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The Impact of a Metaverse Environment on Technological Concept Development among Depressed Students

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ABSTRACT

This study aimed to explore the impact of a Meta verse-based learning on the development of technological concepts among university students diagnosed with depression, as measured by Beck's Depression Inventory-II (BDI-II). The research involved 22 students (11 male, 11 female) from the College of Education at Al-Baha University, using a quasi-experimental approach single group design. Depression levels were assessed with BDI-II, and an achievement test administered to measure students' understanding of technological concepts. The findings highlighted the importance of selecting e-learning tools that aligned with students' psychological conditions to ensure effective participation in learning. The study showed that meta verse applications (VR, AR, MR) significantly improved academic achievement in technological concepts for the study sample. These applications provided a rich sensory experience, enhancing deep understanding through active, hands-on learning. Social interaction within virtual environments helped reduce isolation and enhanced social skills. The supportive learning environment, along with self-directed learning, increased students' autonomy and motivation. Previous studies supported these findings, showing positive outcomes for students who used meta verse technology, boosting academic engagement and participation. By simulating real-life scenarios, these applications helped students overcome mental distractions, leading to improved cognitive and academic performance.

KEYWORDS
Digital learning, mental health, cognitive development, student engagement, immersive learning, academic performance

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1. Introduction

Depression has become a widespread mental health issue among university students, significantly affecting their academic performance. It impairs concentration, motivation, and critical thinking, which hinders effective learning and decreases academic achievement (Zhang and Wang, 2022). Students dealing with depression often experience fatigue and isolation, making it harder for them to engage with the curriculum and participate in academic activities (Burnett and McMahon, 2021).

Technology has emerged as a valuable tool in education, offering innovative ways to support students and improve their learning experiences. Virtual learning environments, such as the meta verse, have proven to be particularly effective. The meta verse, a 3D virtual space, allows students to interact with educational content in a dynamic and immersive manner, increasing their interest and motivation to learn. These environments also provide personalized learning experiences, promoting social interaction and offering a safe space for students to express themselves (Johnson and Simpson, 2023). The Meta verse helps students with depression by providing an engaging way to learn and interact with content which can alleviate feelings of isolation and boost academic performance. Research shows that these virtual spaces can also enhance students' technological skills, including virtual reality, programming, digital collaboration, and electronic project management (Liu and Yang, 2023). This approach to learning helps students develop both academically and psychologically, offering them the support they need to thrive. The integration of the Meta verse in education represents a significant advancement in addressing mental health challenges while improving student engagement and performance.

2. Study Problem

The problem of the study was a noticeable decline in academic performance among some students during the teaching of technological concepts. Students suffering from mental health challenges faces particular difficulties in understanding and grasping complex technological concepts. Additionally, the decline in motivation and participation among these students led to poor academic achievement. Mental health challenges, as one of the influencing psychological factors, were identified as the main source of this decline, as they hindered students' ability to engage effectively with the educational content.

On the other hand, the research gap lies in the need to study the impact of virtual learning environments, such as the Meta verse, on students who face psychological challenges, such as depression. Although studies have addressed the use of certain virtual learning environment applications to improve academic achievement in general, there is a lack of research focusing on how these applications affect the enhancement of academic understanding of technological concepts among students with psychological conditions. Therefore, the current research bridges this gap by exploring the impact of virtual learning environments (Meta verse) on the development of technological concepts for these students and enhancing their academic engagement. These students displayed shortened attention spans, poor academic achievement, lack of participation, delayed or improperly submitted assignments, and a need for improved focus to enhance their academic success.

Previous research, such as those by (Pollak *et al.*, 2024 and Nurbekova *et al.*, 2022) highlighted the effectiveness of online learning environments in improving attention using audio, visual, and interactive stimuli, engaging multiple senses to increase cognitive engagement and social interaction. Other studies, including those by (Yang *et al.*, 2020 and Salim 2022) found that depression negatively impacts students' motivation, personalities, and academic performance by diminishing their ability to engage socially and perform daily activities.

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The sub-problems related to the current research problem can be summarized in several key aspects. First, students may experience difficulties in social interaction within the Meta verse environment due to the feelings of isolation often caused by depression. Second, a knowledge gap in technological skills may hinder their ability to effectively interact with the Meta verse. Third, the impact of using the Meta verse on intrinsic motivation for learning may be limited in students suffering from depression. Additionally, an over-reliance on technology could exacerbate digital isolation if its use is not effectively managed. Finally, the Meta verse environment may present challenges related to accessibility and effective interaction if the curriculum is not adequately aligned or if necessary technological resources are unavailable.

To explore this issue, the current study utilized the Beck Depression Inventory-II (BDI-II) with 83 university students to identify potential psychological symptoms affecting learning. Of the participants, 22 scored between 11-20 points, indicating mild depression, which correlated with poor academic performance, weak attention, and low interest in learning.

The study hypothesizes that the use of e-learning applications, such as Meta verse platforms, could positively influence the academic achievement of students with depression in learning technological concepts. Thus, the central question of the study is:

What is the potential of using Meta verse applications (virtual reality, augmented reality, mixed reality) to enhance the academic achievement of technological concepts among university students with mild depression?

