An-Najah National University

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THE EFFECTIVENESS OF USING VIRTUAL REALITY IN VOCATIONAL EDUCATION

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This Thesis was Defended Successfully on 11/10/2023 and approved by

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Dedication

Thank Allah for this blessing.

I dedicate this work to my parents,

my brothers,

all my family,

and all my friends and colleagues.

Acknowledgements

I would like to start by expressing my gratitude to my mentor, Professor Allam Mousa, for his constant oversight and insightful feedback during the duration of this research project. He was really encouraging and a model of a hard work ethic.

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I'd like to thank my colleagues at Hebron Industrial Secondary School for their help during the study. They made a big difference in making the study and data collection go smoothly.

I'd like to thank everyone who helped me with this study.

Declaration

I, the undersigned, declare that I submitted the thesis entitled:

THE EFFECTIVENESS OF USING VIRTUAL REALITY IN VOCATIONAL EDUCATION

I declare that the work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

Student's Name: _____

Signature: _____

Date: _____

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THE EFFECTIVENESS OF USING VIRTUAL REALITY IN VOCATIONAL EDUCATION

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Abstract

This study aimed to find out the effect of using virtual reality in vocational education to raise the level of academic achievement for students, enhance their skills and motivation to learn, and also keep pace with technological development to plan for the future and manage resources properly for the eleventh-grade students of auto mechanics in Palestine. The researcher used quantitative and qualitative approaches in collecting and analyzing information, as the sample size was 50 students.

To ensure academic achievement, the researcher used the pre- and post-exam to compare traditional learning with learning through virtual reality; the results of academic achievement were positive, as the value of the post-exam paired sample correlations was 0.835, and the significance coefficient was 0.00, which indicate an improvement in the academic level of students.

Virtual reality has proven its efficiency in enhancing students' skills and raising their motivation to learn through several variables included in the study, namely: 1- EOU: ease of use; 2- USE: usefulness; 3- VRF: virtual reality features; 4- M: motivation; and 5- COB: cognitive benefits. A questionnaire was built based on these variables, and the results were analyzed using the Smart-PLS program. The results confirmed a positive effect of usefulness on motivation, a positive effect of ease of use and VR features on usefulness, and a strong positive effect of motivation on cognitive benefits. In contrast, ease of use and VR features did not positively affect motivation.

In light of these results, the researcher recommended the use of virtual reality in technical education because of its positive effects on raising the academic level of students, enhancing their skills, and increasing their motivation to learn, which reflects positively on their abilities and soft skills and facilitate their involvement in the labor market.

Keywords: Motivation; Technology; Virtual Reality; Vocational Education.

Chapter One
Introduction

1.1 Overview

With the great technological development that our world is witnessing and the trends towards a fourth industrial revolution, technology must be kept up with and adopted in all economic, educational, political, social, and other fields. One of the most important areas witnessing great development is the educational field, especially as the world moves towards distance education during the Corona pandemic (Singh et al., 2020).

The most important technology that is highlighted globally is virtual reality because of the many advantages it provides, especially in education. Virtual reality will be used in this study to study the impact of its application in education. In particular, vocational education in Palestine (Billett, 2011).

Virtual reality is a type of digital technology that provides a virtual environment for simulation through which to interact with objects, places, and some scenarios, allowing the user to learn subjectively and remember better (Shen et al., 2022),(Matsika & Zhou, 2021),(Lee & Wong, 2014) Virtual reality systems are classified into three systems, which are fully immersive virtual reality, non-immersive "desktop VR " virtual reality and semi-immersive virtual reality (Gandedkar et al., 2021),(Lee & Wong, 2014).

The use of virtual reality in training and learning began in 1989 (Pantelidis, 2009). And because in the era of information technology, educational tools must be updated and used; this includes virtual reality, which has been used in training and education (Ya & Xing, 2013).

Technical and vocational education and training TVET is to provide students with the foundational skills, knowledge, attitudes, and competencies necessary to pursue a career and to participate productively in society (Ministry of education, 2022). The importance of vocational and technical learning lies in the fact that it helps the student be hired faster, engage in the labor market, start their enterprise, and be a pioneer in their work. This contributes to economic development and benefits society (Hilal, 2012).

Secondary vocational education in Palestine has received attention from governments, society, and individuals because of its importance in developing professions in Palestine and providing the Palestinian market with qualified professionals. The number of vocational schools in the West Bank and Gaza Strip until 2019-2020 is 24 schools; the number of vocational units in schools is 39; and the number of students enrolled in vocational education in the vocational schools and vocational units until 2019-2020 is 6342 male and female students (Ministry of education, 2022).

