Investigating Students' Attitudes toward Learning Based on Metaverse

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Abstracts: By merging augmented Reality (AR) and Virtual Reality (VR), the real world becomes a metaverse. This study aims to determine students' attitudes toward learning based on a metaverse platform depending on different variables. The researchers applied a Quasi-experimental method of one group post-test design to a random sample of 100 students from the Faculty of Information Technology, Mutah University. The system of the human body was selected and three topics were introduced: the circulatory system, the nervous system, and the digestive system. A scale was developed to measure the students' attitudes after watching the lessons prepared by the proposed AR platform and then to analyze their feedback from the answers collected in a well-prepared questionnaire. The results showed that there is a statistically significant difference in students' attitudes toward learning based on the metaverse. Furthermore, the study recommends adopting the use of the metaverse platform in learning and promoting research in the areas of AR and metaverse.

Keywords: Augmented Reality (AR), Learning; Metaverse, Virtual Reality (VR).

1. INTRODUCTION

Today's digital and technological developments have proven their importance in various fields, especially in school and higher education. Information technology and communication provide easy access to information and knowledge available in various forms and multimedia. As a result, the education system is embracing these developments and facilities to utilize their features and characteristics in the classroom.

What has been imposed on the inputs and outputs of the entire educational system, including the teacher, curriculum, learner, teaching strategies, and evaluation methods, has forced educational institutions to work to absorb these changes and improve the teaching skills of teachers to deal with it and be able to produce and use knowledge, which aids the development of the educational society rather than information consumer knowledge (Ahmad, Qawaqneh& Qwider, 2020).

Technological applications in education are thus characterized by creating suitable and supportive conditions for the educational process. They can motivate students by engaging them in advanced pedagogical tools and practices, which in turn creates an innovative and more attractive learning environment by encouraging cooperative work and interaction between learners (Ramírez-Montoya et al, 2021).

The availability of technological tools such as smart devices and their widespread applications have opened up the possibility of making the best use of these applications in the educational process (Qureshi et al, 2021). This type of technology helps create virtual simulations of reality that can be used to create (AR) that integrates virtual and real environments.

In the context of education, many assistive technologies linked to the concept of AR emerged through smart device applications and the integration of (VR) during the introduction of educational content. VR provides two or three-dimensional graphical interfaces for users' interaction and smart devices, in which several graphical applications can be developed as 2D or 3D models, such as interactive and non-interactive game engines, interactive web browsers, 3D simulation, and a wide range of other applications (Dahasi, 2017). AR is the

technology in which VR is integrated with real-world environments to make it appears as if the virtual object is presented in the real world (Suleiman, 2018); therefore, AR can be combined in various activities and used for different purposes.

The beginnings of AR may be traced back to the late 1950s; however, it became prominent in the twenty-first century (Paro, Hersh & Bulsara 2022). AR is located in the "Real Environment" as a continuum between actual and virtual settings (Laroche et al, 2019). Because of this connection to the world, AR may be a mobile technology, with the user navigating in actual areas during AR sessions. According to MacCallum & Parsons, 2019, AR gives the potential to add more digital elements to explore and extend sceneries and settings from the real world.

1.1. Metaverse in Learning

AR is characterized as a type of simulated space or VR that enhances the real world; however, it does not alter an actual reality since it enables the students to see a genuine world through the lens of virtual images that seem to be either purely speculative or attributed to reality. The learner can use all of his/her senses, not just the vision, through AR. Both AR and VR offer prospects for interactive learning (Ferguson et al, 2017); nevertheless, there are some key differences between the two.

Many assistive technologies related to the notion of AR arose in education through smart device apps and the integration of VR during the demonstration of instructional information.VR provides a two- or three-dimensional graphical interface for user interactions and electronic objects that include a diverse range of graphical applications, such as interactive and non-interactive game engines, interactive web browsers, 3D simulations, and a variety of other applications (Dahasi, 2017).