3. Study Objectives

The general objective of the study explores the impact of using Meta verse applications on the academic achievement of technological concepts among students with depression by assessing the effectiveness of these applications in enhancing cognitive understanding and mitigating psychological factors affecting learning, such as depression. Additionally, the study seeks to examine the sustainability of this impact over time.

Based on the research hypotheses, this study is based on the following specific objectives:

- Assess the impact of Meta verse applications on depression levels among university students by:
  - Measuring depression levels before and after the intervention using the Beck Depression Inventory**.**
  - Identifying whether there are significant reductions in depression symptoms after exposure to Meta verse-based learning.
  - Exploring the potential role of immersive technologies in enhancing students' emotional well-being and engagement.
- Investigate the effect of Meta verse applications on students' comprehension of technological concepts by:
  - Comparing students' performance in the technological concepts test before and after the intervention.
  - Examining the extent to which virtual, augmented, and mixed reality applications enhance cognitive understanding.
  - Identifying which specific Meta verse features (e.g., interactivity, immersion, collaboration) contribute most to knowledge acquisition.
- Examine the long-term retention of technological concepts learned through Meta verse applications by:
  - Comparing students' scores in the post-test and follow-up test to determine whether the acquired knowledge is retained over time.
  - Assessing whether Meta verse-based learning provides a more sustainable impact compared to traditional learning methods.
  - Investigating potential factors that influence knowledge retention, such as the frequency of engagement with Meta verse applications.
- Evaluate the overall effectiveness of Meta verse applications in enhancing students' academic performance and motivation by:
  - Exploring students' attitudes, motivation, and engagement levels in Meta verse-enhanced learning environments.
  - Analyzing qualitative and quantitative feedback from students regarding their experiences with Meta verse applications.
  - Identifying potential challenges and limitations in implementing Meta verse technologies in education.

4. Study Hypotheses

- There are statistically significant differences at the 0.05 level between the pre-test and post-test scores in depression levels as measured by the Beck scale, favoring the post-test.
- There are statistically significant differences at the 0.05 level between the pre-test and post-test scores of the experimental group in the technological concepts test, favoring the post-test.
- There are no statistically significant differences at the 0.05 level between the post-test and follow-up test scores of the experimental group in the technological concepts test.

5. Study Significance

The study significant examines the influence of a Meta verse-based learning environment on the development of technological concepts among students experiencing depression. With the growing integration of virtual reality and immersive technologies in education, understanding their impact on students' cognitive and emotional engagement is crucial.

5.1. The Theoretical Importance:

The current study can illustrate how Meta verse applications (virtual reality, augmented reality, mixed reality) can address depression-related challenges that impact academic performance. It also explores how these applications can enhance academic achievement and performance, including focus, social interaction, and time management. This may contribute to improving the quality of life for students academically and psychologically while introducing potentially more effective tools for managing depression compared to traditional methods.

5.2. The Practical Importance:

This study highlights the potential for further research on virtual learning methods for students with depression and can be used to guide the development of tailored educational programs and virtual assessment tools. Additionally, the findings could encourage educational institutions to adopt virtual platforms, fostering student engagement and addressing the challenges faced by those with psychological disorders like depression.

5.3. Limitations of the Study:

Objective Limitations: This study examines the impact of Meta verse applications on the academic achievement of technological concepts among students with depression.

Human Limitations: The study was conducted on a sample of 22 students (11 males and 11 females) in the first level of education.

Spatial Limitations: The research took place at the College of Education, Al-Baha University.

Temporal Limitations: The study was conducted during the first semester of the academic year 1445 AH.

6. Study Terminology

This section defines key terms to ensure clarity and consistency throughout the study.

6.1. Meta verse Applications:

Defined by Almeman *et al.* (2025) as a shared virtual environment that enables users to interact with one another and with 3D content using various technologies such as virtual reality, augmented reality, and mixed reality. Meta verse applications are used in multiple fields, including education, gaming, entertainment, and social interaction.

The researcher defines the Meta verse in this study as an interactive virtual learning environment that utilizes virtual reality (VR), augmented reality (AR), and mixed reality (MR) technologies to present educational content on technological concepts in a dynamic way. This environment provides sensory and visual experiences that allow students to interact with the educational material in a 3D setting. It aims to enhance academic understanding of technological concepts, fostering social interaction among students, especially those suffering from depression, and helping reduce isolation while improving their academic participation.

6.2. Virtual Reality:

Defined by Salama (2024) as a technology that allows users to interact with a simulated 3D environment using devices like specialized glasses. It enables users to engage with a fully virtual environment, isolated from the physical world, creating a sense of being in another place.

According to the current study, virtual reality (VR) is defined as an interactive learning environment that uses 3D simulation technologies to enable students to engage with technological concepts within a simulated environment. This experience is activated through devices such as VR headsets and controllers, allowing students to interact with educational content in dynamic and direct ways. It can also enhance understanding of technological concepts through an immersive sensory and visual experience, contributing to the improvement of academic achievement for students with depression through active learning and social interaction within the Meta verse environment.