1.2 Problem statement

Vocational education in Palestine faces many difficulties and obstacles as a result of the specificity of vocational education and the equipment and tools it requires on a regular basis, and this is what makes it expensive. This leads to a shortage of the necessary tools and equipment in education as a result of the weak capabilities in this sector, and this directly affects vocational education students and their skills (Ministry of Education, 2021).

The lack of equipment and materials is a problem that most vocational and technical specializations suffer from, as it affects the expected output of the student and his performance in the market after graduation. The teacher deals with this deficiency through videos or illustrations only; that is, without the presence of the objects or the equipment, this is not enough for students of vocational education, and they lose part of their self-confidence (Ministry of Education, 2021).

Virtual reality is an opportunity to connect teachers and learners in a new way through the experience and the acquisition of new cognitive skills; through this, a large part of the lack of equipment and tools is overcome due to the advantages that virtual reality provides to compensate for part of this deficiency. Among these benefits of virtual reality is that it uses visual, interactive forms like 3D and 360-degree images and videos. Also, when using VR, subtly take advantage of it because it makes students more engaged. After all, it's more like game-based learning and helps them improve their skills (Claudia et al., 2019). By doing this, work to give the market the skills it needs and to improve the student's productivity and tech skills.

1.3 Objectives

1. To investigate the relationship between virtual learning and the quality of student learning compared to traditional education in secondary vocational education in the West Bank.
2. To determine the motivation of secondary vocational school students when performing an activity using VR technologies.

1.4 Purpose of the study

The purpose of this study is to raise the educational level of vocational education students by increasing their practical achievement and increasing motivation for their ability to memorize and study, as well as to enhance the students' technological skills and abilities by learning about technology and using it to compensate for some of the shortcomings in traditional education. This allows students to keep up with the labor market and the new skills and technologies it needs; thus, students are ready to engage in the labor market.

1.5 Hypotheses

Hypotheses were identified based on the objectives of the study. Is there an impact of the use of virtual reality on vocational education students? This hypothesis stems from two directions that must be studied. First is the effect of virtual reality on students' cognitive benefits and motivation toward learning. This was done through hypotheses H1, H2, H3, H4, H5, and H6 as follows:

H1: There is no statistically significant effect at $P <= 0.05$ between the ease of use of virtual reality and the motivation.

H2: There is no statistically significant effect at $P <= 0.05$ between the ease of use of virtual reality and the usefulness.

H3: There is no statistically significant effect at $P <= 0.05$ between the usefulness of using virtual reality and the motivation.

H4: There is no statistically significant effect at $P <= 0.05$ between the features of virtual reality and the motivation.

H5: There is no statistically significant effect at $P <= 0.05$ between the features of virtual reality and the usefulness.

H6: There is no statistically significant effect at $P <= 0.05$ between the motivation of using virtual reality and the cognitive benefits.

Secondly, the effect of using virtual reality on academic achievement, through hypothesis H7, where its null hypothesis is:

H7: There is no statistically significant effect at $\alpha <= 0.05$ between the average scores of students in the traditional exam and the virtual reality exam for academic achievement.

Each hypothesis of (H1-H6) and H7 took a different direction with scientific research tools. It is explained in Chapter 3.

1.6 Research Approach

The study approached the quantitative approach and the qualitative approach with multiple methods. To begin with, to know the impact of virtual reality on academic achievement was done through a quantitative approach. The experimental method used a pre-exam and a post-exam and compared these results from a statistical point of view. The study of the effect of virtual reality on cognitive benefits was done through a quantitative and qualitative approach by conducting interviews with students and a post-questionnaire.

Chapter Two
Literature Review

Technology is always developing, and using it in all parts of life is becoming more and more important and necessary. For example, when the computer came out in 1945, it didn't have much to do with our lives. Now, it's an important and necessary part of our lives.

So, must not overlook virtual reality and its developments and keep an eye on how it can be used and how it can help in all fields.

2.1 Metaverse

It is a new technology term that has recently appeared to denote the three-dimensional virtual environment that allows individuals to participate in and interact with it, and it is intended to enhance the real world (Clemens, 2022),(F. Shi et al., 2023).

