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DEVELOPING AND EVALUATING PHYSICS TEACHING MATERIAL WITH ALGODOO (PHUN) IN VIRTUAL ENVIRONMENT; ARCHIMEDES' PRINCIPLE

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ABSTRACT: This study examines pre-service teachers' computer-based learning (CBL) experiences through virtual physics program, Algodoo (phun). We took one specific physic topic for the 10th grade according to the physics curriculum in Turkey. Archimedes` principle is one of the most important basic concepts needed in the study of fluid mechanics. We decided to design a simple virtual simulation in Algodoo (phun) related to Archimedes' principle. Smart board was used in order to make clear demonstration. There were 37 participants in this study who are studying pedagogical proficiency at Kırıkkale University, Faculty of Education in Turkey. Case study method was used and the data was collected by the researchers. The questionnaire consists of 28 items and 2 open-ended questions that had been developed by Akbulut, Akdeniz & Dinçer (2008). The questionnaire was used to find out the teachers` perceptions toward Algodoo for teaching physics. The result of this research recommends that using Algodoo program in physics teaching has positive impact and can improve the students' understanding.

Keywords: Physics teaching, virtual environment, Algodoo, Archimedes' principle.

INTRODUCTION

The most emphasized and explored field in analysis of the physics educational research on the computer-based learning is related to the application of simulation (Şengel, Özden & Geban, 2002; Bayrak, Kanlı & İngeç 2007; Bozkurt & Sarıkoç, 2008; Jaakkola & Nurmi, 2008; Çelik, Özbek & Kartal, 2013). In the physics area, there are so many abstract concepts and principles so that it is important to generate some simulations with the kinds of computer program for the physical activities and experiment. Researchers have found that using computer simulations in instructional contexts may afford students with opportunities to promote their understanding of unobservable phenomena in science (De Jong et al., 1999; Khan, 2002; Stratford 1997).

Technology provides some of products that can be used for educational purposes. For example: smart board with related instruments can be used for teaching physics, it also parallel takes part of the continuous development for enhancing the quality of education (Geban& Demircioğlu, 1996).Technology-based teaching environment accommodates simulation so that students can use it for calculating data, sorting data, recording intended layout, testing the hypothesis, changing the variables, observing the results and visualizing the process of information. The simulation accommodates students' initiative so that they can control or operate by their own without teachers. İt also provides tips and access information to the students. Increasing the students' motivation enables them to have the opportunity to learn everything by their own (Edelson, Gordin & Pea, 1999; Tao & Gunstone, 1999; Şen, 2001).

There are some prepared and used software that can be applied for simulation-assisted instruction, such as: Interactive physics, Crocodile physics, Phet and Algodoo. All of the programs have different properties and uniqueness. The specification of Algodoo is that it provides dynamic simulation using water that can't be found

in other physics simulation programs. Algodoo provides fluid dynamic simulation in which gravitational acceleration automatically works. So it can be used to explain the phenomena of Archimedes' principle virtually. We decided to use and develop the physics material program with Algodoo in order to prepare an alternative physics course in virtual environment.

The new modified physics program had been prepared to improve students' scientific process skills, develop a framework of students' analytical and critical thinking skills, realize the physics concepts in their daily activity, and build a suitable correlation between science, technology, society and environment. The application of information technology, like smart board, can be used for performing a simulation or practicing an educational activity on virtual laboratory. It becomes an important issue in educational activities (MEB, 2013).

Algodoo is a unique 2D-simulation software from Algoryx Simulation AB. It is designed in a playful, cartoony manner, making it a perfect tool for creating interactive scenes. Explore physics, build amazing inventions, design some cool games or experiment with Algodoo in your science classes. It encourages students and children's own creativity, ability and motivation to construct knowledge while having fun. Making it as entertaining as it is educational game. It is also a perfect aid for children to learn and practice physics at home (www.algodoo.com). As Algodoo is the number one software for creating interactive physics simulations, it is the perfect tool for learning, exploring and experimenting with real physics.

This study tried to develop a physics course program with Algodoo in virtual environment. Researchers focused on designing Archimedes' principles with Algodoo program that provides some useful simulations. This study also explored the pre-service physics teachers' perceptions towards Algodoo for teaching physics.

METHODOLOGY

Research Model

The overall research methodology was comprised of two effective assessments, including quantitative and qualitative research methods. For that reason, case study method was used in this research (Cohen &Manion, 1994). Since few contemporary physics education programs had been effectively implemented in schools in Turkey, the present study focused on pre-service teachers' learning performances to upgrade their competence via integrated simulations in physics teaching. In this research we used Algodoo program as integrated animations of physics instruments. All of the followed-up questionnaires had assessed pre-service physics teachers' performances in the Algodoo-based instruction toward Archimedes' principles. It was believed that physics instruction in Algodoo program would stimulate more interactions between students and instructors and it is suitable for the students' learning competence. We decided to choose the Algodoo program because it was so easy to operate, suitable for physics simulation and provide water simulation that are not available in other simulation programs.

