BRING COSMOS INTO THE CLASSROOM: 3D HOLOGRAM

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ABSTRACT: Three-dimensional structures of heavenly bodies and the fact that people make observations about universe only from their vantage point on Earth make difficult to understand astronomy concepts. Basic astronomy concepts such as shapes, sizes, distances and celestial motion contain spatial thinking ability. The students who lack spatial thinking ability have difficulties to constitute these concepts in their mind. Consequently, the necessity of using different learning environments and materials supported by technology is showed up. Beyond using available instructional materials, creating their own materials not only provides students with accessing to more knowledge through research but also fosters their thinking ability with variables. Concordantly, current study aims to give an artifact implementation example designed three-dimensional hologram mechanism with simple materials oriented teaching basic astronomy topics. Hologram mechanism consists of a truncated-pyramid shaped reflector made of transparent and hard material, a video about astronomy and a screen. The study group consists of volunteer prospective science teachers (N=15) in a Western Anatolian University. The research aim is not only to create permanent artifacts but also support prospective teachers' thinking and problem solving skills using mental processes. The activity is enabled participants to use engineering and mathematic skills with designing hologram device and technologic tools via video making process. Implementations conducted with by six weekly workshops that each one takes about two hours. Participants created a permanent artifact with activity. Researcher notes and artifact assessment form were used as data collection tools. Prospective teachers' astronomy interests were supported and their astronomy knowledge increased by the artifacts designed by them. Moreover, they have begun developing spatial thinking abilities with moving and three-dimensional model which assists them to perceive depth phenomenon in universe. They experience artifact design process at firsthand and find solutions to encountered problems. Participants learned how to create a three-dimensional model. Furthermore, the activity provides opportunity to use science, technology, engineering and mathematic related skills.

Key words: Astronomy teaching, artifacts, 3D hologram

INTRODUCTION

Main subject of astronomy is celestial objects. When people look at the night sky they observe stars only located in Milky Way galaxy. Beyond that had been mysterious for thousands of years due to human observation limit. First observation of extragalactic objects was made by Edwin Hubble using a large telescope in 1922-1923. Considering this dates, we are at the beginning of our cosmic journey compare with the emergence of mankind. Humans still struggle to make sense of what's out there in the Universe which lies beyond the limits of even our most powerful telescopes (Siegel, 2015). By nature of the fascinating topics it encompasses, astronomy awakens a great deal of curiosity. People are fascinated to understand different astronomy topics such as day and night cycle, lunar phases, meteor showers and eclipses.

People make observation about celestial bodies only from their vantage point on Earth. Celestial objects are so far away from earth and it does not allow people to create depth perception. We perceive heavenly objects in the sky as if they are moving in a two-dimensional plane. Besides, astronomy contains three-dimensional concepts. It is hard to understand celestial events such as moon phases, eclipses and oppositions without using three-dimensional thinking and three-dimensional geometry. Spatial thinking ability which means rotating and inverting objects in 3D when they are presented graphically in 2D have a major role learning three-dimensional concepts (Barnea and Dori, 1999). Earth-bound observations and lack of spatial thinking ability usually pose problems understand of astronomy topics (Arny, 1994; Barnea and Dori, 1999; Padalkar and Ramadas, 2011). Therefore, students find hard to understand astronomy topics as a school subjects (Yair, Schur and Mintz, 2003; Plummer, Kocareli and Slagle, 2014). In this case, using different learning environments and materials supported by technology are effective for students to enhance astronomy knowledge and to support their astronomy interest (Bakas and Mikropoulos, 2003; Mulholland and Ginns, 2008; Küçüközer, Korkusuz and Küçüközer, 2009; Uçar and Demircioğlu, 2011). Inquiry-based teaching and hands-on activities are more effective than the classical lecture-textbook approach for astronomy education from elementary to university (Percy, 2006). Within this context, beyond using available instructional materials, creating materials by student provides them accessing to more knowledge through research and fosters students thinking ability with variables. Concordantly, purpose of the study is to conduct with an artifact-based activity with designing a three-dimensional hologram assembly.