The term metaverse spread and expanded after Facebook announced in 2021, headed by Mark Zuckerberg, that it would change its name to Meta and the company's future view of the world of the metaverse and artificial intelligence in order to make social media more realistic and interactive. Also, there are many other companies that follow Meta's example, such as Nevada, Microsoft, Google, etc. (Deng & Matthes, 2023),(Vidal-Tomás, 2023)

The first appearance of the term metaverse was in 1992, when writer Neal Stephenson mentioned it in his novel Snow Crash and talked about practical imagination, and mentioned that the second life is a virtual life that contains symbolic and virtual images and that it is possible to communicate, buy, and sell in this life (De Felice et al., 2023),(Huynh-The et al., 2023).

This term comes from two syllables, meta and verse, where the former is a word of Greek origin that means after, and the latter is derived from the word universe. These connotations of the two syllables together are of great importance to the term metaverse, and this term means beyond the universe. Also, the universe means space and time, and this indicates the close connection of the metaverse with space and time and what it can cause in terms of transcending time and space (F. Shi et al., 2023),(Weking et al., 2023),(Goldberg & Schär, 2023).

This fits with the vision of the metaverse, which is to break the limits of time and space through immersion in the virtual environment and use this in all parts of life, not just video games (Yang, 2023).

Based on what was previously stated, the metaverse will enter into all the details of life, and from here, we will see how metaverses can be compatible with and intertwined with Maslow's Hierarchy of Needs. Maslow's Hierarchy of Needs consists of five elements that are important for human fulfillment in the following order: physiological, safety, love and belongingness, esteem, and self-actualization (F. Shi et al., 2023).

Beginning with the aspect of physiological need, for example, food, where it is possible through the metaverse to obtain the ingredients of any meal and learn the method of cooking with ease and mastery, it will also enable the metaverse in the future to have a spatial and temporal presence by transmitting the smell and taste of meals and ingredients (F. Shi et al., 2023).

Secondly, the aspect of safety needs, for example, transportation, where the metaverse provides safe travel through immersion in the virtual environment without the need for planes, trains, or any other means of transportation, as it saves time, effort, and money. It also provides visits to dangerous and remote places, such as the frozen poles (F. Shi et al., 2023)

Thirdly, the aspect of love and belongingness needs, for example, friendships, where the metaverse enables one to communicate with any person around the world within one environment as if they were together and also to establish any new relationships with any person from different countries and orientations (F. Shi et al., 2023),(Daneshfar & Jamshidi, 2023).

Fourth, esteem needs are an example of that social appreciation, where a person can get appreciation in the virtual environment as in the real environment, and also in the metaverse, there are virtual social environments in which a person can feel appreciation as in reality, and there is an important part of appreciation such as the person living the life of a king or an emperor by default, which gives him a sense of appreciation (F. Shi et al., 2023).

Finally, self-actualization needs can be met, for example, by practicing hobbies or finding similar people. This can be done through metaverse (F. Shi et al., 2023).

2.2 Extended reality

In this section, the essential terms, types, environments, histories, and applications of virtual reality will be clarified.

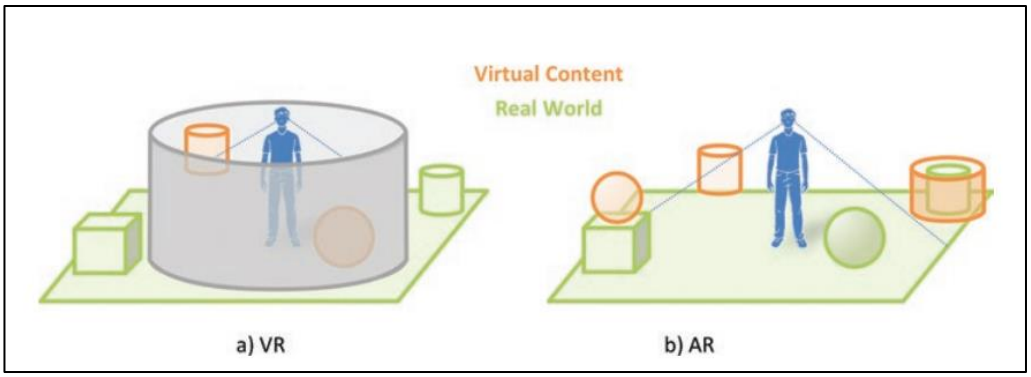
2.2.1 Virtual reality

It is an interactive simulation environment with a virtual world that doesn't exist. The user interacts with it as if it were real, and his senses are affected so that he becomes a part of the simulation (Doerner et al., 2022). The user is immersed in the virtual environment and cannot see what is going on around him in the real environment, as seen in Figure 2.1 a.