6.3. Augmented Reality:

Defined by Koumpouros (2024) as the integration of digital elements (such as images or information) with the physical reality, enabling users to view added information via their device screen, like mobile phones or smart glasses, without separating them from their actual surroundings. It aims to enhance users' sensory experiences.

The researcher defined augmented reality (AR) as a technology that integrates digital information with the real-world environment, allowing students to interact with technological concepts in an innovative and realistic way, through the use of smartphones, tablets, or AR-specific glasses to present digital educational content overlaid onto the real world. The aim is to assist students, especially those dealing with depression, in improving their understanding of technological concepts through interactive experiences that contribute to enhancing social interaction and academic activity within the Meta verse environment.

6.4. Mixed Reality:

Defined by Al-Nawaisehe *et al.* (2023) as a blend of virtual reality and augmented reality, integrating real-world environments and objects with interactive digital elements in real-time. It allows users to simultaneously interact with the digital and physical worlds.

In this study, mixed reality (MR) is defined as a technology that combines elements of virtual reality (VR) and augmented reality (AR) to create an environment aimed at improving students' technological understanding by providing an immersive learning environment that integrates sensory and interactive experiences with real-world experiences, enhancing social interaction and academic activity within the Meta verse environment.

6.5. Academic Achievement:

According to Steinmayretal (2014) academic achievement refers to the measurable outcomes of a learner's efforts in educational settings, reflecting how well they have met established learning objectives in schools, colleges, or universities. Educational systems often set cognitive goals that span various disciplines such as critical thinking or that focus on mastery within specific fields like literacy, numeracy, science, or history. As such, academic achievement is best understood as a complex and multidimensional concept encompassing diverse areas of learning.

The researcher defined academic achievement as a measure of a student's success in the educational process, reflecting the level of knowledge and skills acquired during the study period, usually assessed through grades or scores in exams and educational activities.

6.6. Technological Concepts:

Defined by El-Sabagh (2021) as the fundamental ideas and concepts related to technology, including understanding devices, software, applications, and networks, as well as their use in various fields of life. It also involves understanding technological innovations and developing related skills.

Operationally, it refers to concepts linked to technology that university students must know, such as smart boards, holograms, and digital resources.

6.7. Students with Depression:

The study focused on students aged between 18-22 years who experienced disorders due to persistent feelings of sadness and frustration, affecting their academic performance, concentration, and ability to interact socially.

Operational definition of the concepts students with depression, the operational definition does not differ from the referential definition for students with depression, as they are students who suffer from chronic mood disorders that affect their academic and emotional performance.

7. Theoretical Framework and Previous Studies

The current study addressed the theoretical framework and previous studies of the current research through two main axes: Theoretical Framework and Previous Studies.

7.1. Theoretical Framework:

This included learning through Meta verse applications, depression and its impact on students' academic achievement, and educational theories that help understand how Meta verse applications influence students with early-stage depression.

Meta verse and its impact on educational achievement: Alhawary (2023) defines meta verse applications as shared 3D virtual worlds that integrate virtual reality (VR), augmented reality (AR), and mixed reality (MR) across various platforms, offering immersive and engaging educational experiences. Interactive learning applications, such as games, quizzes, and simulations, enhance student engagement by providing personalized content tailored to individual needs (Lozano *et al.*, 2023). These applications foster collaboration and increase social interaction (Holly *et al.*, 2025). Technologies like cloud computing, VR, AR, and MR improve accessibility, learning immersion, and interaction, enhancing academic achievement and supporting various learning styles in educational settings.

7.2. The Effect of Depression on Students' Academic Performance:

Depression is a complex psychological disorder marked by persistent sadness, loss of interest in activities, and difficulty concentrating, which significantly impacts academic performance (Salim, 2022; Bardan, 2023). It reduces focus, motivation, and participation, hindering students' ability to succeed in their studies. Contributing factors include genetic predisposition, stress, and changes in brain chemistry (Al-Sultani and Al-Aarji, 2024), leading to emotional and social challenges. Symptoms among students may include poor academic performance, mood swings, and social withdrawal (Nurbekova *et al.*, 2022). These symptoms hinder both academic and social success. Depression is common in young adults and can worsen if left untreated, especially when combined with chronic illnesses, potentially leading to severe consequences. Early recognition and intervention are essential to improving mental health and academic achievement. Depression can be influenced by genetic factors, chemical imbalances, and life stressors, with treatment being critical for long-term well-being (Ettman *et al.,* 2023).

7.3. The Impact of Meta verse Applications on Academic Achievement in Students with Depression:

According to Al-Muqbil (2024) Meta verse applications like VR, AR, and MR enhance academic performance and improve the lives of students with depression by:

- Enhancing social skills through virtual interactions.
- Alleviating depression symptoms by offering safe spaces for real-life scenario practice.
- Encouraging emotional engagement, allowing students to process negative emotions in guided environments.
- Boosting academic achievement by providing interactive, immersive learning experiences that engage students indirectly through augmented and mixed reality technologies.

7.4. Key Theories Related to Meta verse Applications Include:

Social Learning Theory: This theory posits that learning occurs through observing and imitating others in a social environment. In virtual environments, students can observe social interactions, learning new behaviors and improving social skills, which can lead to increased academic achievement (Al Maghrabi and Wazani, 2024).

