Impact of an augmented reality system on students' motivation for a visual art course

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Introduction

Motivation: The force that initiates and directs behavior.

Role of Technology in Education:

Significant technological integration in educational environments, including computers, multimedia materials, internet, simulations, and mobile technologies.

Technologies like 3D virtual worlds and AR are enhancing learning by providing more immersive and interactive experiences.

Role of Technology on Motivation:

Empirical studies suggest that technology in education often leads to positive attitudes and enhanced motivation.

Web technologies particularly enhance motivation through increased control over learning and collaborative knowledge creation.

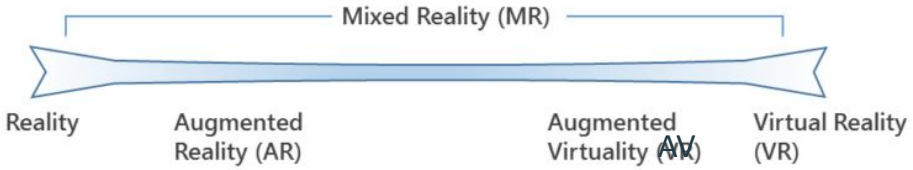
AR vs VR

AR: Technology that enhances the user's sensory perception of the real world with a computer-assisted contextual layer of information

VR: A simulated experience that employs 3D near-eye displays and pose tracking to give the user an immersive feel of a virtual world.

Similarity: Both are contained within the **Milgram Reality-Virtuality Continuum** and reflect different levels of user's immersion in environments where physical and digital objects co-exist.

Difference: VR technology completely replaces a real environment with a synthetic environment, whereas AR brings virtual information to the user context.



Three properties of AR systems

Immersion: Combine real and virtual objects in a real environment.

Including both the physical aspects of the environment and the condition whereby people are absorbed by an activity

Degree of physical immersion depends on what display and tracking technologies are used.

Poor alignment of digital information with real objects would cause a loss of immersion feeling.

Navigation: Align real and virtual objects with each other.

Digital information is superimposed on the real environment for the user's perspective.

Interaction: Run interactively, and in real time.

AR technology naturally supports learner-content interaction, whose quality depends on the kind of AR interface used.

Learner-instructor and learner–learner interactions should be supported by the environment itself and are tied to collaboration.

AR’s impact on education & student motivation

These features are expected to improve student satisfaction, help in knowledge comprehension and are potentially useful in learning tasks that require experimentation; spatial ability; and collaboration among others.

A variety of **motivation theories** support the discussion on motivation in education, with key focuses on self-regulation and task-value models which suggest that motivation can be increased through strategies that enhance students’ sense of inclusion, competence, and relevance.

Among those, Keller's ARCS model (Attention, Relevance, Confidence, and Satisfaction) shows a motivational design process and demonstrates its applicability in designing learning experiences that ensure students are motivated and engaged.

In this paper, Instructional Materials Motivation Survey (IMMS), an instrument developed to measure learner motivation following the ARCS mode, was employed to evaluate motivation levels of middle-school students towards a visual art course.

Research Questions and Hypotheses

Primary Research Question

- The study's main goal was to assess whether an AR-based teaching environment can enhance student motivation in a middle-school art course compared to traditional methods.

- This question is based on the assumption that AR could make the learning experience more engaging and meaningful, particularly for visual and interactive subjects like art.

Sub-questions

1. Motivation Differences Between Scenarios

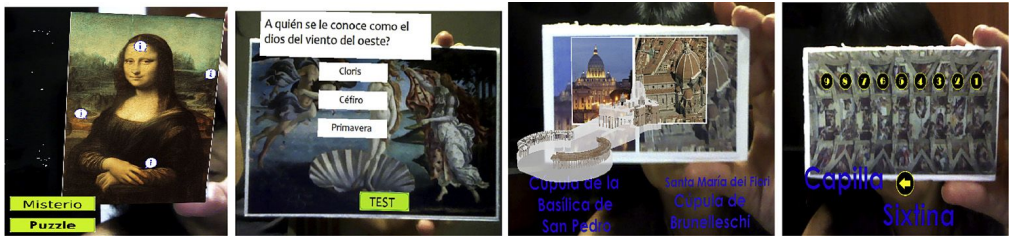
2. Impact on Each Motivational Factor (Attention, Relevance, Confidence, Satisfaction)

3. Student Response to AR

4. Barriers to AR Acceptability

Methodology

Procedure



- The study was structured in two teaching sessions on the topic of **Italian Renaissance Art**.