The display

Figure 2.1

Immersion in a virtual reality vs augmented reality environment



(a)Virtual reality shows the isolation of the surrounding environment from the user. (b)Augmented reality shows the user's interaction with the surrounding environment and the virtual environment at the same time.

Head-mounted displays are used to display virtual reality; these are glasses with screens in the lenses, and in immersive virtual reality, these screens prevent us from seeing the real world, as previously mentioned (see Figure 2.2 a).

2.2.2 Augmented reality

Unlike virtual reality, which immerses you in a virtual environment, augmented reality allows you to see the real world while also displaying virtual objects (see Figure 2.1 b) (Peddie, 2017).

The display

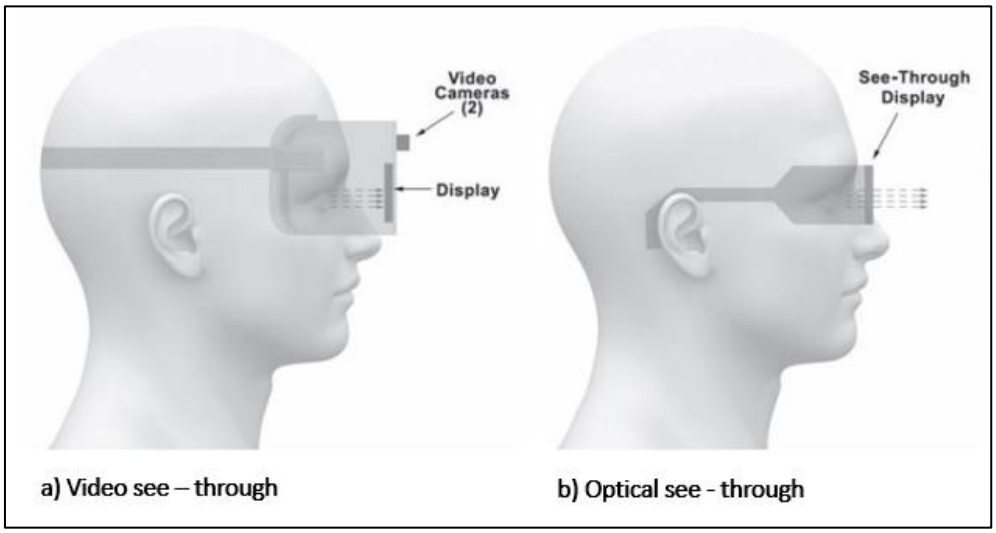
Augmented virtual reality is also shown on head-mounted displays, but the screens used are semi-transparent, so can see both the real world and the virtual environment at the same time see Figure 2.2.b.

VR technology allows for two-way communication with the virtual world. This is done through the virtual reality interface, and in addition to that, the main link between the virtual interface and the user is the user interface.

All these relationships between the user, the user interface, and the virtual reality interface, and the influencing elements between each, are shown throughout Figure 2.3 (Mihelj et al., 2014)

Figure 2.2

Display through virtual reality vs augmented reality glasses



(a)Virtual reality glasses showing a screen. (b)Augmented reality glasses showing a transparent screen

