

Augmented Reality Based Instructional Approaches to Enhance Understanding Abstract Concepts of Physics among Higher Secondary Students

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Abstract This research examined the augmented reality based instructional approaches to enhance understanding of abstract concepts in physics among higher secondary students. Augmented reality is the blending of interactive digital elements – like dazzling visual overlays, buzzy haptic feedback, or other sensory projections – into our real-world environments [1]. Augmented Reality, or simply AR, is the incorporation of information in digital format that includes live footage of a certain user's real-time environment [2]. The aim of education is not merely imparting of knowledge or the preparation of a finished product, its aim is to arouse curiosity, develop proper interests, attitudes and values and the build up habits of independent study and the capacity to think and evaluate. Without thinking it is not possible for one to become a responsible member of a democratic society. Augmented Reality turns the environment around into a digital interface by placing virtual objects in the real world, in real-time. Augmented Reality can be seen through a wide variety of new experiences. A teacher will have to integrate the new technology based skills of teaching and also help the students to grow intellectually, emotionally and socially with commitment to a set of values. For this, a teacher must have knowledge of his subject, methods and resent technological based techniques of teaching. Many skills are needed to communicate effectively like the skill of questioning, illustrating, demonstrating, explaining, skill of arranging and logically sequencing the subject matter [3]. These digital experiences, skills and attitudes can be developed through systematic learning.

Keywords: *abstract concepts, augmented reality and instructional approaches*

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1. Introduction

Augmented reality has recently received a lot of attention in education [4]. Virtual information and physical objects are deployed in regular teaching all over, and until recently, blending these two environments has been a very difficult task at best [5]. Augmented Reality is the modification of real-life surroundings with the addition of visual parts, sounds and other stimuli. In simple words, it is a combination of real and virtual elements [1]. The virtual objects is appearing in coexistence as the same space as the objects that is located in the real world. AR is now a common technology commonly used in instructional environments in the education sector [6]. The teaching – learning process from teacher-centred instruction in to learner-centred instruction with more interactive, engaging, experiential method [4]. A technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view. The real, physical

world in which users find elements enhanced by computer-generated input. The ultimate goal of augmented reality is to create a convenient and natural immersion, so there's a sense that phones and tablets will get replaced, though it isn't clear what those replacements will be. While augmented reality offers new technology based learning opportunities, it also creates new challenges for educators. The students in augmented reality environments may be cognitively overloaded by the large amount of information they encounter, the multiple technological devices they are required to use, and the complex tasks in understanding of abstract concepts they have to complete [6].

Our quality of life and economy in future years depends on how well our students utilize digital learning resources today. Students need a training ground to sharpen their existing skills, acquire new technological skills, conceive of and experiment with new ideas and enhance the curiosity level. Today's children are tomorrow's citizens and hence the beginning should be made from the early stages of education itself [8]. To the majority of people, quality education ensures a comfortable and secure life.

It is expected that education provides hope and opens avenues for a prosperous life [9]. It should create intelligent hard working and productive men and women. Education should enable youngsters to become contributing members of the society through knowledge, skills and character development; provide access to first rate training for people of all ages and backgrounds and make it possible for them to compete in a global economy. To achieve this, our courses and syllabi should emphasize relevance and applications to the real world. In a knowledge based society the content and process of education has to undergo continuous reorganization and up gradation. Unless the system of education works properly, all the ambitious programme of educational reforms envisaged in the National policy on Education 1986 will come to nothing [10]. So we need a radical technological based change of the education system.