In education, especially in science subjects where there are many complex and abstract concepts that are difficult to convey to the teacher. VR can significantly contribute to improving the teaching of science subjects, which requires some kind of imagination, visualization, and logical thinking to understand abstract topics that are difficult to imagine (Aqel & Azzam, 2017). Technology is based on three-dimensional design and multimedia in which all the senses of students are used to understand scientific concepts, perceive them correctly, connect them and implement them through life experience; and improve their motivation and academic level (AL-Dulaimi & Hamadallah, 2021).

1.2. Metaverse platform

Metaverse is a platform that allows users to use or produce E-content with some kind of interaction (2019, MetaverseApp). From a pedagogical point of view, Metaverse has many aspects that make it attractive. It has a studio tool for creating experiences that can help students learn by supporting their learning and integrating numerous web resources (MacCallum& parsons, 2019).

Metaverse does not force you to explicitly tie an experience to a physical stimulus, which, unlike HP Reveal, allows more flexibility in creating interactions. To illustrate, an interaction could simply be a collection of scenarios, such as surveys and quizzes that relate to the environment but are not overtly connected to it. In contrast, Metaverse allows you to link an experience to a goal, which is not possible with many other AR technologies (Mystakidis, 2022). As a result, the environment can become an essential element of the learning process. A task may require the learner to perform an activity in a natural environment, such as solving problems, acquiring knowledge, or simply exploring their environments, before using the explicit features of the program to check the results.

Other features that distinguish Metaverse from other AR production tools, besides targeting, are the integration of a Google AI service and the ability to implement user-created artifacts. These additional features can potentially be used to create more complex AR experiences. (Park & et al., 2022).

In addition, Metaverse allows learners to submit their digital content, created by the students themselves or

imported from databases). This allows the addition of 3D graphics or other digital material to enhance the actual environment. Students can even create their own components for their activities by coding them. (Pimentel &et al., 2022)

These components can be used to add new features, and they can be shared in the Metaverse database. Experiences can make their source code publicly available so that students can understand how they work and use it as a basis for their programming.

Students can learn different skills when designing their own experiences in Metaverse, with computational thinking skills being one of the most general. To make many of these experiences work, students must use complicated serial processes that require conditional branching and loops... (Pimentel & et al., 2022)

For this reason, and after looking at several possible tools, we have chosen Metaverse for the following reasons:

1) It is free and open source.

2) The Studio app (where the Metaverse "experiences" is created) runs in most browsers and the mobile app where these experiences are delivered runs on both iOS and Android mobile devices.

3) The Studio app allows users to create and import their content.

4) Multiple types of experiences can be created depending on the scenes selected and combined, with different options for triggers and overlays. (MacCallum& parsons, 2019).

2. PROBLEM STATEMENT

Traditional teaching, where the blackboard is filled with concepts, examples, exercises, and 2D drawings as well as various teaching aids, sensors, and other means of clarification consumes more time and effort from the teacher. It is also an inadequate means that may not be suitable for all learners, because the student struggles to transform the teacher's explanations and observations into drawings and images suitable for his or her way of learning, without benefiting from the teacher's pedagogical experience.

Reda (2018) also pointed out that teaching scientific content to students is currently not only about learning scientific concepts but also about helping them to change the mental perceptions that may be present in their knowledge structures about these concepts.

The use of a virtual, and enhanced learning environment and the use of an incarnation-based and interactive learning system play an important role in translating mental perceptions into real, recalcitrant models, including a learning environment (Metaverse).

Images and videos in 2D do not fully serve the purpose of communication and real meaning with the full understanding of the concept, especially about the systems of the human body, so there is a need for modern methods of technology to clarify the internal processes and concretely depend on mental perceptions to properly understand them for students to treat as virtual models that mimic reality and undoubtedly the environment (Metaverse).

The study problem can be identified in the following questions:

1- What are the student's attitudes toward learning based on the metaverse?