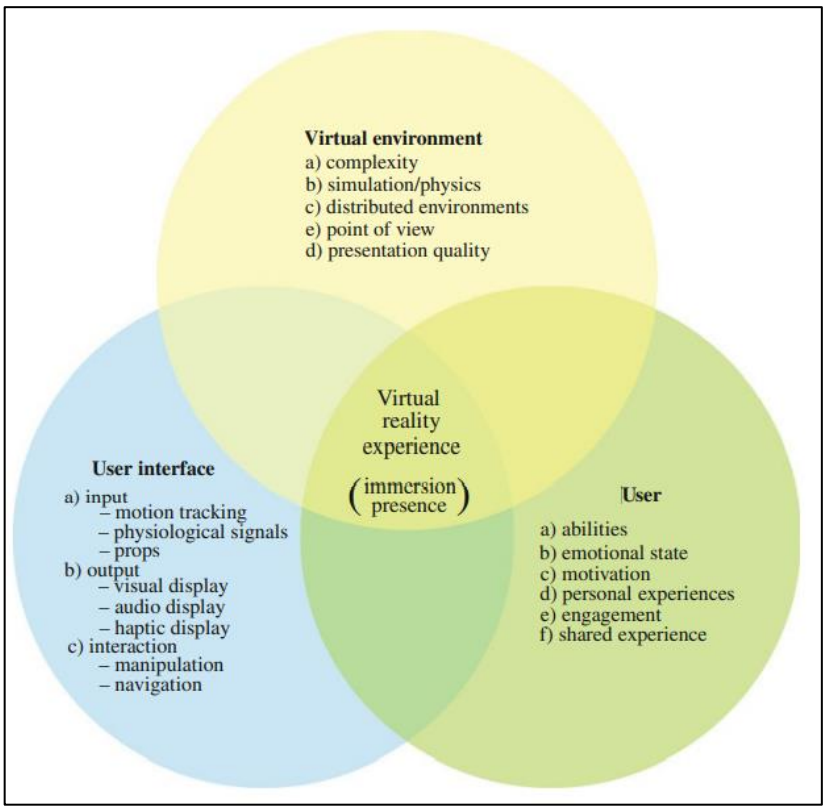
2.2.3 Presence in the environment

As we knew earlier, there are two environments in virtual reality. First, immersive virtual reality eliminates the real environment and immerses the user in a completely virtual environment. Secondly, there is augmented reality, which mixes the real environment with the virtual environment. So'1me see that it is two different environments, but from a practical and scientific point of view, they are one mixed environment because it does not

cancel the real environment, but rather changes it and adds a new meaning to it by enhancing it with other elements. (Arnaldi, 2018)

Figure 2.3

Virtual reality experience factors include the virtual environment, the user, and the user interface



2.2.4 Three-dimensional objects

The object is a symbol of enormous information when viewed well beyond what could have been first guessed, and it is one of the most important elements of the virtual world (Geroimenko, 2022).

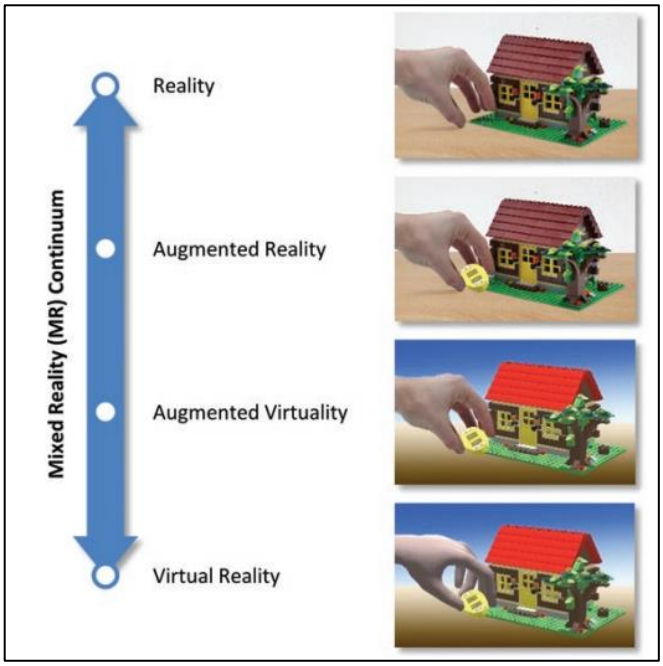
Virtual reality and augmented reality applications deal with 3D models, so these models must be as close to reality as possible, with high quality and interaction. This is what these applications aspire to, as they need to be developed and improved to reach the required level, Like the quality of 3D computer graphics. Therefore, it is recommended to simplify collision geometries for objects before using them in virtual reality applications to obtain the best quality (Doerner et al., 2022).

2.2.5 Mixed reality

Mixed reality includes both virtual reality and augmented reality. Mixed reality represents a continuum from virtual reality to augmented reality, as seen in Figure 2.4, where if the share of virtual reality is large, then the share of real reality is small, so this is closer to virtual reality, and if the percentage of real reality is greater, the share of virtual reality is a little less, and this is closer to augmented reality (Doerner et al., 2022).