METHODS

Description of the Study

This study aims to give an artifact implementation example designed three-dimensional hologram mechanism with simple materials oriented teaching basic astronomy topics. The research aim is not only to create permanent artifacts but also support prospective teachers' thinking and problem solving skills using mental processes. The participants comprise volunteer third-year prospective science teachers in a Western Anatolian University. Total number of participants is 15 (N=11 female; N=4 male). Hologram mechanism consists of a truncated-pyramid shaped reflector made of transparent and hard material, a video about astronomy and a screen. The activity is enabled to use participants' engineering and mathematic skills with designing hologram device and technologic tools via video making process. Participants created a permanent artifact with activity Data were collected for the research through researcher notes using for process evaluation and artifact assessment form using for outcome evaluation. Hologram assembly assessment form (see app. 1) developed based upon thermometer assessment form (Oğuz Ünver, 2015). The form consists of three main parts which are video, reflector and design and functionality of the hologram assembly. The researcher notes used to understand effectiveness of the activities. Researcher notes takes within the scope of three main questions: *"What are difficulties for participant during activities?" "Which skills are used by participant?" "How do activities affect participants' astronomy interest?* Implementations conducted with by six weekly guided workshops that each one takes about two hours. (See Figure 1).

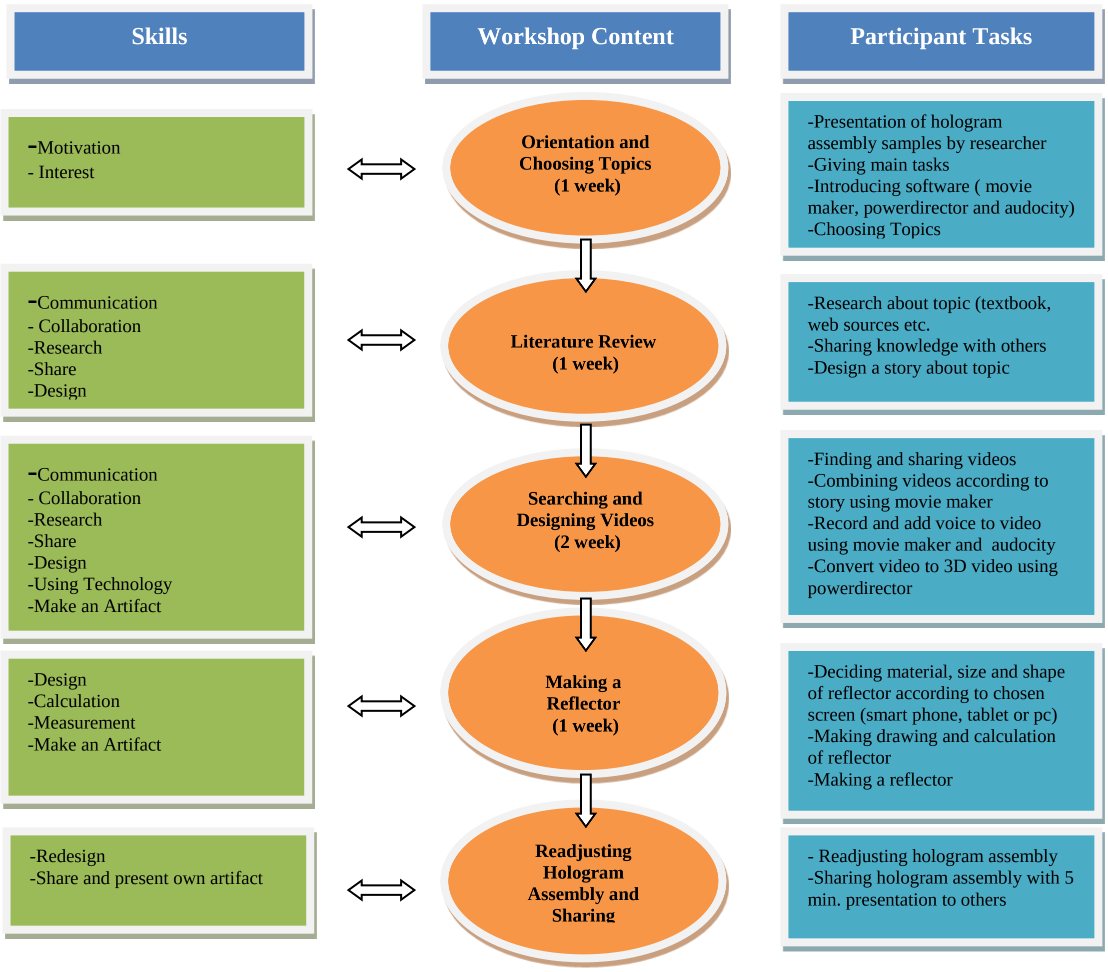

Figure 1. Skills, workshop content and participant tasks during the implementation