Population and Sampling

Assessments of statistical samples for surveys were taken from 37 pre-service physics teachers in Kırıkkale. The participants take some pedagogical courses and practical teaching in Education Faculty of Kırıkkale University. They were enrolled in a course entitled "the Archimedes' principles with Algodoo simulation". This was a required course for pre-service physics teachers and taught by a bilingual Turkish and English instructor.

### Data collection instrument and procedure

Data's gathered with quantitative and qualitative method was analyzed for this study. Quantitative data sources included a questionnaire that used semantic differentials of a likert scale. Akbulut, Akdeniz & Dinçer, (2008); Yalın, (2001); Öztekin, (2001); Uşun, (2000); Şahin & Yıldırım, (1999) had developed and used it to test teachers' perception on computer-based learning in 5 likert scale. The developed questionnaire consists of 4 major factors with 28 questions. Twenty eight questions were completed and returned by participants. The questionnaire that evaluates computer assisted teaching material was used to collect the pre-service physics teachers' perception on Algodoo-based teaching instruction. The first part which was made up of four factors, such as: instructional relevance, convenience of the program, convenience of instruction & program and formal conformity. The first factor consists of 14 questions, the second factor 4, the third factor 5 and the fourth factor 5. In the second part, two open-ended questions were conducted as qualitative data sources to find out and explore the participants' opinions about virtual physics teaching through Algodoo. The participants could write

freely about their opinions toward virtual physics teaching through Algodoo. We used SPSS 17.0 to find out the statistical calculation.

Materials

In this study we developed a physics material through Algodoo in virtual environment. We decided to take one physics course in accordance with the standard curriculum of Turkey. In this point we used the 10th grade course program in accordance with the instruction of the Turkish Ministry of Education. We agreed to take the physics topic of Archimedes' principles. The Archimedes' principle was explained to the pre-service teachers from the basic concept. We tried not to use formula in the beginning of learning. The virtual simulation through Algodoo (phun) was conducted to visualize how the Archimedes' principle works in the fluid without real experiment in laboratory (Fig. 1.). Algodoo program is appropriate to be operated for this topic. Algodoo provides dynamical simulations that help the teachers' performance when they were explaining physical phenomena to the students in the class. Algodoo program also provides a simulation of fluid dynamic so it can be applied to show the Archimedes' principle in virtual environment. Some of the tools in Algodoo can be changed automatically by the users. For example: the material's density can be changed just by controlling a bottom so that we can get any desired value of density.

Figure 1. Example of Algodo program output
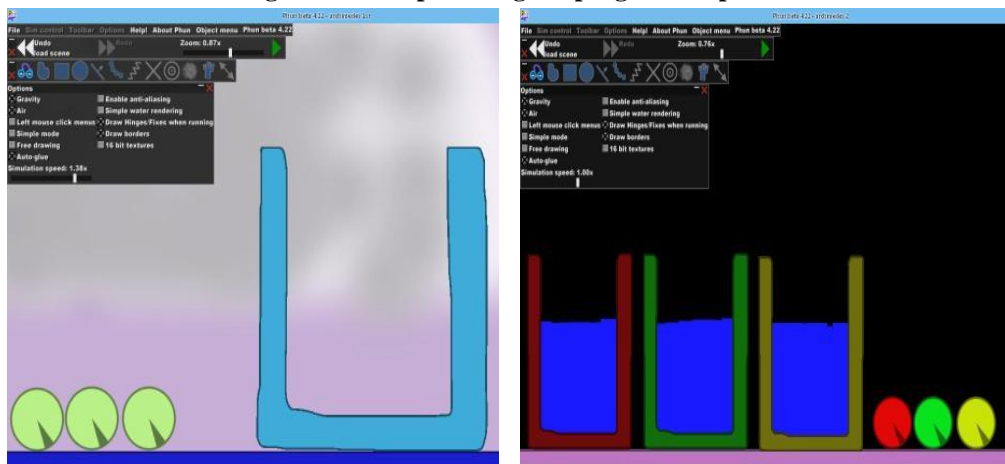
RESULTS and FINDINGS

Table 1 showed some mean values from all factors: instructional relevance ($\bar{x} = 3.98$), convenience of program (3.59), convenience of instruction and program ($\bar{x} = 3.89$) and formal conformity ($\bar{x} = 3.89$). Each factor has mean value more than $\bar{x} = 3.43$. It indicates that Algodoo is good enough as a virtual program for teaching the Archimedes' principles. There are 3 items that have mean value more than $\bar{x} = 4.23$, show specific reason why Algodoo has high influence for teaching physics, such as: remarkable, using appropriate visualization, and encouraging creativity and developing the logical thinking.

