Research Article

Mobile Augmented Reality in Teaching Upper Primary School Science: Perspectives of Subject Handling Teachers

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Abstract

The incorporation of technology into education is necessary and inevitable in our technological society of today. The application of Mobile Augmented Reality (MAR) in education is becoming gradually more significant in the global dissemination of knowledge. The majority of school teachers in Tamil Nadu use MAR, and they have sufficient experience using it in the classroom. This research investigates how upper primary school science instructors view the usefulness of MAR in the classroom. To gather the necessary data, 135 science teachers were randomly selected from the Coimbatore district of Tamil Nadu and given the Teacher Perception Scale on Mobile Augmented Reality. The study's key findings show that the majority of teachers believed that MAR helped them reasonably when teaching science at the upper primary level, and there was a significant difference between perception teachers in terms of gender, but not in terms of locality or teaching experience of teachers.

Keywords: Augmented reality, Content teaching, Perception of teachers, Student learning, Upper primary schools

Introduction

In today's technologically advanced culture, it is more challenging than ever to keep students' attention and active participation in the classroom due to the various stimuli in their learning environment that make them more demanding during the learning process. While teaching science content in schools, most of the teachers use traditional way teaching and learning, and many times they use two-dimensional media according to their convenience. The science content is related to three-dimensional things, and a teacher handling this subject may not make the students immerse in the subject at the expected level. As a result, there is a need to integrate technology into teaching and learning to increase student motivation and commitment to academic activities (Shapley et al. 2011). The purpose of integrating technology into classroom activities is to improve the teaching and learning processes, especially in science-related subjects. Nowadays, the application of augmented reality (AR) in teaching and learning is becoming more and more important, gaining a foothold in the educational system from elementary school to higher education (Huang, Li, & Fong, 2016; Carlson & Gagnon, 2016). Augmented reality can be expressed as the synchronized blending of digital and physical information using different technological devices.

According to Di Serio, et al. (2013), AR system has the characteristics, such as the combined nature of real and virtual

images within virtual surroundings; reciprocated association between real and virtual images; and interaction implemented in accurate time. Further, it involves computer-generated files, including visuals, sounds, films, or digital information, encrusting various environments. Perfect interaction between the actual and virtual environments is supported by AR as well (Singhal et al., 2012), and virtual objects and real-time visuals are provided simultaneously (Azuma et al., 2001). This helps the students to have access for gaining more knowledge than they usually would have through their sense organs. Early on, this technology was employed with equipment like head-mounted displays, but it is now simple to use with any computer or mobile device (Sirakaya, and Sirakaya, 2018).

The majority of science topics in Tamil Nadu school textbooks have two-dimensional square-shaped QR codes that allow for the storage of a wide range of numeric characters and may then be seen using a QR reader application. In Tamil Nadu, the State Council of Educational Research and Training (SCERT) and the Department of School Education (DSE) provided adequate in-service training programmes for school teachers on how to use mobile augmented reality (MAR) technology during their subject teaching through mobile and computer devices. The purpose of using MAR technology in the school system is to promote a better understanding of an abstract concept among students through proper motivation, participation, and engagement in classroom practices. In this context, a study investigated upper primary school science teachers' perspectives on the utility of MAR technology in classroom practices.

Literature Review

According to Khairuldin et al. (2019), augmented reality (AR) is technology-driven learning that incorporates virtual items into authentic learning scenarios to fill in information gaps. Students who attend school can retain a high level of motivation and engagement by using augmented reality (AR) technology (Rasalingam et al. 2014). Further, as per AlNajdi et al. (2020), AR gives students the chance to see how theories are put into practise while also giving them the chance to observe and learn from real-world situations. Additionally, AR reduces students' anxiety levels when learning science (Beyoglu et al., 2020).

According to Bistaman et al. (2018), Augmented Reality (AR) gave primary school pupils effective learning opportunities and helped teachers include their students more actively in classroom activities. As per Tashko and Elena's (2015) research, augmented reality dramatically increased students' interest in, comprehension of, and interiorization of the learning materials. Arici et al. (2019) found that smartphone applications and marker-based content are the most popular types of Augmented Reality (AR) utilised in science education since they can be generated more quickly.

According to Lu et al. (2021), students' perceptions of the AR app improved their awareness, learning, knowledge, and engagement. This finding allayed worries about how to keep students interested while teaching and learning about real-world chemistry. The study's findings, according to Yilmaz (2021), showed that AR is the best method for teaching abstract concepts in science classes that don't involve direct observation and assessment. The usage of AR in other science education courses is similarly well-received by students. Also Abdullah et al. (2022) found that AR significantly improved students' achievement, interest, and science-process skills.

