

The App That Simplifies Physics: All About Buoyancy

Rana Taki

rana.taki@hisarschool.k12.tr

Abstract

All About Buoyancy is an application which helps high school students to practice buoyancy in the context of simple games. The application is designed according to the curriculum and requirements of NGSS. Data from different research centers and universities were analyzed to conclude that the main reason students disliked a topic was the lack of understanding on that certain topic. Therefore, before the application was being built virtually, games were designed on paper according to the curriculum NGSS provided. The paper design was transferred into a digital environment resulting to simplify certain aspects creating the second prototype. Feedback was given on the digital prototype to improve the games and the application. Finally, a third, functioning prototype was created in a digital platform. The third prototype helped the student maintain their focus and motivation while studying because it was designed in such a way that the student could access the application in seconds whenever he or she had a question. This application's goal is to minimize the misconceptions and make the learning process of the students easier and more entertaining. It aims to teach the student how to approach and solve a question systematically through simple games. By using graphics, the application intends to increase the understanding of visual concepts.

Introduction

Highschool physics is not an easy subject since most highschool students encounter physics for the first time in their lives. According to a research made by the department of physics in the University of Liverpool, 46% of year 10 students in Turkey dislike physics (Figure 1). Not all students are expected to like physics, however, this is a very high rate of disengagement on the subject which makes us question: Do students dislike physics only because of the topics, or do they dislike it due to their lack of understanding? One of the reasons students dislike physics is that "It is challenging in the sense of what requires from the student: dedication, attention to detail, discipline and constant practice"[4]. Supporting this claim, according to a research made in Wolaita Soddo University, a total of 36.7% of the students reported to hate physics due to the difficulty of the units [2]. This awakens a major concern about the future of physics and its relationship with the students. "Many studies indicate a drop in the number of students enrolled into physics studies and therefore also the number of those graduating from such study programmes"[3]. This decrease could result in less physics scientists which will also affect the development of this area negatively. The issue is mainly caused by the shortage of time highschool students have. Due to the rapid development of technology, it gets harder to keep up with the pace of life each day which challenges most highschool students. The average amount of time a highschool student has for studying each subject is not enough to fully understand physics. So the student tends to skip learning the logical explanation of physics theories due to the amount of time it takes to understand. A solution to this could be to turn studying physics into a free time activity by making a game out of the topic. This way, the students would both have time to take a break from the uninteresting paperwork and learn a challenging topic on physics. If the difficult units of physics were implemented to a mobile game app, the time spent on viewing the unit would also increase resulting in a better understanding of the topic.

Distribution of students' finding physics entertaining with respect to gender

Gender	I find physics entertaining			Total	P
	Yes	No	Partly		
Female	18	34	17	69	.212
	37%	50%	56%	47%	
Male	30	34	13	77	
	62%	50%	43%	53%	
Total	48	68	30	146	
	100%	100%	100%	100%	

Figure 1 [1]

Student causes	No. Male	No. Female	Percent (%)
Teachers Approach	70 (28%)	110 (45%)	36.7
No Significance of the Subject	40 (16%)	0 (0%)	8.2
No Practical Session	40 (16%)	50 (20.8%)	18.4
Contains Difficult Unit	30 (12%)	40 (16.7%)	14.3
Difficulty of Subject	70 (28%)	40 (16.7%)	22.4
Total	250 (100%)	240 (100%)	100

As students responded on the above table majority of students hate or not interested in physics due to the approach of the teacher (36.7%) and secondly the subject difficulty (22.4%). The reason for declined interest of student is different for females and male students, teacher approach (45%) for and the second reason is the lack of practical session (20.8%).

Figure 2 [1]

Expected Achievements from a Highschool Student

According to the STEM curriculum for K12 students, Buoyancy consists of three main: Archimedes' Principle, Pascal's Law and Bernoulli's Principle. These laws are then applied to daily life examples and questions. The student is expected to analyze the state of the object and find the missing variable by using the laws and formulas. The student is also expected to understand the usage of these laws in real life such as analyzing how a very heavy ship floats in water. At the end of the topic, the student must be able to "Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes" [5]. The students are mainly expected to understand the principles and be able to implement them when analyzing real life situations. [5]