- Experiential Learning Theory: Learning through direct interaction with the environment is central to this theory. In Meta verse settings, students engage in safe, simulated social situations that allow them to practice social skills, reducing anxiety and isolation.
- Self-Directed Learning Theory: This theory suggests that learners take responsibility for their learning. Meta verse applications offer self-regulated environments where students set personal goals and engage in educational activities based on their needs, improving both social communication and academic performance.
- Self-Determination Theory: This theory focuses on intrinsic motivation. VR and AR technologies in the Meta verse motivate students to engage in activities that enhance both their psychological well-being and academic achievement.

8. Previous Studies

These previous studies were linked to the study variables represented in Meta verse applications (virtual reality, augmented reality, and mixed reality) and students suffering from depression.

8.1. Studies Related to Virtual Reality (VR) in Education:

Salama (2024) examined Thai students' attitudes towards VR in learning English as a foreign language. A survey of 101 students revealed positive perceptions regarding ease of use and perceived usefulness. The study emphasized the potential of VR in enhancing engagement and language learning outcomes.

Shankar *et al.* (2023) explored mobile VR learning, highlighting its potential in various disciplines. However, limitations such as educators' lack of IT skills and unappealing text-based content hinder its effectiveness. The study proposed a framework consisting of three modules: knowledge dissemination, learning preparation, and knowledge assessment. The effectiveness of the system prototype will be evaluated through case studies.

Marks and Thomas (2022) assessed a purpose-designed VR laboratory at The University of Sydney. Over 2.5 years, the lab facilitated 7,952 student visits, with engineering students being the primary users. Survey results indicated that 71.5% of students experienced enhanced learning outcomes. The study concluded that investing in VR technology can be a cost-effective strategy for higher education institutions.

8.2. Studies Related to Augmented Reality (AR) in Education:

Helwa (2019) investigated the impact of mobile AR (MAR) applications on EFL descriptive writing skills. A mixed-methods study involving 35 student teachers showed significant improvements in writing skills and motivation. The study highlighted the potential of MAR applications in fostering engaging and effective language learning experiences.

Abu Ziden *et al.* (2022) analyzed AR's effectiveness in enhancing academic achievement in high school chemistry. The study used a quasi-experimental design, finding significant improvements in students' cognitive achievement and practical skills. The study concluded that AR technology effectively enhances learning outcomes and recommended further integration in educational settings.

Amores-Valencia *et al.* (2023) examined AR's impact on fifth-grade students' academic achievement. Using an experimental design, the study found that students exposed to AR-based instruction significantly outperformed those taught using traditional methods. The study recommended integrating AR into education to enhance student engagement and comprehension.

Al-Anazi and Khalaf (2023) studied teachers' use and attitudes toward AR in the Al-Jouf region. While teachers' use of AR was low (M=2.56), their attitudes were positive (M=3.63). Challenges included inadequate school infrastructure and lack of training. The study recommended awareness programs and training initiatives to improve AR integration in teaching.

Canbaz and Yalçın (2024) investigated the use of AR in teaching mathematics in Al-Qunfudhah Governorate. Using a descriptive survey with 78 mathematics teachers, findings indicated moderate use of AR (M = 1.75) and significant obstacles (M = 2.75), primarily due to a lack of training and technical support. The study recommended specialized AR training courses for teachers.

Koumpouro (2024) explored AR's effect on ninth-grade students' understanding of scientific concepts. An experimental study found that AR significantly improved conceptual understanding. The study recommended teacher training programs to integrate AR into science education to enhance engagement and comprehension.

8.3. Studies Related to Mixed Reality (MR) in Education:

Tang *et al.* (2020) investigated MR's effectiveness in teaching design subjects. The study assessed students' creativity and systematic approaches using pretests and posttests. Results showed significant improvements in geometric analysis (mean difference = 4.36, $p <$

0.01) and creativity (mean difference = 1.59, $p < 0.05$). The study concluded that MR is more effective than traditional teaching materials in enhancing visualization skills.

Ahmed and Lataifeh (2023) examined MR's benefits in education, emphasizing increased engagement, hands-free interaction, and support for underachievers. The study highlighted MR's potential in facilitating remote learning and complex training. The findings suggested that MR could transform education by making learning more interactive and accessible.

8.4. Studies related to Meta verse in Education:

Huertas-Abril *et al.* (2021) explored AR adoption in teacher training programs. Conducted with 87 trainee primary teachers, the study found that while AR is not widely used in university courses, it offers pedagogical benefits such as enhanced creativity and motivation. The study recommended structured training programs to ensure effective AR integration in teacher education.

Salloum *et al.* (2023) explored Meta verse adoption in academic institutions. Using a survey of 953 respondents, key factors influencing adoption included innovativeness, context awareness, and perceived enjoyment. The study emphasized the importance of creating an innovative academic environment and recommended awareness initiatives such as seminars and workshops to facilitate Meta verse integration in education.