AlNajdi (2022) discovered that

integrating augmented reality and quick response (QR) codes in teaching enhances and improves student performance. The research findings of Saputra et al. (2022) demonstrate that augmented reality in scientific education materials might enhance students' comprehension and learning motivation. Because the learning skills are so enjoyable, augmented reality has a beneficial impact on students' passion for learning science. This prevents students from becoming disinterested in their studies.

Objectives of the Study

- To examine the perceptions of science subject handling teachers at the upper primary school level on the usefulness of mobile augmented reality in teaching science and
- To analyse the impact of gender, locality, and teaching experience on their perception of the usefulness of mobile augmented reality in teaching science.

Research Questions

- What are the different perspective levels of upper primary school science teachers on the usefulness of MAR in classroom practices?
- In which components of instruction through MAR, the science teachers are strong or weak?
- Whether the upper primary school science teachers differ in their perception of the usefulness of MAR in classroom practices?

Methodology of Research

The study's survey technique of inquiry was adopted to find out how certain teacher participants viewed the value of mobile augmented reality (MAR) in teaching upper primary students in science. The researchers contacted upper primary school teachers before the survey and talked with them about the convenience of MAR in their classroom instruction. They addressed their experiences using MAR from a motivational, instructional, educational, and technical perspective. After interacting with the teachers, the researchers gave them a research tool-the teacher Perception Scale on Mobile Augmented Reality (TPS-MAR) along with appropriate instruction.

Sample

A total of 135 school science teachers who teach classes from sixth to eighth were selected randomly from the Coimbatore district of Tamil Nadu as a study sample. Self-developed research tool: The distribution of the sample selected is furnished in the following table.

Table-1: Sample distribution

Sample		**Frequency**	**Percentage**
Gender	Male	57	42.22
	Female	78	57.78
Locality	Rural	78	57.78
	Urban	57	42.22
Experience	Less than 10 years	53	39.26
	10 years and above	82	60.74
In General		**135**	**100.00**

Research Tool Used

A self-developed research tool- The teacher Perception Scale on Mobile Augmented Reality was used in this study with four components, such as, motivational aspects; content teaching; student learning; and technical aspects. Each component of the scale contains five statements and all statement items are set against a five-point rating from 1 (strongly disagree) to 5 (strongly agree). Each subscale has a maximum score of 25, and therefore, the composite scale has a maximum score of 100. When developing the tool, the content validity was confirmed by soliciting feedback from the jury, and the test-and-retest methodology was used to determine the reliability of the composite tool (0.78).

The utility of mobile augmented reality in teaching science was divided into three categories, namely, low useful, reasonably useful, and more useful based on the teachers' perception scores. The teachers' perception of the utility of mobile augmented reality in teaching science is considered to be more useful if the perception scores were above one standard deviation from the mean score (Mean + SD).

Likewise, the teachers' perceptions of the usefulness of mobile augmented reality in science teaching are considered to be low useful if the perception scores were less than one standard deviation from the mean score (Mean - SD). According to the ratings between Mean + SD and Mean - SD, teachers believe mobile augmented reality in teaching science in upper primary classes is reasonably useful.

Research Findings and Discussion

Teachers' perspective level on Mobile Augmented Reality (MAR)

The perspectives of teachers regarding the usefulness of mobile augmented reality in teaching science at upper primary classes concerning their mean and standard deviation scores in the teacher perception scale for mobile augmented reality are summarised in the following table.

Table-2: Teachers' perception level on the usefulness of MAR

Usefulness of MAR in Teaching Science	Low useful	Reasonably useful	More useful
N (=135)	24	93	18
%	17.78	68.89	13.33
Mean (M)= 63.68 & Standard Deviation (SD) = 5.12			

According to the data in table 2, the sample's mean and standard deviation on the teacher perception scale are 68.68 and 5.12, respectively. Further, it is found that 13.33 per cent of the science teachers believed that MAR was more useful to them for their classroom instructional purposes, 68.89 per cent felt that it was used reasonably, and 17.78 per cent felt that it was low useful for teaching science subjects.

Utility of MAR: Strength and weakness

The following table examines the strengths and weaknesses components of MAR in teaching and learning science contents at upper primary level classes.

Table-3: Profile on MAR Utility

Teacher Perception	Mean (M)	Remark	
Motivational aspects	15.93	Strong	M > GM
Content Teaching	16.37	Strong	M > GM
Student Learning	15.87	Weak	M < GM
Technical Aspects	*15.52*	*Weak*	*M< GM*
Grand Mean Score (GM)	***15.92***		

By comparing the sample's mean scores for each component to the overall mean of the component mean scores for the research instrument, the usability of mobile augmented reality in teaching science was assessed. The assumption is that the MAR is strongly supporting the teacher to teach the subject in classroom practices if the mean of any component is more than the grand mean of mean scores of components; otherwise, it is regarded to be a weak one. According to the information in Table 3 above, teachers who teach science in upper primary schools said that MAR was very helpful for motivating students and teaching science content, but not so much helped them for boosting student learning and in terms of technical aspects.