2- Do students' attitudes towards learning based on metaverse differ in the following variables (gender, tool used, and learning style)?

Study Hypotheses:

1- There are no statistically significant differences at the level (α ≤ 0.05) between the averages of students' attitudes toward learning based on the metaverse.

2- There are no statistically significant differences at the level (α ≤ 0.05) between the averages of students' attitudes towards learning based on the metaverse due to gender variable.

3- There are no statistically significant differences at the level (α ≤ 0.05) between the averages of students' attitudes towards learning based on the metaverse due to the learning tool variable.

4- There are no statistically significant differences at the level (α ≤ 0.05) between the averages of students' attitudes towards learning based on the metaverse due to the learning style variable.

2.1. Variables of the Study

Independent variables: learning method based on metaverse, gender, learning tool, learning style

Dependent variables: students' attitudes towards learning based on the metaverse.

2.3. Aims and Objectives:

1- Identifying the students' attitudes toward learning based on the metaverse.

2- Identifying the nature of the differences in the attitudes of students towards learning based on metaverse according to the variables: (gender, learning tool, and learning style).

3. MATERIEL AND METHODS

Study methodology:

 Quasi-experimental method, one group post-test design was used. The aim of using this approach is to identify (students' attitudes toward learning based on the metaverse).

Materials:

Lessons were prepared through the metaverse platform, which included some of the human body systems such as (the digestive system, circulatory system, and nervous system). This was over a semester, and after the students were exposed to the experience of watching lessons through the three-dimensional metaverse environment, questionnaires were distributed to identify their attitudes toward learning based on the metaverse.

The study population:

 consisted of (300) male and female Mutah University information technology students for the academic year 2021/2022.

The study's sample :

(100) male and female students from Mu'tah University's Faculty of Information Technology were chosen at random. Table 1 shows the demographic sample's characteristics:

Table 1: The demographic sample's characteristics

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Variable	variable levels	Number	Percentage
Gender	Male	45	45%
	Female	55	55%
	Total	100	100%
Preferred tool	Laptop	30	30%
	Mobile	54	54%
	iPad or Tablet	12	12%
	Total	100	100%
Learning Style	Visual	32	32%
	Audio	3	3%
	Kinesthetic	4	4%
	All	61	61%
	Total	100	100%

3.1. Study tool

Previous studies such as Huang, Rauch, & Liaw, (2010), and El-Gamal, (2022) studies were used to develop a questionnaire tool to measure the students' attitudes toward learning based on the metaverse. Validity of the tool: The apparent validity of the questionnaire was verified by presenting it to a group of arbitrators working in the field of educational technology, psychology, administration, curricula, and computers with specialization and experience. The percentage of agreement was high, and some phrases were amended and approved in their final form, bringing the number of phrases to 25.

To ensure the stability of the scale, the questionnaire was applied to an exploratory sample of the study population consisting of 40 students. The questionnaire was applied twice, between them a time interval. The stability was calculated using the Cronbach alpha coefficient method, as shown in table 2:3.

Table 2: Stability of the tool

Reliability Statistics	
Cronbach's Alpha	N Items
0.947	25

The data contained in the table indicate that the stability coefficient has a high degree, reaching 0.947, and this indicates that the tool is valid for application and achieving the objectives of the study.

3.2 Correction tools:

The response scores were distributed on the scale statements using the five-point scale Likert method, where the respondent gets (5) degrees when he answers strongly agree,(4)when he answers agree,(3) when he answers neutral, (2) when he answers disagree and (1) when he answers strongly disagree. noting that all the statements are positive and have been completed to find out the degree of agreement with students' attitudes towards learning based on metaverse. The five-point scale categories were calculated as follows; Scale range = upper limit of the scale – the lower limit of the scale,......5-1=4 Category length = scale range / number of categories = 4/3 = 1.33 The category length was added to the minimum for each category to obtain the arithmetic average categories as shown in table (3).