Camilleri (2023) examined the Meta verse's advantages and challenges in education. While the Meta verse offers multi-sensory 3D learning experiences and fosters interaction, challenges include high infrastructure costs, data privacy concerns, and mental health risks. The study recommended cautious and informed integration to maximize benefits while addressing risks.

Al-Nawaiseh *et al.* (2023) measured the impact of the Meta verse on university students' reading comprehension skills. A quasi-experimental study with 72 students found significant improvements in the experimental group. Additionally, students reported positive attitudes and high satisfaction levels. The study concluded that the Meta verse enhances academic skills and student engagement.

Sharma *et al.* (2023) investigated collaborative learning strategies in Meta verse-based education. The study, involving educational technology students, found that all strategies improved communication skills and digital resource production. The simulated classroom strategy yielded the best outcomes. The study recommended further integration of collaborative strategies in Meta verse environments.

9. Study Methodology and Procedures

The Study Methodology and Procedures outline the research process. It includes the study's design (type, purpose, sample), data collection methods (e.g., surveys or interviews), and tools used. It details the step-by-step procedure, including a timeline, ethical considerations, and data analysis methods. Finally, it covers how data was managed, stored, and ensured for reliability and validity, providing a clear roadmap of the research process.

9.1. Study Methodology:

The nature of the study necessitated the use of the experimental method in using a quasi-experimental approach single group design. The study employed a one-group experimental design, which required dealing with two key variables: one independent and the other dependent. In this study, Meta verse applications (virtual reality, augmented reality, mixed reality) represent the independent variable, while academic achievement in technological concepts among a sample of university students with depression is the dependent variable.

9.2. Study Population:

Study population refers to the group of individuals selected to participate in a research study and from which data is collected. This population is defined by specific characteristics relevant to the research question, such as age, gender, health condition, or academic status, depending on the scope of the study. The study population is central to the research because the findings are meant to generalize to this group. Polit and Beck (2017) defined the study population as a subset of the target population, from which a sample is drawn, ensuring it is representative of the broader population being studied. The selection of an appropriate study population is crucial for the validity and applicability of research findings (Polit and Beck, 2017).

9.3. Study Sample:

The sample consisted of 22 male and female students from the College of Education at Al-Baha University, intentionally selected using the Beck Depression Inventory. The students' ages ranged from 18 to 20 years, with a mean age of 18.5 years and a standard deviation of 0.503. The sample included 11 males and 11 females. When selecting the students for the main sample, care was taken to include those with low scores on the Beck scale, i.e., those in the lowest quartile, while excluding the remaining students with high scores.

9.4. Study Tools:

The study tools included two instruments:

- Beck Depression Inventory-II (BDI-II)
- An achievement test on technological concepts (prepared by the researcher).

9.4.1. Beck depression inventory-II (BDI-II)

To select the study sample according to its objectives, which targets students with mild levels of depression, the current study used the Beck Depression Inventory-II (BDI-II) to measure the level of depression among students. The Beck Depression Inventory (BDI-II) consists of 21 questions, each with four options, scored on a scale from 0 to 3. The level of depression was measured by the total score obtained by the individual, with a maximum score of 63.

9.4.2. The achievement test

This test assesses the cognitive achievement of university students with depression in technological concepts, based on Bloom's cognitive levels. Test items are multiple-choice, with clear, concise, and scientifically accurate questions and options. The instructions ensure clarity and guide students in completing the test. The instructional hours (contact hours and credit hours) for each targeted concept were determined, as well as:

- The relative weight of the topics, as follows:

$$\text{Relative weight for topics} = \frac{\text{Number of hours per subject}}{\text{Number of hours for all subjects}} \text{ x100}$$

Accordingly, the teaching topics, their allocated hours, and their relative weight within the curriculum or instructional plan are outlined. The topics covered include Smart Board, Educational Websites and Platforms, Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR). Each topic is allocated 2 teaching hours, contributing equally to the overall instruction. The relative weight for each topic is 11.11%, and the total teaching hours sum up to 10 hours, making up 100% of the instructional content. This distribution suggests an equal emphasis on each of the five technological tools or methods in education.

- The relative weight of each goal:

The number of goals for each cognitive level was determined and the relative weight of each goal was calculated through the following equation:

$$\text{The Relative Weight of Objectives} = \frac{\text{Number of hours for the topic}}{\text{Number of hours for all topics}} \text{ X } 100$$

The distribution of vocabulary is categorized into three cognitive levels: "Remember," "Understand," and "Apply." Three words fall under Remember, four under Understand, and three under Apply, making a total of ten words. The assigned weight for each level is 30% for Remember, 40% for Understand, and 30% for Apply, collectively adding up to 100%.

- Validity of the test:

The current study used two methods to ensure the validity of the test:

- Face Validity (Judgment Validity):

The current study ensured the validity of the test by presenting its initial version to a group of university professors specializing in computer science and educational technology. They were asked to provide their opinions regarding:

- Linguistic accuracy.
- Scientific accuracy.
- Representation of test items to the content.
- Suggestions for additions or deletions.

The feedback and observations provided were taken into consideration, leading to modifications such as rephrasing some of the questions and their alternatives and performing linguistic refinements.