Implementations consist of five steps which are orientation and choosing topics, literature review, searching and designing videos, making a reflector and readjusting hologram assembly and sharing. Each workshop provides participants to share their knowledge, skills and experience and to do their tasks collaboratively. During workshops researchers guide participants in different ways such as the define order of tasks, lead to participants determining knowledge and scientific knowledge and motivating them to difficult problem. The workshops support participants individual and group skills such as interest, sharing knowledge and collaboration. The primary aim of workshops is not produce the artifacts, they aim to create a collaborative and inspirational learning environment which constitutes peer learning. One of hologram assembly sample created by a participant is shown on Figure 2.

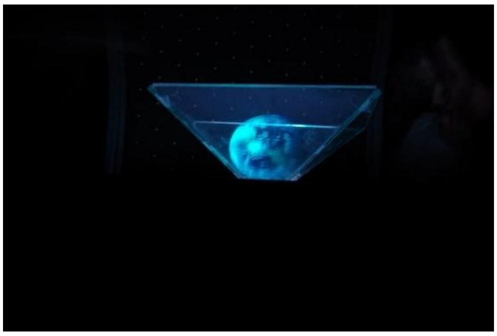

Figure 2. Hologram assembly sample-rotation of the earth

The quantitative data obtained from hologram assembly assessment form analyzed with descriptive statistics. The qualitative data obtained from researcher notes analyze via content analyses by two researchers.

RESULTS AND FINDINGS

The findings of the research are presented as quantitative and qualitative results. The finding of artifact assessment form using for outcome evaluation is shown Table 1.

Table 1. Descriptive statistics obtained from artifact assessment form (N=15)

Video			
Topic of video	Black Holes, The Sun, Artificial Satellites, The Milky Way Galaxy, The Seasons, Galileo Galilei, Lunar Phases, The Formation of Moon, Known Universe, Jupiter and Moons, Day and Night Cycle, Light, Universe Models and Rotation of the Earth (N-15)		
Length of videos	Change between 2,16 and 6,15 minutes		
Video contains scientific knowledge	N=12 (Yes)	N=3 (Partly)	N=0 (No)
Appropriate display screen	Smart Phone (N=6), Tablet (N=3), PC (N=6)		
Video contains depth perception	N=15 (Yes)	N=0 (No)	
Video contains voice	N=15 (Yes)	N=0 (No)	
Video is well fictionalized	N=9 (Yes)	N=3 (Partly)	N=3 (No)
Video quality	N=0 (Low)	N=2 (Medium)	N=13 (High)
Recording format	MP4 (N=13), AVI (N=1), WMV (N=1)		
Hologram Reflector			
Material of hologram reflector	Glass (N=3), Hard Plastic (N=3), Acetate Paper (N=9)		
Hologram reflector is portable	N=15 (Yes)	N=0 (No)	
Size of hologram reflector	Change between 3 and 13 cm (high)		
Number of hologram reflector' faces	4 faces (N=15)		
Hologram reflector is symmetrical	N=14 (Yes)	N=1 (No)	
Hologram reflector works well	N=14 (Yes)	N=1 (No)	
Hologram reflector is transparent	N=15 (Yes)	N=0 (No)	
Hologram reflector uses easily	N=12 (Yes)	N=3 (No)	
Hologram reflector is durable	N=12 (Yes)	N=3 (No)	
Design and Functionality of The Hologram Assembly			
Hologram assembly has low cost	N=12 (Yes)	N=3 (No)	
Hologram assembly can use easily	N=15 (Yes)	N=0 (No)	
Hologram assembly can use by independent user	N=15 (Yes)	N=0 (No)	
Hologram assembly is interesting	N=15 (Yes)	N=0 (No)	
Hologram assembly can set up easily	N=15 (Yes)	N=0 (No)	
Hologram assembly can store easily	N=9 (Yes)	N=6 (No)	
Hologram assembly has long shelter life	N=15 (Yes)	N=0 (No)	