Table (3) The correction

Arithmetic mean classes	Percentage	Degree of agreement
1- 2.33	20- 46.6%	Low
2.34- 3.67	46.7- 73.4-%	Medium
3.68-5	73.5-100%	High

4. LITERATURE REVIEW

The literature on science education provides many studies that show the importance of providing students with a kind of technique when performing tasks that require thinking skills. Several studies proved that the students who used applications to understand some basic concepts in a science field outperformed traditional learning compared with their peers who have not seen or used these applications. (Kamarainen, & et al., 2018)

Oddone (2019) pointed out that students benefit from developing interactive images and overlays more than from using accessible images. Tools such as Metaverse Augment Reality can be used for this purpose. Metaverse Studio is easy to use and has a simple storyboard function for designing changes. Users can either build a new engagement from scratch or discard an existing public experience. These tools can help in exploring any topic and are relevant for teaching, especially in the fields of science, history, and geography.

The study subjects were offered the choice to build mobile AR experiences using the Metaverse AR tools. They were requested to reply to a survey aimed to record their attitudes toward its educational caliber. The collected data revealed that the dynamic nature of AR tools generates new ideas about how they can be applied in education; however, enacting these new ideas necessitates a level of expertise that entry-level teachers seem to lack.

Aqel & Azzam,(2017) demonstrated the effectiveness of employing AR in developing students' motivation and raising their educational achievement in chemistry topics. They used the (Element 4D) program and indicated the need to employ technology in the educational process to suit the Palestinian curriculum.

SMART (System for Teaching) is an interactive AR system that is developed to teach 2nd graders a variety of means of transportation and animal species. The devices used in this investigation were an AR marker, a laptop, software, a web camera, and a projector. They performed the study in collaboration with 54 children (ages 7-8) from three local primary schools to meet the purpose of the study. Participants were separated into two groups for each school. The first group served as a control group, employing a standard teaching and learning strategy. The SMART system was utilized as a learning aid by the second group. The outcome demonstrates a beneficial influence on students' motivation, learning capacity, and cooperation(Bistaman, Idrus & Abd Rashid, 2018).

Another reference is Gopalan, Zulkifli, Mohamed Abu Bakar & Saidin. (2016). Their study describes an augmented science textbook that uses (e-STAR) to help students understand science. The e-STAR program is designed to pique students' interest in science. This paper also argues the appraisal of e-STAR among a sample of form two secondary school pupils. Questionnaires were used to obtain quantitative data for analyzing the following dimensions: motivation, ease of use, engagement, pleasure, and fun. The findings show that all of the measurements were agreed upon by the users. The data demonstrated that the e-STAR program might be one of the viable solutions to the problems above.

According to Gopalan, Zulkifli & Bakar (2016), The purpose of this study is to examine an enhanced science textbook utilized to improve the scientific learning process of middle school learners. A total of 70 middle school students participated in the study. Pearson Correlation and Regression analyses were performed to assess the impact of ease of use, engagement, amusement, and entertainment and their impact on the students' desire to utilize the science textbook for science learning. The findings give empirical support for a positive and statistically significant association between students' motivation for scientific learning, engagement, amusement, and entertainment. However, simplicity of use has no positive and substantial association with students' enthusiasm to learn science.

MacCallum & Parsons (2019) present a novel study that involved both experienced and inexperienced teachers and explored their approach to using AR in their practice. Participants had the opportunity to experience using the Metaverse AR mobile tools and were asked to express their opinions on the tool's pedagogical capabilities in a questionnaire. Their answers showed that the dynamic nature of AR technologies generates new ideas on how to use them in the classroom. Even experienced teachers tended to focus on the material rather than the benefits of the AR tools for learning. If teachers of all levels of experience are to take full advantage of the pedagogical possibilities of AR when using these tools, appropriate professional development must be provided.

