 3D - Taking the design into hands - See and touch what was designed - Abstract things being concrete
Production	- This is real production - I can model 3D characters - Design and also produce it
Ability	- I can do anything with 3D - I can make colorful designs and productions
Excitement	- Interested and excited in game and 3D design - Makes me very excited

It can be said that the transition from design to production and abstract concept concretizing are effective factors for children to like the activity. For example different children stated that *"I can see and touch what I have designed"* and *"I can model whatever I want with 3D design"*. Children already familiar with computer felt that what they did was more meaningful when they used computer as a means of production. Also, children experienced that they could do 3D designs. In addition, answers and the fourth theme shows that 3D design and production is an exciting environment for children.

The second question was; "Have your ideas about what you can do related to information technologies changed after the activity? What else can you do?" 4 separate themes were identified after coding the answers: toys, organ, sports product and accessorizes. The answers to the mentioned themes are presented in Table 7:

Table 7

The Views of Children on What Else They Can Do

Theme	Answers
Toys	- Ship - Submarine - Mobile phone - Small house
Organ	- Arms - Hands
Sports Product	- Running man model - Balls
Accessorize	- Mobile phone case - Home tools, objects - Trinket

Children gave remarkable responses about their ideas such as "*My point of view has changed.*" or "*I realized that I could make more than what we did here*." and stated what else they can make from now on. Themes indicate that children imagine producing things both for fun or usable in daily life. Statements such as; "*Arms can be developed for people with disability*." or "*I can make hands for people who do not* *have hands.*" indicate that children aware of the use of technology for solving the serious problems. Even participating to a one-day activity, children stated these ideas regarding production with 3D design. These statements indicate the changes in the children's minds after a one-day activity and realizing that they can design and produce.

Conclusion

This study, which aims to gain awareness of children regarding production with information technologies via 3D design and production activity, lasted for one day but has some positive effects. The first research question shows that children and their parents do not have any difficulty accessing to technological devices and the Internet. Also, children stated to use information technologies both for education, fun and other activities. Children already familiar with information technology did not have any difficulty in participating in 3D design and production activity.

Children gained achievements for production with information technologies. The awareness of producing with information technologies for children in these young ages is an important step for their future. The current study results establishes a relationship with the universally accepted approaches such as "digital production" and "maker movement" (Blikstein, 2013; Blikstein & Krannich, 2013; Buhler, Kane & Hurst, 2014). Today's children will be engineers in the future so it can be said that production with information technologies is an important achievement and key element for children.

Because this was just a one-day study, the children watch the introduction video and started to work on their computers by following the instructions. Observations during the study showed that children did not have difficulty in design. According to the second research question, when the findings regarding children's completing the activities are examined, it is seen that they completed their designs expectedly. The fact that children who did not do any previous activities regarding 3D design did their tasks on an expected level shows that 3D design is easy to use for children. As Bulut and Köroğlu (2000) states, this study showed that there is a relationship between 3D design, spatial knowledge and problem solving. Although this was a one-day study, students solved problems in terms of designing 3D key-holders with given instructions.

The last research question shows that all students had ideas about 3D. However, none of the children had participated in a 3D design activity previously. They did not speak of design and production when they were asked what came to their mind about 3D. Thus, the findings of the interviews after the study are important. All the children were excited about and interested in the 3D design and 3D printer production process. The sentences "I can do this, I can get involved in the production process" show that children gained a certain level of awareness of informatics and production. These explanations are similar with the report of an international institution in educational technology, NMC (New Media Consortium). This report was published in 2014 and it emphasized that materials and objects would be rediscovered by teachers and students with 3D design and production. Moreover, 3D design and production technology will provide students some opportunities in education such to touch their own concrete models and share them with others (Johnson, Adams Becker, Cummins & Estrada, 2014).

Recent studies show that 3D modeling is important for spatial knowledge, problem solving and developing new thinking skills (Clements & McMillen, 1996; Clements, 1999; Planchard, 2007; Peppler & Bendler, 2013; Roque, 2015). This study is important because it supports students from two other perspectives. One of them is 3D modeling and the other one is producing them with 3D printers. In this study, 3D modeling is not limited only with virtual environment because of the reason that students printed their designs via 3D printer. Dougherty (2012) asserts that every human being is an inborn maker and people gain self-confidence when they satisfy this need. The child involved in the design and production process in person might have the chance to increase self-confidence and self-respect and develop thinking skills. The studies stated that 3D design and production activities gained children a new way of thinking (Peppler & Bendler, 2013).

There are many kinds of objects are produced with 3D printer in different areas. In future, lots of different 3D model samples are expected to be produced. With the importance of STEM in recent years, 3D printers form an exciting experience for STEM approach. 3D printing technology is presented to the students of technology education as an important motivation tool (Lacey, 2010). This study verifies these statements in terms of gaining students awareness and vision for future. This study have some limitations that this was a one-day activity and convenience sampling was used because of the activity environment (Child Council). In order to measure the variables self-confidence, self-respect and thinking skills, long-term studies of this kind are suggested to be implemented in education environment. Further longitudinal studies will enable children to get involved in design and production process, and present findings which can reveal the changes regarding children's self-confidence, self-respect and thinking skills.

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