As seen Table 1, hologram assembles evaluated in three main themes. The video theme contains content and features of videos. Topics of videos are black holes, the sun, artificial satellites, the milky way galaxy, the seasons, Galileo Galilei, lunar phases, the formation of moon, known universe, Jupiter and moons, day and night cycle, light, universe models and rotation of the earth. There of videos has partly scientific content. The videos are different length between 2,16 and 6,15 minutes and suitable for different display screens. All of videos have depth perception which means background of video is black and contain voice recorded by participants about the relevant astronomy topic. Nine of videos is well fictionalized which means the video has appropriate content knowledge and story. Generally, the videos have high qualities and in MP4 format. Hologram reflector theme is about the features of reflector. Generally, the participants used acetate papers as material. It is flexible and easy to make reflector. Rest of them used glass and hard plastic (CD case). Relatively, these materials are fragile and hard to cut. All of reflector are portable, transparent and has four faces. The sizes of these reflectors change between 3 and 13 cm (high) according to suitable screen. Generally, reflectors are symmetrical, work well, use easily and durable because of used acetate papers. Last evaluation them is design and functionality of the hologram assembly that contains seven criteria. These criteria include the general features an artifact. All of assembles can use easily and set up by independent user. All of them are interesting, can set up easily and has long shelter life. Because of used materials, glass and hard plastic reflectors are fragile, do not fold and have high price.

The qualitative findings obtained from researcher notes were classified in terms of the three basic categories which are difficulties, used skills and astronomy interest. A part of participants' research about selected topic contains web sources. Most of the participants do not distinguish knowledge and scientific knowledge due to being away from the nature of science especially in astronomy and astrology topics. They could not internalize the criteria of scientific knowledge despite being third grade prospective science teacher. Some of participants don't have qualifications and interests for technology. They find hard to make hologram assembly especially in video process. But, participants share their knowledge, experiences and skills during workshops. That allows peering learning and learned with mistakes. They improve to use technology skills. One of participant emphasized *that* with fallowing statement. *"At first, finding videos and combining them were very hard. But now, I can use movie maker, power director and audacity software. It is easy to make video in 3D. I can prepare it in a short time. I will create a hologram about biology (Participant 4)".* Also, participants have lack of measurement and calculation skills (e.g. using ruler, angels etc). Some participant statement emphasizes astronomy interest: "*When I searching for universe I found Cosmos series. It is very fascinating. I almost watch all episodes (Participant 7)".*

CONCLUSION

The current study allows prospective teacher to create their own artifacts using technology, mathematic and engineer skills about an astronomy topic. Prospective teachers created permanent artifacts and their thinking and problem solving skills support using mental processes to find solutions to encountered problems. Also, activity support spatial thinking abilities with moving and three-dimensional model which assists them to perceive depth phenomenon in universe. The activity is enabled to use participants' engineering and mathematic skills with designing hologram device and technologic tools via video making process. Participants learned how to create a three-dimensional model. Prospective teachers' astronomy interests were supported and their astronomy knowledge fostered by the products designed by them. A specific artifact assessment forms sample for hologram assembly were developed. Prospective teachers experienced product design process at firsthand.

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Appendix 1. Hologram Assembly Assessment Form

Video			
Topic of video			
Length of video			
Video contains scientific knowledge	**Yes**	**Partly**	**No**
Appropriate display screen			
Video contains depth perception	**Yes**		**No**
Video contains voice	**Yes**		**No**
Video is well fictionalized	**Yes**	**Partly**	**No**
Video quality	**Low**	**Medium**	**High**
Recording format			
Hologram Reflector			
Material of hologram reflector			
Hologram reflector is portable	**Yes**		**No**
Size of hologram reflector			
Number of hologram reflector' faces			
Hologram reflector is symmetrical	**Yes**		**No**
Hologram reflector works well	**Yes**		**No**
Hologram reflector is transparent	**Yes**		**No**
Hologram reflector uses easily	**Yes**		**No**
Hologram reflector is durable	**Yes**		**No**
Design and Functionality of The Hologram Assembly			
Hologram assembly has low cost	**Yes**		**No**
Hologram assembly can use easily	**Yes**		**No**
Hologram assembly can use by independent user	**Yes**		**No**
Hologram assembly is interesting	**Yes**		**No**
Hologram assembly can set up easily	**Yes**		**No**
Hologram assembly can store easily	**Yes**		**No**
Hologram assembly has long shelter life	**Yes**		**No**