2. Review of Literature

Aronson and Patnoe [11], Walker. I, Crogan. M, [12] and Doymus. K [13] suggests that as a result of cooperative learning, self-esteem, liking of school, liking of peers, and racial prejudice students will develop more empathy. Berger, Roland et. al [14], M. Hanze and R. Berger [15] and Maftai. G and Maftai. M, [16] revealed that group activities, peer tutoring/mentoring, group games, and problem-solving activities assist learners to understand concepts and acquire long-term mastery abilities and cognitive levels the jigsaw classroom is a powerful method. According to Luminita dinescu, Cristina miron et. al [17], it is advised that some didactic approaches be used that are tailored to each student's knowledge level, style, and rhythm. Christine Howe, Andy Tolmie et. al [18] report on a research of heating and cooling concepts. Sébastien Cuendet, Quentin Bonnard, Son Do-Lenh et.al [8] to be employed in the classroom integration, awareness, empowerment, flexibility, and minimalism. Noreen M. Webb and Sydney Farivar [19] investigated the impact of two instructional methods designed to teach students in small groups about achievement and linguistic interaction. Woolnough J.A and R. S. Cameron [20] We have gradually introduced a more conceptual approach. According to Brian E. Woolnough [21] and Zammuner V.L. [22] physics teachers, students' enthusiasm and interest in other extracurricular activities. J. Buchner and J. Zumbach [23] D. Nincarean et.al [24] Kevin Bonsor and Nathan Chandler [25] to focused on augmented reality works and promoting intrinsic motivation with a mobile augmented reality learning environment. According to Maftai. G, Popescu. S. [26] Smithers, R. [27] Williams, K., and Cavallo, A.M.L. [28] Reasoning ability, meaningful learning and students' understanding of physics concepts.

3. Rationale of the Study

The effectiveness of the augmented reality based instructional strategies will enhance the understanding of any abstract concept in any branch of science. The

researcher has made an attempt to deal with all kinds of approaches and in particular has selected the augmented reality based instructional approach as a suitable means to enhance the understanding of the abstract concepts in physics among the higher secondary students, the researcher to develop augmented reality based instructional strategy will be helpful to the students to learn and retain in memory the abstract concepts easily to enable them to score high marks in examinations and also to use the same in their day to day life. The researcher attempts to find out the effectiveness of the augmented reality based strategy statistically, so the study is necessitated.

4. Need for the Study

In a rapidly developing country like India which is surging fast in the new millennium, the whole system of education revolves round academic achievement, though various other outcomes are also expected from the system. Thus a lot of time and effort of the schools are used to help students to achieve better in their scholastic endeavors. In spite of this, our students score low marks in various subjects but this shortfall in achievement is high in Physics. Even though many attempts have been made to improve the level of attainment there seems to exist mainly three categories of students as high- average- and low achievers. The importance of achievement has raised several questions for the psychological factors that promote achievement in students. The variables contributing to the educational achievement are to be identified. A review of the previous studies reveals that there are various strategies to promote numerical reasoning, ability to use symbols, abstract reasoning, inductive reasoning, deductive reasoning, problem solving ability, creativity, self-concept, achievement, motivation etc., which can be tried to promote achievement in Physics [9]. The effectiveness of the augmented reality based strategies will enhance the understanding of any abstract concept in any branch of science. Researchers have attempted to deal with all kinds of approaches and in particular have augmented reality based the instructional approach as the suitable means to enhance the understanding of the abstract concepts in Physics by higher secondary students. They have traced the growth of methods of teaching since the ancient days and listed the shortfalls of the traditional passive method of learning and the advantage of the present mode of teaching through the instructional approach.

5. Statement of the Problem

International competition has fuelled the flame of educational reforms in different countries. One of the core issues in on-going educational reforms is the development of a highly qualified, skilled and committed teaching force for educating all students from diverse backgrounds with a view to preparing them to meet the challenges in future. The National Policy on Education (1986) proposed the need for modifying curriculum and methodologies

of learning through appropriate research and enhancing attention-activation techniques [10]. Innovative new technologies have provided a new dimension to teaching and learning. The present study has been undertaken with a view to promote understanding of abstract concepts in Physics among higher secondary students. The problem for the present study is based on the issue of “Augmented Reality Based Instructional Approaches to Enhance Understanding Abstract Concepts of Physics among Higher Secondary Students”.