Figure 2.4

Reality to Virtual reality

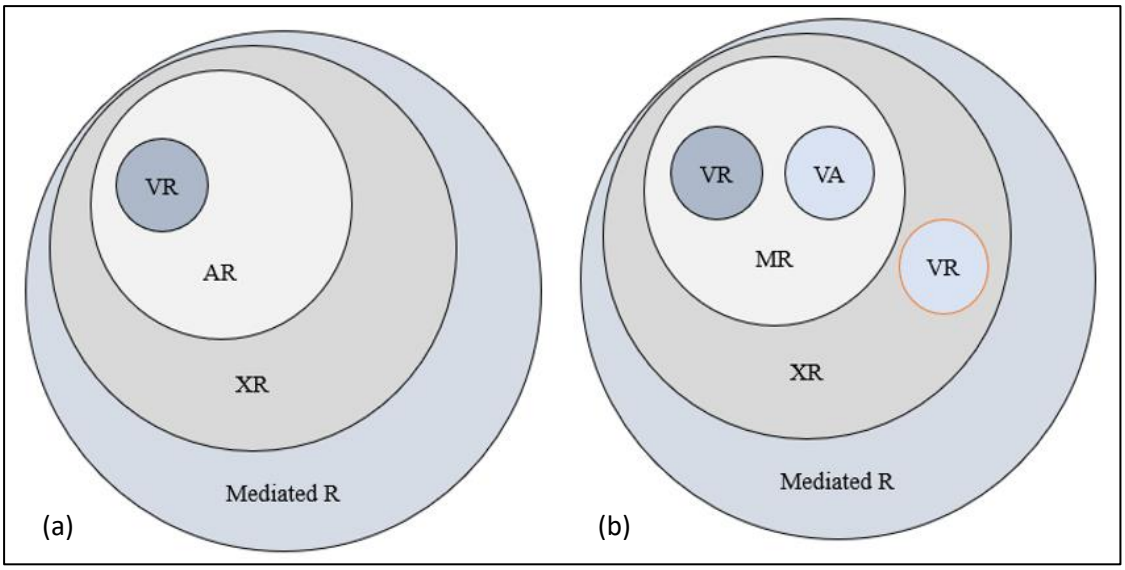


As for the relationship between virtual reality and augmented reality, there are several opinions, including Azuma's, who says that virtual reality is a special case of augmented reality (see Figure 2.5 a). As for Paul Milgram, he sees that they are separate and that each one is a type (see Figure 2.5 b) (Doerner et al., 2022).

There are also other special terms such as XR, or "extended reality," which includes virtual reality, augmented reality, and virtual augmented reality, and it is also called "cross reality." Intermediate reality includes all the previous types, where the user is aware of the real environment in a large and direct manner, and the realization of the real environment is controlled, such as by reducing the contents of the real environment deliberately and in real-time (Peddie, 2017).

Figure 2.5

Classifications of virtual reality



(a)Classification of VR by Azuma, (b)Classification of VR by Milgram

2.2.6 Immersion levels

The amount of immersion felt in the virtual environment and the level of immersion vary depending on the settings of the virtual model. which depends on the input tools, display quality and resolution, stereoscopic size and field of view, and many other factors (Mazuryk & Gervautz, 1996). The most important of these types are:

- Immersive: It is a complete immersion in the virtual environment with all its components. This requires special tools that move the user from real reality to virtual reality. In this system, a head-mounted device is mainly used. Gloves, sensors, and some augmented audio and sensory systems can also be used (Mazuryk & Gervautz, 1996).
- Non-immersive (desktop virtual reality): Some call it "Window on World" (WoW); this system uses the traditional screen to display 3D models, and it is controlled through the mouse, keyboard, or touch directly on the screen (Mazuryk & Gervautz, 1996).

2.2.7 History of virtual reality

The first form of virtual reality appeared in 1957 when Morton Heilig built a model for driving a bicycle. He used the bike and added some other senses during the ride, such as city sounds, wind, and some smells. He called this model Sensorama (Mihelj et al., 2014).

In the 1960s of the last century, virtual reality began to enter the field of technology and science, specifically in 1965, when Ivan Sutherland mentioned in his book The Ultimate Display that a computer could control the existence of matter. In 1968, Sutherland developed a head-mounted helmet containing a screen and a tracking system for sound waves. This system was called the Sword of Damocles (Doerner et al., 2022).

This system allowed people to watch virtual reality and real reality at the same time because it used transparent screens, so this was the first appearance of virtual reality (VR) and augmented reality (AR) (Mihelj et al., 2014).