- **Session 1 (TS1)**: Students learned about four Renaissance masterpieces through slides in a traditional classroom setting. This session resembled a typical art history lesson with limited interactivity.

- **Session 2 (TS2)**: In the AR session, students explored another set of Renaissance artworks with augmented content (text, audio, video, and 3D models) using the **Popcode markerless AR tool**.

  This AR content allowed students to interact with the masterpieces, viewing enhanced details and multimedia elements on a computer screen with webcams.

Participants:

- The study involved 69 middle-school students from a public school in Madrid, Spain.
- Students ranged from ages 13 to 16 and participated in both a traditional (slides-based) and an AR-based learning session to allow for paired comparisons of their experiences.

Motivational Assessment Tool:

- The study used Keller's Instructional Materials Motivation Survey (IMMS), which is based on the ARCS motivation model.
- IMMS Questionnaire: This 36-question survey uses a 5-point Likert scale to measure the four motivation factors (Attention, Relevance, Confidence, Satisfaction).
- Data Collection: After each session, students completed the IMMS survey to rate their experience. Results from both sessions were then compared using statistical methods, particularly paired-sample t-tests, to analyze the differences in motivation.

Result

Overall Motivation Levels

Students reported higher overall motivation in the AR-based scenario (TS2) compared to the traditional slide-based approach (TS1).

This finding supports the hypothesis that interactive and immersive AR environments enhance student motivation for visual and contextual subjects like art.

Table 2
Descriptive statistics for all subscales.

Subscale	TS1		TS2	
	M_1	SD_1	M_2	SD_2
Attention	3.28	0.55	3.76	0.72
Relevance	3.31	0.47	3.48	0.47
Confidence	3.4	0.53	3.63	0.57
Satisfaction	3.11	0.68	3.51	0.59

Student Feedback

Qualitative data from observations and interviews provided insights into student enjoyment and ease of use. Many students mentioned that they found AR more interactive and fun, leading to better concentration.

Table 3
Mean scores and standard deviations of the attention items.

	Item	*M*	SD
2	There was something interesting at the beginning of the AR lesson that caught my attention	3.95	1.14
8	Augmented reality technology is attention-grabbing	4.19	1.01
11	The quality of the augmented reality material helped to hold my attention	3.88	1.05
12	The material is so abstract that it was hard to keep my attention on it (Reversed)	3.72	1.28
15	The images, videos and text that I discovered through the lesson are unappealing (Reversed)	3.77	1.34
17	The way the information is arranged using this technology helped keep my attention	3.98	1.14
20	The information discovered through the experience stimulated my curiosity	3.56	1.10
22	The amount of repetition of the activities made me feel bored (Reversed)	3.54	1.38
24	I learned some things from the augmented reality that were surprising or unexpected	3.46	1.13
28	The variety of audio visual material helped keep my attention on the lesson	3.68	1.00
29	The audio visual material is boring (Reversed)	3.88	1.25
31	There is so much content that it is irritating (Reversed)	3.63	1.36

Table 5
Mean scores and standard deviations of the satisfaction items.

	Item	*M*	SD
5	Completing the exercises in this lesson gave me a satisfying feeling of accomplishment	3.60	1.12
14	I enjoyed this lesson so much that I would like to know more about this topic	3.26	1.03
21	I really enjoyed studying this lesson	3.53	1.07
27	The wording of feedback after the exercises, or of other comments in this lesson, helped me feel rewarded for my effort	3.11	1.06
32	It felt good to successfully complete this lesson	3.63	1.06
36	It was a pleasure to work on such a well-designed lesson	4.14	0.88

Student Feedback

“It helps me remember the information.”