6. Augmented Reality Based Instructional Approaches

Teachers select approaches that can help students learn more and achieve a deeper understanding of the curriculum content is considered as instructional approaches [4]. Teaching of science is of a special kind and the content has a lot of abstract concepts and mathematical derivations. Students are not aware of units and measurements. Due to lack of mathematical background and understanding, students develop an aversion to physics. To remove this aversion and create interest, new technology based instructional approaches may be followed in this present study the investigator implemented the following augmented reality based instructional approaches

- Explained Formulae charts
- Simplified Symbolic instructions
- Developed Joint group instruction
- Encouraged Peer group instruction
- Transformed concept teaching into activity- based learning
- Formulated simplified table instructions
- Focused on Pictorial presentation rather than audio visual instruction
- Illustrated through augmented reality based demonstration and
- Improvised augmented reality diagrammatic representation of instructions.

7. Objectives of the Study

The main objective of the study is to make the students proficient in basics like “units and measurements” in Physics and their level of understanding of certain concepts in the areas of “Atomic Physics” and Nuclear Physics.

- To identify the level of difficulties experienced by the students in learning Physics particularly areas like Units and Measurements, Atomic Physics and Nuclear Physics
- To identify the level of achievement in Physics of the higher secondary pupils of Government Higher Secondary School, Melakidaram, Ramanthapuram District, TN, India before implementation of the augmented reality based instructional approach.
- To design, validate and implement augmented reality based instructional approaches to facilitate better achievement level in Physics.

- To find out enhancement effected among higher secondary students after implementation of the augmented reality based instructional approach.

8. Assumptions of the Study

- The augmented reality based instructional approaches can be categorized in terms of their specific objectives.
- Augmented reality based Instructional approaches play a vital role in the teaching – learning process.
- The effectiveness of augmented reality based instructional approaches can be measured.
- The outcome implementation of augmented reality based instructional learning approaches can be compared statistically with one another to find out the effectiveness of inductive approaches, deductive approaches and instructional approaches.

9. Hypotheses of the Study

The following hypotheses are formulated to give a specific direction to the present study.

- There will be significant mean difference between pre assessment and post assessment level of the achievement through augmented reality based instructional approaches among higher secondary students.
- There will be significant mean difference between pre assessment and post assessment scores on units and measurement through augmented reality based instructional approaches among higher secondary students.
- There will be significant mean difference between pre assessment and post assessment scores on Atomic Physics through augmented reality based instructional approaches among higher secondary students.
- There will be significant mean difference between pre assessment and post assessment scores on Nuclear Physics through augmented reality based instructional approaches among higher secondary students.

In this study all the directional hypothesis were converted into null hypothesis for the purpose of statistical analysis.

10. Methodology

Single-group Experimental method of Research was employed in this study. In a single-group experiment, a pre-test and a post-test are given to one group to measure the effect of an intervention without using a control group. The present investigation was conducted at Government Higher Secondary School, Melakidaram, Ramanthapuram District, TN, India. All the 50 higher secondary school students formed the sample of the study. Purposive sampling technique was followed.

Table 1. Mean and Standard Deviation of post-assessment and pre-assessment scores of higher secondary school students in atomic physics, nuclear physics and units and measurement through augmented reality based instructional approaches.

Content	Assessment	N	Max Scores	Mean	SD
Atomic Physics	Pre	50	50	15.84 (31.68)	4.46
	Post	50	50	43.50 (87.00)	3.56
Nuclear Physics	Pre	50	50	15.46 (30.92)	4.51
	Post	50	50	44.32 (88.64)	3.30
Units and Measurement	Pre	50	50	15.34 (30.68)	4.61
	Post	50	50	44.34 (88.68)	2.88

(Percentage in parenthesis).