Various research studies reported that the accomplishment of any technology-based instruction depends on factors, such as ability, interest, and involvement of students in learning (Huang, Chen, & Chou, 2016). The study results of Erbas & Demirer (2019) found that using the augmented reality technique had no impact on the science achievement of ninth-grade students, contrary to the research report of Lindgren, et al. (2016) which found that students at the middle school level displayed high levels of interest in learning science. Furthermore, Billinghurst (2021) noted in his research study that many teachers encountered technical difficulties when utilising AR.

Analysis of teacher perception scores on MAR: Variable wise

The following table provides a comparison of the mean scores of teachers on the teacher perception scale concerning various teacher variables.

Table-4: Variable wise comparison of mean scores of sample

Variable wise Teacher Perception Score		Male			Female			Total		
Locality	**Experience in Years**	**Mean**	**N**	**SD**	**Mean**	**N**	**SD**	**Mean**	**N**	**SD**
Rural	**10 years and above**	77.11	19	4.70	79.97	30	4.25	78.86	49	4.60
	Less than 10 years	78.92	13	4.59	80.44	16	5.07	79.76	29	4.84
	Total	77.84	32	4.67	80.13	46	4.50	79.19	78	4.68

Urban	**10 years and above**	75.73	15	7.94	80.83	18	5.40	78.52	33	7.05
	Less than 10 years	78.90	10	6.62	82.14	14	6.99	80.79	24	6.89
	Total	77.00	25	7.47	81.41	32	6.08	79.47	57	7.02
Total	**10 years and above**	76.50	34	6.27	80.29	48	4.68	78.72	82	5.68
	Less than 10 years	78.91	23	5.43	81.23	30	6.00	80.23	53	5.82
	Total	77.47	57	6.01	80.65	78	5.21	79.31	135	5.76

In accordance with the results of a study by Dirin et al. (2019), stated that, female participants' perception of using AR technology was better than male participants, the mean scores of the teachers given in the above table show that the mean score of female teachers is better than that of male teachers. Additionally, teachers in urban areas score well than those in rural areas. This finding may be attributable to the technical resources offered in schools, and it is corroborated by the findings of a study by Putiorn et al. (2018), who noted that teachers in rural schools found it challenging, in terms of technical aspects, to implement augmented reality (AR) technology. Additionally, teachers with less than ten years of teaching experience scored well than those with ten or more years of experience. The experienced teachers, due to their age and health conditions, may found hard and less comfortable to use of the latest technologies in the classroom practices than the young teachers.

In addition to the aforementioned, an ANOVA test was carried out to determine whether there was a difference in significance between the mean scores of teachers according to the variables of gender, locality, and teaching experience of the teacher sample. The results are provided in the following table.

Table-5: Three-way ANOVA test teacher perception scores

Source	Sum of Squares	df	Mean Square	F-value	p-value
Gender (A)	311.66	1	311.66	9.97	0.00
Locality (B)	2.67	1	2.67	0.09	0.77
Experience (C)	88.17	1	88.17	2.82	0.10
A x B	30.32	1	30.32	0.97	0.33
A x C	19.78	1	19.78	0.63	0.43
B x C	9.22	1	9.22	0.30	0.59
A x B x C	0.50	1	0.50	0.02	0.90
Within	3969.66	127	31.26		
Total	4444.93	134			

The results from the table above indicate that gender affected teachers' perceptions on the usefulness of MAR in teaching science at the upper primary

level (F = 9.97; p = 0.00); however, locality and teaching experience had no effect on the teachers' perceptions because their corresponding p-values were greater than 0.05. Additionally, there was no interaction effect of gender, locality, and teaching experience on teachers' perceptions of the usefulness of MAR in teaching science.

Conclusion

According to the main findings of the present study, the upper primary school teachers have viewed that MAR as reasonably useful to them in teaching science subjects in upper primary classes. The use of augmented reality in education is growing in acceptance at all levels of the worldwide educational system. It is more participatory than other traditional classes because both students and teachers in this setting are constantly involved in virtual modes of academic activities. When used in a school setting, AR helps the students and teachers to get pleasure in teaching-learning processes and hold unforgettable learning experiences. Students will remember the knowledge they have learned in the classroom better as a result. Through the use of the AR technology, the students will get improvement in their learning skills and maximise their content understanding. Therefore, the school administrators may set up the necessary classroom infrastructure and support their teachers by providing them with the right technology tools to boost students' academic performance.

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