“I can concentrate better using this system than reading a book.”

“I feel like I have been inside the picture.”

“When I don’t understand something, I can see or hear the information again.”

“It was more fun than sitting in class, I did not feel bored.”

“I like it better than the reading material or attending class.”

“I prefer watching the videos than reading the text.”

“I liked the 3D models.”

Barriers to AR Acceptability

Despite some technical issues, such as difficulty keeping images aligned or slight “shaking” in the visuals, students quickly adapted and continued to engage with the material.

Table 4
Mean scores and standard deviations of the confidence items.

	Item	*M*	SD
1	When I first looked at the lesson, I had the impression that it would be easy for me	3.67	1.12
3	This material was more difficult to understand than I would like for it to be (Reverse)	4.11	1.19
4	After the introductory information, I felt confident that I knew what I was supposed to learn from this lesson	3.21	0.88
7	The information that I was exploring was so much that it was hard to remember the important points (Reverse)	3.68	1.27
13	As I worked on this lesson, I was confident that I could learn the content	3.70	1.24
19	It was difficult to discover the digital information associated with the real image (Reverse)	3.61	1.33
25	After working on this lesson for a while, I was confident that I would be able to pass a test on it	3.44	1.07
34	I could not really understand quite a bit of the material in this lesson (Reverse)	3.63	1.40
35	The good organization of the material helped me be confident that I would learn this material	3.72	1.10

Barriers to AR Acceptability

“Nice, it is so easy!”

“I find that it is really easy to use.”

“It is just like a game.”

“It is difficult to keep the picture in the right position.”

“I notice that I have to maintain the picture centred but . it is fine!”

“The image is shaking, this is a little bit annoying but . I can continue.”

“Sometimes, I lose the image. Nevertheless, it is easy to recover it.”

“How did you achieve it?”

“The picture has marks and when I click on them, I get information.”

Discussion

No control group: The same motivational instrument was applied twice to the same group of students in order to evaluate both scenarios.

Distractions eliminated: neither the content nor the order of sessions could be an important disturbing factor on results.

Motivation Factors:

Attention and confidence were notably higher with AR; relevance scores were nearly unchanged, indicating that content alignment with student interests is crucial irrespective of the learning medium. (Risk of confusion in answers for confidence)

Attention and confidence received highest ratings, suggesting AR's efficacy in gaining and holding the attention of learners.

Despite satisfaction with the use of AR to support the learning environment, low mean scores in relevance subscale suggest that students were pleased to fulfill an academic requirement even though their needs were not aligned with course objectives.

Conclusion

Positive Impact on Motivation:

Quantitative results confirm that AR improves motivation among middle-school students.

AR-based learning environments scored higher in motivation metrics compared to traditional slide-based lectures, with mean scores of 3.62 versus 3.29, respectively.

Improvement in Attention and Satisfaction:

Attention and satisfaction were significantly better in AR scenarios than in traditional learning setups.

AR learning environments were perceived by students as more appealing and easier to understand.

Relevance Factor:

The relevance of the material to students' interests remained comparable across both AR and traditional environments, highlighting that technology alone doesn’t guarantee increased relevance.

Qualitative Results:

Enhancements in concentration and memorizing were noted through AR's interactive and immersive features.

Students were able to engage more deeply with the material, showing improved analysis and retention after AR sessions.

Control and Multimodal Information:

AR technology facilitated more learner-centered activities, allowing students to control their exploration of material and receive information in multiple modes, which helps cater to different learning styles and keeps engagement high.

Social Aspect:

AR prompted more social interaction and sharing among students, particularly noticeable in discussions post-AR sessions compared to traditional sessions.

Ease of Use and Adaptability:

Students adapted quickly to AR systems, overcoming technical challenges with relative ease, which contributed to a favorable attitude towards ongoing AR use in educational settings.

Future Research Directions:

Further studies are recommended to confirm findings, explore long-term effects, and reduce potential biases from the novelty of AR.

Research should also focus on identifying learning activities where AR can have greater impact.

Thank you for listening!