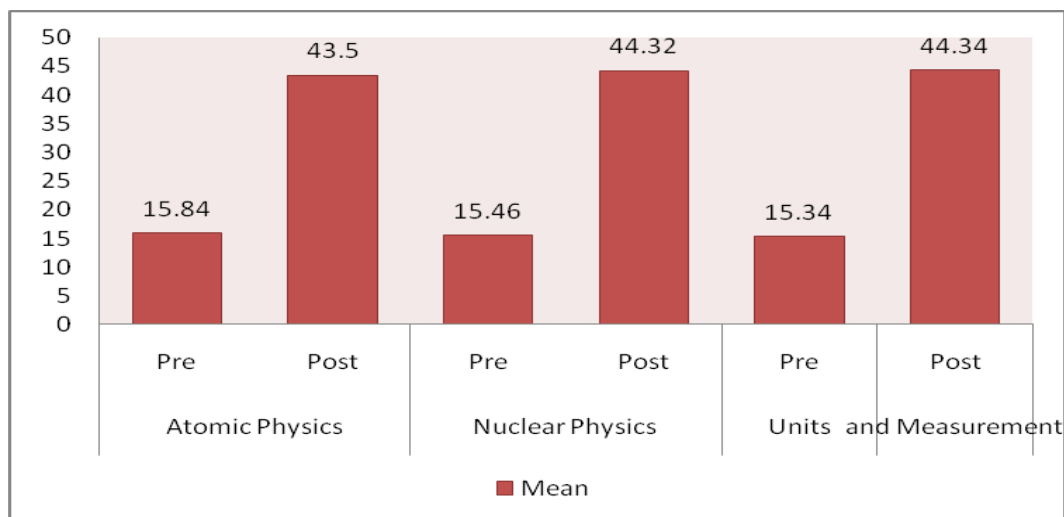


Figure 1.

From the mean scores of pre assessment and post assessment of higher secondary school students in atomic Physics, it is observed that the mean score of higher secondary school students in pre assessment (15.84) in atomic Physics is found to be less than (55.32%) that of post assessment (43.50) scores in atomic Physics. The mean score of “Atomic Physics” in post assessment is greater than the mean score of “Atomic Physics” in pre assessment. The increase in the mean score shows the effectiveness of augmented reality based instructional approaches in improving the achievement in “Atomic Physics”.

From the mean scores of pre assessment and post assessment of higher secondary school students in nuclear Physics, it is observed that the mean score of higher secondary school students in pre assessment (15.46) in nuclear Physics is found to be less than (57.72%) that of post assessment (44.32) scores in nuclear Physics. The mean score of “Nuclear Physics” in post assessment is greater than the mean score of “Nuclear Physics” in pre assessment. The increase in the mean score shows the effectiveness of augmented reality based instructional approaches in improving the achievement in “Nuclear Physics”.

In the mean score of higher secondary school students in pre assessment (15.34) in units and measurement is found to be less than (58%) that of post assessment (44.34) scores in “Units and Measurement”. The mean score of “Units and Measurement” in post assessment is greater than the mean score of “Units and Measurement” in pre assessment. The increase in the mean score shows the effectiveness of augmented reality based instructional approaches in improving the achievement in “Units and Measurement”.

11. Major Findings of the Study

- It is observed that the mean scores of post assessment on understanding of abstract concepts in physics are greater than the mean scores of pre assessment. Hence it is found that there is a gradual enhancement due to the implementation of augmented reality based instructional approaches.
- It is observed that there is a significant association between the pre and post assessment scores due to the implementation of augmented reality based instructional approaches.
- All the ‘t’ values are significant at 0.05 level between the pre assessment and post assessment in augmented reality based instructional approaches. It is inferred that the experiment enhanced the understanding of abstract concepts in physics to the higher secondary school students.
- The ‘ ω^2 ’ values indicate the increase in understanding of abstract concepts in physics to the higher secondary school students is due to augmented reality based instructional approaches.
- Mann Whitney ‘U’ test between pre and post assessment scores on Physics shows that the obtained ‘Z’ value is less than the critical value of 1.96 at 0.05 level. Therefore, the improvement in Understanding of Abstract Concepts in Physics from pre to post assessment is due to the augmented reality based Instructional Approaches.
- Kruskal – Wallis ‘H’ test values between pre and post assessment on Physics is greater than the

theoretical value of 7.08 at 0.05 level. It indicates that there is significant difference between pre and post assessment which is due to the augmented reality based Instructional Approaches.