- Internal Consistency Validity:

Internal consistency validity of the test was determined by administering the test to a pilot sample of 10 students. Pearson's correlation coefficient was calculated between the score of each test item and the total score of the test it belongs to, using the SPSS statistical software. The following table illustrates the results:

Table 1. Correlation Coefficients between each question of the achievement test and the total score

Item	Internal Consistency Coefficient	Item	Internal Consistency Coefficient	Item	Internal Consistency Coefficient
1	0.665*	2	0.721*	3	0.590*
4	0.683*	5	0.571*	6	0.666*
7	0.570*	8	0.681*	9	0.459**
10	0.385*				
Consistency Ratio	0.804*				0.762*

*Significant at 0.05 level
**Significant at 0.01 level

The correlation coefficients between each question and the total score in the achievement test ranged from 0.762 to 0.804, indicating acceptable validity. This suggests that the test results can be trusted for generalization. Additionally, internal consistency validity was confirmed by calculating the Pearson correlation coefficient between each cognitive achievement test level and the total test score, ensuring the test's reliability and consistency.

Table 2. Pearson correlation coefficient between the score of each level of the test and the total score.

Level	Correlation Coefficient
Remember	0.652**
Understand	0.762**
Apply	0.978**
Significant at p < 0.05	

It is clear from Table (2) that the correlation coefficient between the score of each level of the cognitive achievement test and the total score of the test is statistically significant at a significance level of less than (0.05), indicating the consistency of the test levels and their suitability for application on the study sample.

- Test Correction Method:

The student receives one point for each item they answer correctly and zero points for each item they leave unanswered or answer incorrectly. Therefore, the total score for the test is equal to the number of items on the test. The final score for the achievement test was (10) points.

- Pilot Test Experiment:

A sample for the pilot test was selected from male and female students at the College of Education at Al-Baha University, with the total number being (10) students, which is outside the main study sample. The purpose of the pilot test was as follows:

To calculate the difficulty and ease coefficients for the test items. The ease coefficient for each item was calculated using the following equation:

$$\text{Difficulty Coefficient} = \frac{p}{p+k}$$

P = Number of correct answers.
K = Number of incorrect answers.

Table 3. The difficulty and ease coefficients for the items in the achievement test

Question	Ease Coefficient	Difficulty Coefficient	Question	Ease Coefficient	Difficulty Coefficient
1	0.6	0.4	2	0.6	0.4
3	0.55	0.45	4	0.35	0.65
5	0.65	0.35	6	0.55	0.45
7	0.55	0.45	8	0.45	0.55
9	0.6	0.4	10	0.45	0.55

The study calculated difficulty coefficients for test items, ranging from 0.35 to 0.65, indicating acceptable difficulty levels. It also calculated the discrimination coefficient to assess how well test items distinguish between high and low-performing students. The sample was divided into upper and lower groups to evaluate each item's effectiveness in differentiating student performance.

$$\text{Discrimination coefficient} = \frac{\text{The number of correct answers in the upper category} - \text{The number of correct answers in the lower category}}{\text{The number of one of the two groups}}$$

The result of the discrimination coefficient is often ranged between 0 - 1, and the closer the result is to one correct, the more distinctive the question is. The following table shows the results of the discrimination coefficient for cognitive achievement test questions.

Table 4. Discrimination coefficient for achievement test questions

question	Discrimination Coefficient	question	Discrimination Coefficient
1	0.80	2	0.80
3	0.90	4	0.90
5	0.70	6	0.80
7	0.90	8	0.70
9	0.80	10	0.80

It is clear from Table (4) that the values of the test's discrimination coefficient are statistically acceptable, as studies indicate that an acceptable discrimination coefficient ranges between 0.30 and 1.00. The values of the discrimination coefficient for the current test ranged from 0.70 to 0.90.

- Test Reliability:

The reliability of the test was assessed using Cronbach's Alpha formula. The reliability coefficient was found to be 0.818, indicating a high level of consistency. This suggests that the results obtained from administering the test to the main research sample are reliable. Determining the Test Duration: The time needed to complete the achievement test were calculated using the following formula:

$$\text{Appropriate test time} = \frac{\text{time of the fastest student to answer} - \text{time of the slowest student to answer}}{2}$$

From the previous formula, the test time was 20 minutes.

- Final version of the achievement test:

The final version of the achievement test consisted of 10 items, with one point assigned for each item, resulting in a total score of 10 points.

- Pre-test: To measure students' technological concepts knowledge and depression levels.

Implementing the Training Program in the Meta verse Environment (for 6-8 weeks): The first session begins with an introduction to the Meta verse environment and how to interact with it. This is followed by educational sessions held twice a week within virtual reality or augmented reality environments. Activities include exploring 3D models, completing group projects, and using virtual simulations to apply technological concepts. The current study provides psychological support through relaxation and meditation sessions within the virtual environment to help students reduce stress. It also evaluates students' satisfaction with the experience, gathers feedback, and analyzes the extent of their benefit from the Meta verse environment.

- Statistical methods for analyzing study results.