From the qualitative analysis, researchers found some of the advantages on using Algodoo for teaching physics, such as: increasing the students' understanding toward physics (29.03%) and providing good visualization (27.42%) (Table 2.). We also found some disadvantages of using Algodoo for teaching physics, such as: problem of foreign language (26.47%), incapability to represent the overall of physical phenomena (17.65%) and preparation time (17.65%).

Table 1. Table pre-service physics teachers' perceptions about Algodoo for teaching physics

Instructional relevance		N	Mean	St. Dev.		
Q1	Accuracy and topicality of information	37	4,00	0,707		
Q2	Compatibility of content and activities	37	4,06	0,674		
Q3	Evident and understandable instructions	37	3,73	0,902		
Q4	Feedback properties	37	3,76	0,796		
Q5	Compliance between individual and collaborative learning	37	4,00	0,745		
Q6	Content of comprehensible level	37	4,05	0,848		
Q7	Active participation and interactive accommodation	37	4,05	1,104	Total $\bar{x} =$ 3,98	Total SD= 0,803
Q8	Encouraging creativity and developing the logical thinking	37	4,41	0,644		
Q9	Appropriate content of partition and logical sequence of presentation	37	3,89	0,699		
Q10	Remarkable	37	4,54	0,650		
Q11	Increasing the motivation	37	3,97	0,866		
Q12	Easy to operate	37	3,65	0,949		
Q13	Understanding the content level	37	3,81	0,811		
Q14	Compatibility of students' characteristics and growth	37	3,86	0,855		
Convenience of the program						
Q15	Clear of errors	37	3,43	0,765		
Q16	Working properly	37	3,57	0,603		
Q17	Faultless display to the students' input	37	3,58	0,692	Total $\bar{x} =$ 3,59	Total SD= 0,726
Q18	The speed of operation	37	3,81	0,845		
Convenience of instruction and program						
Q19	The length of working time	37	3,57	0,689		
Q20	Compliance between the course's objectives and outcomes	37	4,03	0,763		
Q21	Providing complete subject	37	4,03	0,833	Total $\bar{x} =$ 3,89	Total SD= 0,751
Q22	Using flexibility and upgradeability software	37	3,84	0,688		
Q23	Constructivism activity	37	4,00	0,782		
Formal conformity						
Q24	Using color and graphic	37	4,16	0,727		
Q25	Using appropriate visualization	37	4,24	0,723		
Q26	Display intensity	37	3,92	0,924	Total $\bar{x} =$ 4,06	Total SD= 0,835
Q27	Available to read the display	37	3,81	0,938		
Q28	Using the screen space	37	4,16	0,866		

Table 2. Table pre-service physics teachers' opinion about Algodoo for teaching physics

Advantages		Frequency	Percentage
1.	Increasing the students' understanding toward physics	18	29,03
2.	Providing good visualization	17	27,42
3.	Easy to operate	7	11,29
4.	Enhance the students' creativity	5	8,06
5	Making physics easier	5	8,06
6.	Represent the physical phenomena in visual program	5	8,06
7.	Entertaining	3	4,84
8	Good for fluid simulation	2	3,23
Disadvantages			
1.	Problem with foreign language	9	26,47
2.	Can't represent the overall of physical phenomena	6	17,65
3.	Preparation time	6	17,65
4.	Lack of properties and tools	5	14,71
5.	The water density can't be changed	4	11,76
6.	Unavailable for mathematical calculation	2	5,88
7.	Lack of computer literacy	1	2,94
8.	Operating program	1	2,94

CONCLUSION

Findings indicated that most pre-service teachers were highly interested in using the Algodoo for teaching physics. According to the participants, the integration of data acquisition experiments with closely associated computer simulations has proved to be particularly effective in the learning process (Kocijancic & Q'sullivan, 2004). In this study, deemed appropriate and supporting meaningful learning of the simulation program is remarkable. So, we believe that there is considerable additional pedagogical advantage to be gained by the integration of the various CBL tools and concepts available, particularly by integrating "teaching cirriculum" and "virtual" laboratory activities (Podolefsky, Perkins & Adams, 2010; Tatlı & Ayas, 2010; Sarı &Güven, 2013).

RECOMMENDATION

The computer program can be used to enhance the students' motivation toward physics (Şen, 2001). Computer program sometimes provides an alternative solution for solving unobserved phenomena. Algodoo is one program that can be operated in various physical phenomena. It provides fluid simulation so it can be utilized for explaining the Archimedes' principle to the students. By giving attractively demonstration and virtual visualization, it can increase the students' motivation and gain a better understanding toward physics. To gain a better educational service, the teachers and students should improve their English language skills because almost the computer program is operated in English instructional language. And Algodoo should develop their program in order to provide a better and more complete physical simulation.

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