5. RESULTS /FINDINGS

Results of the first question: "What are the students' attitudes towards learning based on the metaverse?" To answer the first question, the arithmetic means and standard deviations of the student's attitudes toward learning based on the metaverse were calculated, as shown in Table (4).

Table 4: Arithmetic means and standard deviations of the student's attitudes towards learning based on the metaverse, arranged in descending order.

Items	Mean	Std. Deviation	Variance	order	degree of agreement
23. I intend to use the metaverse AR learning environment in the future	4.00	.876	.768	1	High
1. I can easily translate and move 3D objects using the metaverse AR learning environment.	3.96	.994	.988	2	High
25. I believe the metaverse AR learning environment is a valuable learning tool	3.96	1.044	1.089	3	High
9. I believe that using the metaverse AR learning environment has improved my comprehension of the relative placements of objects.	3.93	.935	.874	4	High
14. I believe that the 3D virtual environment helps me focus better when I'm learning	3.93	.956	.914	5	High
2. I can effortlessly rotate 3D items using the metaverse AR learning environment	3.92	.961	.923	6	High
17. The collaborative learning system has made it possible for me to communicate with my team members.	3.88	.844	.713	7	High
24. I wish that other classes would use a 3D collaborative virtual system to help me learn.	3.86	.985	.970	8	High
4. Using the metaverse AR learning environment, I can quickly view 3D objects from different perspectives.	3.84	1.042	1.085	9	High
7. I believe that using the metaverse AR learning environment makes it easier to understand anatomical structures.	3.82	1.067	1.139	10	High
10. Utilizing the metaverse environment. has helped me better understand how each organ's shape works.	3.82	.947	.897	11	High
11. It's easy to use the collaborative	3.79	.977	.955	12	High

learning tool to help you recall the relative locations of the organs					
6. The metaverse AR learning environment allows team members to communicate with one another	3.78	.949	.901	13	High
13. I feel the 3D virtual world offered by metaverse augmented reality learning is immersive	3.78	.927	.860	14	High
12. I feel the metaverse AR learning's 3D simulated world is realistic	3.77	.941	.886	15	High
19. Learning in a collaborative learning environment is advantageous.	3.74	1.016	1.033	16	High
8. I believe that using the metaverse AR learning environment has improved my comprehension of the shapes and orientations of objects.	3.75	.989	.977	17	High
21. Using metaverse AR learning, I can interact with my classmates more frequently.	3.71	.967	.935	18	High
22. I believe that the metaverse AR learning environment can strengthen my learning intentions.	3.67	1.113	1.238	19	Medium
16. Whenever I need it, I can get assistance or solutions right away	3.67	.937	.879	20	Medium
15. I might immediately make inquiries if problems arise.	3.66	.909	.826	21	Medium
18. I can collaborate with teammates to complete organ assembly tasks	3.65	.877	.769	22	Medium
20. I am working with team members to solve problems.	3.63	1.025	1.052	23	Medium
3. I can simply change the size of 3D objects using the Metaverse AR learning environment.	3.62	.925	.856	24	Medium
5. The metaverse learning environment makes it simple to communicate with other team members	3.61	.993	.985	25	Medium
Total Marks	3.80				High

It is clear from Table (4) that the students' attitudes toward learning based on metaverse were significant as the arithmetic average of the total score was (3.8), and the arithmetic averages ranged between (3.61-4). Table (4) shows that the item (I intend to use the metaverse AR learning environment in the future) with an arithmetic mean of (4) and a standard deviation of (0.876), and the item (I can easily translate and move 3D objects using the metaverse AR learning environment.), with arithmetic, mean of (3.96) and standard deviation of (0.944) and the item (I believe the metaverse AR learning environment is a valuable learning tool) with an arithmetic mean of (3.96) and standard deviation of (1.044) obtained the highest degree of agreement about the students' attitudes toward learning based on metaverse.