12. Overview of Findings

- The understanding of abstract concepts in physics to the students is enhanced in the post tests.
- Impact of augmented reality based instructional approaches is found through the progress of the student's achievement in the understanding of abstract concepts in physics.
- The understanding of abstract concepts in physics to the students is enhanced to a higher level in the post assessment than the pre assessment.
- The significant relationship between the augmented reality based instructional approaches and understanding of abstract concepts in physics in all the pre, and post assessment scores.
- It is comprehended that the students level of understanding of abstract concepts in physics is enhanced by the augmented reality based instructional approaches.

13. Educational Implications

- This experimental study investigated the effectiveness of augmented reality based instructional approaches in enhancing understanding of abstract concept in physics among higher secondary level.
- The findings of the study have established that the application of augmented reality based instructional approaches have been more effective than the other regular classroom teaching methods.
- Physics teachers can use their augmented reality based instructional approaches in the regular classroom to enhance the understanding of abstract concept in physics of the students.
- Augmented reality based instructional approaches help the students to attain their goals.
- Teachers of physics can apply the augmented reality based instructional approaches for the students with physics learning difficulties.
- Teachers of physics can develop new augmented reality based instructional approaches and apply it in the classroom.
- Augmented reality based instructional approaches evoke the understanding of abstract concept in physics. Students find out the place where they are in comprehension and they will be ready to upright their position in physics learning.

14. Conclusion

Research has shown that AR can be more efficient in supporting teaching than other improved settings in technology. If content is represented as 3D learners, objects can be manipulated and information handled

interactively. Rapid technological evolution has altered the face of education, particularly when technology has been coupled with appropriate pedagogical foundations. This combination has developed fresh possibilities to enhance teaching and learning experience quality. Learning is a process in which students interact with the teachers and get learning experience [22]. Learning experience is nothing but the enhancement of knowledge in a specific field. If students face any problems or difficulties, naturally the knowledge enrichment process will be affected. They cannot fulfil their expectations from the teachers and they obtain very lower extent of learning experience. It is the indispensable duty of the teacher to provide enough learning experience through teaching-learning process. If teaching learning process is hindered by student's problems and difficulties that should be immediately rectified in order to provide enough knowledge up to the expectancy level of students. By considering the above points, the investigator made an attempt to identify the difficulties and problems of the students in learning physics at higher secondary level.

The investigator identified the difficulties and problems of the student in learning abstract concepts in physics. The researcher through his augmented reality based instructional approaches dealt with the content on 'units and measurement' Associating with adequate training in mathematical concept, the research has revealed that the students have mastered the unit on 'units and measurement'.

With respect to the unit on 'atomic physics', in the beginning student could not understand the atom model. Students only memorized to get marks in exam. By using the innovative augmented reality based instructional approaches blended with life experiences used in, they were able to understand the concept and score high with clarity in understanding.

With respect to 'Nuclear physics' the student found difficulty in calculating the number of Alpha particles, Beta particles and Gama particles. But by the augmented reality based instructional approaches the concept 'radio activity' was well understood by utilizing the different frames of tables explaining the common and different process of radio activation. As a result the students were able to understand the concept on radio activity fully and scored very good marks in the exam.

From this it is found that it would be possible to retain the understanding of abstract concepts provided, students are taught through augmented reality based instructional approaches rather than traditional approaches and if the approaches are planned in such a way as to teach abstract concepts concretely. Then the students would be able to enhance their level of understanding and achievement in any subject. Hence the teacher could periodically design and implement the augmented reality based instructional approaches depending upon the complexity of the content.

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