Statistical Methods Used in the Study The researcher employed various statistical methods to analyze the study data. These methods included: 1. Arithmetic mean and percentage. 2. Standard deviation. 3. Cronbach's alpha equation to measure reliability. 4. Pearson's correlation coefficient to assess the degree of correlation. 5. Paired-sample t-test. 6. Wilcoxon Signed-Rank Test. 7. One-way ANOVA test to determine differences between group means.

10. Instructional Design Model

Integrating the ADDIE Model with Meta verse Applications for Enhancing Technological Concepts among University Students with Depression The current study employs the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) to integrate Meta verse applications for enhancing technological concepts among university students with depression. This model was selected for its simplicity, flexibility, and logical structure, making it well-suited for the experiment. The study followed a structured process: Analysis Phase: Data on students' needs was gathered using psychological assessments, such as the Beck Depression Inventory (BDI-II), along with a pre-test to measure technological knowledge. This phase also involved defining educational objectives, including improving students' understanding, social interaction, and motivation. Design Phase: Plans for Meta verse applications were developed, focusing on creating interactive virtual environments and educational activities incorporating augmented reality for collaborative learning. Development Phase: The virtual environments were customized, educational resources are prepared, and the applications are tested with a small group of students to gather feedback for refinement. Implementation Phase: The educational experiment followed a structured timeline, ensuring that the Meta verse applications are both educationally and psychologically appropriate. The goal was to reduce isolation, enhance motivation, and ultimately improve academic performance among students experiencing depression. Evaluation Phase: The success of the experiment was measured through a post-test, assessing improvement in technological concepts. The results favored the post-test, showing significant enhancements in students' understanding due to active engagement with Meta verse applications. Additionally, the study observes increased social interaction, reduced isolation, and improved mental well-being, as the immersive learning environment provides a more stimulating and less stressful educational experience. This structured application of the ADDIE model demonstrates the potential of Meta verse-based learning in supporting both academic achievement and mental health among students with depression.

11. Study Results and their Interpretation

In this section, the researcher presents the results of the data collected and provides their interpretations as follows:

11.1. Result of the First Hypothesis:

The first hypothesis suggests that a significant difference exists at the 0.05 level between the experimental group's pre-test and post-test scores on technological concepts among university students, with the post-test scores being higher. To evaluate this hypothesis, a paired-sample t-test and Eta-square were used to analyze the data.

Table 5. Results of the t-test for correlated samples and the Eta square (n2) to identify the differences between the pre- and post-application scores of the experimental group for the cognitive achievement test and at all levels of the test.

Levels	Application	Number	Mean	Standard Deviation	Difference between Means	t-value	Significance Level	Eta Squared	Effect Size
Remembering	Pre-test	22	7.33	0.588	1.8833	4.988	0	0.571	High
	Post-test	22	15.6	0.982					
Understanding	Pre-test	22	7.75	0.074	4.6833	8.217	0	0.584	High
	Post-test	22	12.43	1.191					
Applying	Pre-test	22	5.2	1.906	9.1333	10.851	0	0.821	High
	Post-test	22	12.65	2.09					
Total Test	Pre-test	22	20.28	2.37	15.7	14.059	0	0.827	High
	Post-test	22	40.68	4.961					

Table (5) shows significant improvements in the experimental group's mean scores on the cognitive achievement test after using Meta verse applications. Pre-test scores were: remembering (7.33), understanding (7.75), and application (5.20), with an overall score of 20.28. Post-test scores improved to: remembering (15.60), understanding (12.43), and application (12.65), with an overall score of 40.68. Eta-squared values ranged from 0.571 to 0.827, confirming a large effect size and significant improvement in academic achievement. The Wilcoxon signed-rank test also supported these findings, reinforcing the positive impact of Meta verse applications on cognitive achievement.

11.2. Results of the Second Hypothesis:

To test the validity of the hypothesis, which states:"There are no statistically significant differences at the 0.05 level between the post-test and follow-up test mean ranks of the experimental group in the technological concepts test, favoring the post-test."

The Wilcoxon Signed-Rank Test was used to examine the significance of differences between the mean ranks of the experimental group's scores in the post-test and follow-up test of the technological concepts test.

Table 6. Results of the Wilcoxon test for determining the significance of differences between the mean ranks of the experimental group's scores in the post-test for the technological concepts test.

Test and Sub-Dimensions	Rank Direction	Count	Mean Rank	Rank Sum	Z Value	Statistical Significance
Dimension 1 (Smart Board)	Negative	4	6.5	26	-0.159	(0.873) Not Significant
	Positive	6	4.83	29		
	Equal	10				
Dimension 2 (Educational Platforms and Sites)	Negative	5	3.5	17.5	-0.632	(0.527) Not Significant
	Positive	2	5.25	10.5		
	Equal	13				
Dimension 3 (Virtual Reality VR)	Negative	4	4.5	18	-0.577	(0.564) Not Significant
	Positive	5	5.4	27		
	Equal	11				
Dimension 4 (Augmented Reality AR)	Negative	5	6	30	-0.277	(0.782) Not Significant
	Positive	5	5	25		
	Equal	10				
Dimension 5 (Mixed Reality MR)	Negative	5	7	35	-1.213	(0.225) Not Significant
	Positive	9	7.78	70		
	Equal	6				
Technological Concepts Test (Overall)	Negative	8	8.75	70	-0.69	(0.49) Not Significant
	Positive	10	10.1	101		
	Equal	2				