Whereas the item (The metaverse learning environment makes it simple to communicate with other team members) with an arithmetic mean of (3.61) and a standard deviation of (0.993) and the item (I can simply change the size of 3D objects using the Metaverse AR learning environment) with an arithmetic mean of (3.62) and a standard deviation of (0.925) obtained the lowest degree of agreement concerning the students' attitudes toward learning by metaverse.

Results of the second question: Do students' attitudes towards learning based on metaverse differ in the following

variables (gender, tool used, and learning style)? The following hypotheses emerged:

1- There are no statistically significant differences at the level (α ≤0.05) between the average students' attitudes towards learning on based metaverse due to gender.

To examine the first null hypothesis, the (Independent - Sample t-test) was used to find differences between the average students' attitudes toward learning based on the metaverse due to the gender variable as shown in table (5).

Table (5): Results of the independent -Sample t-test) to identify the differences between the averages students' attitudes towards learning based on metaverse due to the gender variable (n = 100)

gender	Number	Mean	Std. Deviation	t-test value	statistically significant
male	45	3.82	.630	0.45	0.66
female	55	3.77	0.49		

The results in Table (5) indicate that there are no statistically significant differences at the level of significance (α ≤0.05) between the average students' attitudes towards learning based on the metaverse due to the gender variable, where the calculated t-value for the total score was 0.45, which is smaller than the tabular t-value 1.96. At the level of significance (α ≤0.05), the value of statistical significance for the total score was 0.66, which is greater than 0.05 and is not statistically significant.

2-There are no statistically significant differences at the level (α ≤0.05) between the student's attitudes towards learning based on the metaverse due to the learning tool.

To examine the second null hypothesis, we find the means and standard deviation of students' attitudes toward learning based on the metaverse due to the learning tool variable.

Table (6): The numbers, arithmetic means, and the standard deviations of students' attitudes towards learning based on metaverse due to the learning tool variable.

Learning tool	# of Responses	Mean	Std. Deviation
laptop	30	3.96	0.496
mobile	54	3.64	0.695
iPad or tablet	16	4.01	0.579
Total	100	3.794	0.640

It is clear from Table (6) that there are apparent differences between the arithmetic averages of students' attitudes towards learning based on metaverse due to the learning tool. To verify the significance of the differences, the one-way ANOVA test was used as shown in Table (7).

Table (7): Results of one-way ANOVA test to identify the differences between the averages of students' attitudes towards learning based on the metaverse due to learning tool variable (n = 100).

one-way ANOVA test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.796	2	1.398	2.852	.031
Within Groups	37.756	96	.389		
Total	40.551	99			

It is clear from the data in Table (7) that there are statistically significant differences at the level of significance (α <=0.05) between the averages of students' attitudes towards learning based on metaverse due to the learning tool variable, as the statistical significance of the total score reached (.031), which is less than (0.031). With this result, the null hypothesis is rejected and the alternative is accepted.

3- There are no statistically significant differences at the level (α ≤0.05) between the averages of students' attitudes towards learning based on the metaverse due to the learning style variable.

To test the third null hypothesis, the arithmetic means and standard deviations of students' attitudes toward learning based on the metaverse were found due to the learning style variable, as shown in table (8).

Table (8): The numbers, arithmetic means, and the standard deviations of students' attitudes towards learning based on metaverse due to the learning style variable:

Learning style	# of responses	Mean	Std. Deviation
Visual	32	3.766	0.734
Auditory	3	3.563	.0.746
Kinesthetic	4	3.937	0.694
All of them	61	3.816	0.591
Total	100	3.797	0.640

It shows from Table (8) that there are clear differences between the arithmetic averages of students' attitudes towards learning based on metaverse due to the learning style. To verify the significance of the differences, the one-way ANOVA test was used as shown in Table (9).