Myron Krueger introduced a new term at the time, "artificial reality," as it allowed virtual reality to recognize users' needs and also enabled users to interact with the virtual environment, and that was in 1969. and this was the precursor of modern telepresence technology, allowing individuals thousands of kilometers apart to interact in real-time via a computer-generated environment (Peddie, 2017), (Mihelj et al., 2014). In the mid-1980s, the NASA Ames Project VIEW appeared, which aimed to develop a space simulation workstation through virtual reality. The term "augmented reality" first appeared in the early nineties through the Boeing Aircraft Company, which used it in a project to extend electrical cables in aircraft. Sega introduced their virtual reality headgear for gameplay and the Mega Drive system in 1991. The system monitored head movements and positions with the use of an LCD display, stereo headphones, and built-in sensors. Nearly 500 participants from all over the world attended the IEEE Conference on Virtual Reality in 1999. Since the beginning of the year 2000, virtual reality and augmented reality have appeared in global trade and electronic exhibitions. During these decades, the use of virtual reality and augmented reality was limited to research institutions, major industrial companies, and government institutions due to their exorbitant and astronomical costs. However, the paradigm shift occurred in 2013 with the advent of high-quality and low-cost Oculus Rift glasses. It entered the commercial markets and reached consumers in 2016, and from that time, it began to spread with the entry of other companies in the manufacture and marketing of virtual reality glasses (Doerner et al., 2022).

2.2.8 Virtual reality applications

VR is applied in many different and diverse fields, including the industrial field and maintenance. For example, the chemical industries use virtual reality to train workers, which helps protect workers from chemicals and exposure to them, as well as reduce material costs (Garcia Fracaro et al., 2021). As for maintenance, workers can be trained to maintain some important devices and tools in dangerous places, which increases the efficiency of the maintenance process and its completion on the ground (Kwegyir-Afful, 2022a). Another field is tourism, where virtual reality can be used to make some visits to archaeological sites and get to know them, especially in cases where it is not possible to visit the site, as happened during the Corona pandemic (Shen et al., 2022b). Also, the medical field makes it easier for inexperienced doctors to train in performing surgical operations and, on the other hand, to identify, analyze, and understand the body's systems well, such as the heart, and also helps in mastering some treatments, such as treating and dealing with cancer (Javaid & Haleem, 2020). All of this contributes to facilitating the work of doctors and reducing medical errors (Singh et al., 2020b). The most important field is education, which suffers from a lack of equipment and competencies and a weakness in the abilities of students (Hilal, 2012), which is discussed in detail in this research.

2.3 Vocational education

Technical and vocational education and training TVET is to provide students with the foundational skills, knowledge, attitudes, and competencies necessary to pursue a career and to participate productively in society (UNEVOC, 2021). The importance of vocational and technical learning lies in the fact that it helps the student be hired faster, engage in the labor market, start their enterprise, and be a pioneer in their work. This contributes to economic development and benefits society (Hilal, 2012).

Vocational education is a very diverse field in terms of specializations, institutions, and participants, but it is the least homogeneous and least fortunate in terms of reputation among the rest of the fields, as it has so far been seen as a specialization for students with low educational attainment (Billett, 2011)

The society in Palestine still views vocational education as education for vulnerable groups, as the percentage of those enrolled in secondary vocational education (from grades 10–12) in Palestine in 2018 reached 3.04% of the total secondary education

students. This percentage is very low and increases the gap in the labor market due to the lack of professionals and skilled technicians.

Among the most prominent problems facing vocational education, according to the Ministry of Education (Ministry of Education, 2021), are:

- Several government agencies share responsibility for overseeing the country's educational and occupational training programs.
- The high unemployment rate among recent college grads, the poor quality of vocational and technical training programs, and the misalignment between supply and demand.
- Participation in TVET programs is disappointingly low.
- Society places little value on TVET programs.
- Skill sets in vocational and technical areas are inadequate in relation to market demands.
- The present infrastructure's frailty (curricula, cadres, equipment, systems, buildings, etc.)

The number of governmental vocational schools in Palestine until 2018 reached 17 schools, and vocational units were also created (these vocational units are vocational classes in academic schools), where 39 vocational units were opened in several schools, and this led to an increase in the number of students enrolled in vocational education, where the number of students enrolled in vocational education for the same year reached 4347, distributed over 32 vocational majors available in Palestine (Ministry of education, 2022).

Secondary vocational education in Palestine is divided into three tracks:

- Vocational Stream (INJAZ/Achievement): In this track, the student takes the high school exam, and after successfully passing the exam, he can join the labor market or study at universities or colleges.
- Vocational competence (Kafa'a): In this track, the student is tested only on professional skills, and after passing the exam, he can join the labor market or study in college (for a diploma only).
- Apprenticeship: This path is taken between 11th and 12th grade. The student spends two days in school and three days in the workplace to learn all the skills they need to

easily enter the workforce. After the student finishes his studies, he can only join the labor market; he cannot join colleges.

2.4 Digitization

With the current technological development, digital transformation has become inevitable, and the term digitalization has appeared. It is the process of converting physical and paper objects into a digital format that can be copied and transferred to smart devices and computers, where documents, images, records, and videos can be digitized and converted into digital data. This facilitates the process of storing, accessing, and retrieving this data, as well as sharing and transferring this digital information.