All About Buoyancy

All About Buoyancy is an application for practicing physics. The application provides its user with the basic information required to know for solving problems based on buoyancy. It appeals to the user by implementing certain rules to basic games which makes the user repeat the formulas a number of times. This way, by reading short texts and playing simple games, the user is able to nearly perfect buoyancy. The application has two practices, one of which contains the very basic rule of buoyancy and is also the first approach on buoyancy problems. In the first practice, the user determines if the object is floating, suspended or sinking. The user starts by selecting a random medium and an object. Then calculates their densities and compares the densities to decide the state of the object. The second practice emphasizes the formula for floating objects, where there is an object with a volume of 10 immersed in a medium. The values of the volume immersed, density of the object and the density of the medium are randomized by the computer when the user clicks the generate button. The computer randomly asks the densities of the medium or the object. The user then has to evaluate these values and input the value of the variable asked. The user can repeat these practices without getting bored for about a few minutes. Given that the user could turn back to the application, if these formulas were to be practised daily for a few minutes, the user would most likely be able to approach and solve most questions about buoyancy in about a week.

Design and Paper Prototyping

Prototype I (Figure 1): The application was first designed on paper. The screens and the flows were shown in these prototypes.

Prototype II: The application was designed on the UI section of Xcode. The errors in design were fixed and certain aspects of the design were altered so that the application could be functional. A

second practice for floating objects was added to increase the effectiveness of the application. Prototype III (Figure 4): The code was implemented on the initial design. While implementing the code, it was noticed that the design had some aspects that made it impossible for the application to function. Those aspects were removed. According to feedback from the professor, a few new levels were added to the application.



Figure 3: Prototype I



Figure 4: Prototype III

Technical Information About the App

The application is coded in Apple's coding language, Swift. The advantages of the language is that it is a simple language and could be used by amateur programmers. Swift is generated on Xcode, which makes it possible to design the UI(user interface) of the application before implementing the code. It had a great impact while designing "All About Buoyancy" since the errors in the paper prototype could be easily spotted and fixed. After finishing the design, Xcode's user friendly platform made it simpler to implement the code on application. Several classes were used for several screens and the code was mostly based on if-else and switch statements since the user had to pick from a few materials and was required to answer questions. Adobe Illustrator was used for the design of the graphics.

Contribution of the App to the Learning of Highschool Students

All About Buoyancy contributes to the learning of high school students by simplifying formulas and by teaching them how to correctly approach a question through games. By making learning easier and faster, the application is intended to motivate high school students and to increase their interest in physics. Whenever the students feel like they're not confident in an approach while solving questions, they can always run the app and make sure if their approach is the right one. This helps the students maintain their focus while studying because instead of searching through the internet or a book, or even emailing the teacher, and spending a lot of time, the student only needs to open an application to find a solution.

Future Plans

Since the application is just a third prototype, it still has a lot of aspects which could be improved. Aside from Archimedes' Principle, Pascal and Bernoulli's laws will be added to the application to complete the required units for the topic. Levels are to be added to the games so that the student would be more likely to return to the application due to the achievements he or she earns by completing levels. Animations of the usages of buoyancy in real life will be designed and added to the application so the student could easily understand how the buoyant force affects objects and in which way this occurs.

Sources

- [1] Boyes, Edward, and Martin Stanisstreet. Why Aren't Secondary Students Interested in Physics? ResearchGate, 2003, https://www.researchgate.net/publication/230918790_Why_aren't_secondary_students_interested_in_physics.
- [2] Hamelo, Shewangzaw. Interest of Grade Ten Students Toward Physics Among Other Science Subjects, Case of Wolaita Soddo Town Governmental Secondary Schools, Ethiopia. 25th ed., vol. 7, IISTE, 2016, pp. 1–4.
- [3] Mirko, and Josip. "Many High-School Students Don't Want to Study Physics: Active Learning Experiences Can Change This Negative Attitude!" Revista Brasileira De Ensino De Física, Sociedade Brasileira De Física, www.scielo.br/scielo.php?script=sci_arttext&pid=S1806-1172012000300013.
- [4] "On Why People Don't Like Science, Especially Physics." Antariksh Yatra, 17 May 2013, vandanasingh.wordpress.com/2009/04/14/on-why-people-don-t-like-science-especially-physics/.
- [5] "The Physics of Fluid Mechanics - Unit." TeachEngineering.org, 8 Dec. 2019, www.teachengineering.org/curricularunits/view/uoh_fluid_mechanics_unit.

Sources For Used in The Application

Ross, Rachel. "Eureka! The Archimedes Principle." LiveScience, Purch, 26 Apr. 2017, www.livescience.com/58839-archimedes-principle.html.

"What Is Buoyant Force? (Article) | Fluids." Khan Academy, Khan Academy, www.khanacademy.org/science/physics/fluids/buoyant-force-and-archimedes-principle/a/buoyant-force-and-archimedes-principle-article.