Table (9): Results of one-way ANOVA test. To identify the differences between the averages of students' attitudes towards learning based on metaverse, due to the learning style variable (n = 100).

one-way ANOVA test					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.295	3	.098	.235	.872
Within Groups	40.256	96	.419		
Total	40.551	99			

It is clear from the mentioned data in Table (9) that there are no statistically significant differences at the level (α ≤0.05) between the averages of students' attitudes towards learning based on the metaverse due to the learning style variable. However, there is a statistical significance of the total score reached (.872), which is greater than

(0.05), With this result, the null hypothesis is accepted because students may need all their senses or one sense to interact with the learning environment based on the metaverse.

6. DISCUSSION

Discussion of the results regarding the first question: What are the attitudes of students toward learning based on the metaverse?

The results show that positive students' attitudes towards learning are based on the metaverse, indicating that learning is effective. The Metaverse promotes positive attitudes towards learning by providing them with new learning opportunities that are exciting, engaging, and interactive, suggesting that environments are enriching. The digital augmented learning environment requires students to have conceptual skills that enable them to see things in three dimensions, perceive them correctly, and interact with them, which helps to improve students' knowledge.

This finding was confirmed by a (Sirakaya & Cakmak, 2018) study, (Chiang, Sun, Lin &Lee,2017), and (Gun &Atasoy, 2017) study. All the mentioned studies indicated the importance of the metaverse environment to enhance the role of students and develop their skills. This indicates that virtual and augmented reality environments encourage students to learn in an atmosphere full of enthusiasm and participation.

Discussion of the results regarding the second question: Do students' attitudes towards learning based on metaverse differ in the following variables (gender, tool used, and learning style)?

The following hypotheses have emerged:

The first hypothesis: There are no statistically significant differences at the level (α ≤0.05) between the average students' attitudes towards learning based on metaverse due to gender. The results indicated that there were no statistically significant differences at the level of significance (α ≤0.05) between the averages of students' attitudes toward learning based on the metaverse due to the gender variable. which means that Females adopt and use learning based on metaverse equally with males; this pattern of learning does not differ according to the gender of the student, and this is also due to the conditions and resources provided to all students males and females.

The second hypothesis: There are no statistically significant differences at the level (α ≤0.05) between the student's attitudes towards learning based on the metaverse due to the learning tool.

The results indicated that there were statistically significant differences at the level of significance (α ≤0.05) between the averages of students' attitudes towards learning based on metaverse due to the learning tool, and this is due to the advantage of the mobile tool. The majority of students prefer to watch the educational content of metaverse through their phones. They can control, interact and exchange information faster using their phones.

The third null hypothesis: There are no statistically significant differences at the level (α ≤0.05) between the averages of students' attitudes towards learning based on the metaverse due to the learning style variable.

The findings revealed that there were no statistically significant differences at the level (α ≤=0.05) between the metaverse-based averages of students' attitudes toward learning and the learning style variable.

The result is attributed to the student's ability to use the appropriate and most effective sense through metaverse-based learning. Some lessons necessitate the use of a kinetic learning style, while others may require the use of a visual learning style. All learning styles and senses may be required during Metaverse-based learning.

CONCLUSIONS

The Metaverse platform encourages positive attitudes toward learning by offering new learning opportunities that are exciting, engaging, and interactive, implying that environments are enriching. Students must have conceptual skills that allow them to see things in three dimensions, perceive them correctly, and interact with them to improve their knowledge in the digital augmented learning environment.

RECOMMENDATIONS

1. teachers are encouraged to use the MAR platform in the classroom to imprint a satisfactory impact on student attitudes.

2. Teachers should consider all students' learning preferences and avoid a particular learning style in favor of using all of the senses and their interactions to create rich and useful learning experiences.

3. All students have access to available tools, especially mobile phones; they prefer them because of their accessibility, flexibility, and portability.

4. Conduct more training courses of all kinds to serve the education and provide the appropriate infrastructure and materials needed to create virtual environments.

5. More research and studies are needed on the use of virtual environments and their various types for application in education.

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