The previous table confirms the validity of the second hypothesis, as the calculated Z-values (-0.159, -0.632, -0.577, -0.277, -1.213, -0.69) for the overall score of the technological concepts test and its sub-dimensions were not statistically significant. This indicates the following:

- There are no statistically significant differences between the mean ranks of the experimental group's scores in the post-test and follow-up test across the sub-dimensions of the technological concepts test (Smart Board, Educational Platforms and Sites, Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), as the calculated Z-values (-0.159, -0.632, -0.577, -0.277, -1.213) were not statistically significant.
- There is no statistically significant difference between the post-test and follow-up test scores in the overall technological concepts test, as the Z-value (-0.69) was not statistically significant. This indicates the sustained effect of Meta verse applications in enhancing achievement, even after a period of one month from the post-test administration.

11.3. Interpretation of Study Results:

The study results showed that the use of Meta verse applications (virtual reality, augmented reality, mixed reality) significantly contributed to improving the academic achievement of technological concepts among students suffering from depression. This effect can be explained by the following factors:

Meta verse Applications Provide a Rich Sensory Experience: These applications allow students to explore concepts on their own, who enhances deep understanding rather than relying on rote memorization, in line with experiential learning theory, which suggests that learning is more effective when students actively interact with educational content.

Active Learning: Learning through Meta verse applications is consistent with the principle of active learning, where students build their knowledge through interaction with the virtual environment, rather than relying on traditional rote learning. According to Vygotsky's theory (1978), interacting with virtual elements and peers helps students gradually develop knowledge through social learning. This was evident in the improved academic achievement of students by practicing technological concepts.

Supportive Learning Environment: Meta verse applications provide a supportive environment where students receive assistance from teachers or virtual tools, thereby enhancing their cognitive development. This combination of active engagement, social interaction, and a supportive learning environment contributed significantly to improving the academic performance of students with depression.

Students Learn through Observation and Social Interaction: Meta verse environments provide opportunities for interaction with peers within a virtual space, which is in line with Bandura's (1986) theory of social learning. According to Bandura, learning occurs through behavior modelling, and students suffering from isolation and depression can improve their social skills by gradually interacting in a safe virtual environment before engaging in real-world social situations. The current study observed that students with depression became more comfortable interacting with their peers in the virtual environment, which enhanced their social skills and reduced feelings of isolation.

Meta verse Applications Support Self-Directed Learning: Students can choose their learning method, review information, and explore content in a way that suits them. This flexible in learning approach supports self-motivation and autonomy, which can contribute to academic improvement.

Freedom to Explore and Increased Control over Learning: The ability for students to take responsibility for their learning explains the noticeable improvement in academic achievement. Meta verse applications in this study allowed students to revisit experiences and engage with virtual content based on their individual needs, helping them improve their understanding without the pressures of traditional classroom settings.

Enhancing Learning: All previous studies, such as those by (Al-Nawaiseh *et al.*, 2023; Sharma *et al.,* 2023; Koumpouro, 2024), showed an improvement in academic learning when using Meta verse applications. These findings align with the current study, which found that Meta verse applications assist in enhancing academic achievement in technological concepts.

Positive Impact: Salama's (2024) study revealed that students had positive attitudes towards using virtual reality, which was confirmed by the current study, as students with depression found the Meta verse to be an encouraging and supportive learning environment.

Social Interaction and Collaborative Learning: The study by Sharma *et al.* (2023) the current study highlights the positive impact of Meta verse applications on students with depression, particularly in enhancing communication skills and academic achievement. Consistent with previous studies, such as (Sharma *et al.* 2023; Koumpouro 2024), the use of meta verse technology made learning more engaging, improved participation, and deepened understanding of technological concepts. These applications fostered self-directed learning, boosted cognitive independence, and helped reduce social isolation by simulating real-life scenarios. As a result, students gained confidence, overcame mental distractions, and were more motivated to learn, leading to overall improvements in their academic performance.

12. Study Recommendations

Based on the results of this study, the current study recommends the following:

- The importance of selecting appropriate e-learning applications based on the psychological conditions of students according to prior assessments, as the proper choice of these applications helps them psychologically engage in learning effectively.
- The necessity of conducting an initial assessment of students' psychological conditions to classify them according to their needs, and then choosing the suitable teaching method, whether through e-learning or traditional learning.
- Integrating e-learning applications into education helps students with psychological symptoms overcome some of the effects caused by these symptoms, such as depression.
- Suggesting frameworks for integrating these technologies effectively into university education.

13. Study Suggestions

- Benefit from the current study in conducting research on teaching methods using other technological innovations for students with depression to improve their educational level.
- Benefit from this study in conducting further research to measure the learning level of students suffering from depression through virtual learning platforms and its relationship to other variables such as perception, attention, and social belonging.
- Benefit from this study in conducting additional research on the impact of the duration of online learning and its effect on academic performance.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author.

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Biographie

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