Digitization has spread to all industrial, commercial, educational, and other fields, and digital transformation has become inevitable. Still, digitization faces many difficulties and obstacles in institutions and companies, some from administrators, some because of cost, and some for technical and logistical reasons (McCarthy et al., 2023). Note that digitization has a positive impact on institutions as it increases the effectiveness of employees and increases their assets and capital (Tian et al., 2023).

Digitization in educational institutions requires concerted efforts, from the highest level to school administrations, teachers, and students, to prepare professional students who can deal with problems and solve them through digital competence (Bygstad et al., 2022).

2.5 Information and communication technologies (ICT) in education

UNESCO defines ICT as the technological tools and resources in their various forms for the transfer of information. These devices include computers, telephones, television, radio, internet, communications, videos, audio, satellites, etc. (UNESCO Institute for Statistics., 2009).

With the current technological development that lives in all walks of life, the impact of ICT on education must be noted, and this impact forced teachers to deal with ICT by bringing technology to education directly and indirectly (Krassadaki et al., 2022). Starting from using social media to communicate with students to using pictures and videos, as well as some educational programs and applications. This is closely related to this study through the application of virtual reality in education as a type of ICT and knowing its impact on students (De Witte & Rogge, 2014).

As mentioned earlier, education has been greatly affected by ICT, and it is worth noting that vocational education is more closely related to ICT in most of its specializations, is linked to the labor market, and must follow the market continuously. Therefore, ICT must be integrated with vocational and technical education through curricula in various disciplines (Dahil et al., 2015).

2.6 Engineering Management and Education

This study integrated the elements of engineering management in terms of implementation, beginning with planning, where a work plan was developed for a complete study and clarification of all the basic stages in the study, such as the beginning of post- and pre-examinations and questionnaires. Secondly, through management, it manifested itself in managing the three divisions, coordinating between teachers, managing classes, exams, and questionnaires, and following up on all equipment and logistics with the competent authorities. Third: Integration with technology through the use of new technologies that enhance education through the use of virtual reality and communication and display technologies. Finally, continuous development and creativity are achieved by keeping pace with technology and all that is new and giving students the opportunity to innovate in different ways and directions.

On the other hand, the study provided students with some directions for engineering management in education, starting with leadership, where the student is self-dependent during the process of applying the virtual reality class, which places on him full responsibility for completing the lesson and achieving leadership, starting from the process of logging in to the platform and also moving between the icons of the platform and the tests and dealing with any possible problem that may be encountered, he made his decision alone (Terkamo-Moisio et al., 2022). Secondly, training programs allow the student to deal with new technology, enhance his skills, and get practical and real experience in this field (Ruiz-del-Pino et al., 2022). Thirdly, student organizations, where students felt something uniting them with each other, distinguishing them from other students in the school, and creating a virtual reality for them to belong and agree with each other (Horace et al., 2021) Fourth, role-playing exercises, where the virtual reality experience allowed the student to learn on his own and to be a student and a teacher at the same time, enhanced his sense of thinking and solving problems on his own (Ortiz-Martínez et al., 2022). Finally, the administration was integrated into education. Virtual

reality created students a sense of responsibility and strengthened their principles of development. Some students worked on development in virtual reality classes and received constructive criticism on how to implement it, which they could implement in various other ways (Vrabie, 2015).

2.7 Variables

As mentioned earlier, this study aims to find out students' cognitive benefits and motivation for the new learning method using new technology (virtual reality) and the extent of their benefit.

After reviewing much of the previous literature, the media technology model (Salzman et al., 1999), (Ai-Lim Lee et al., 2010) and the control value theory of achievement emotions (CVTAE) model (Makransky & Lilleholt, 2018) were adopted in order to adopt the variables, as virtual reality features, motivation, and cognitive benefits were adopted from the aforementioned models. On the other hand, because virtual reality is a new technology in vocational education and the majority of the sample studied has never used it before, it is necessary to understand their behavior toward this technology. In this regard, the Technology Acceptance Model (TAM) (Davis, 1989) is appropriate for this purpose, and it consists of three main variables: 1- behavioral intention, 2- usefulness, and 3- ease of use. Two variables were chosen from the TAM model in accordance with this study, namely ease of use and usefulness, and the third variable can be introduced as the behavioral intention in subsequent studies. Also, some studies have divided the variables of the TAM model, taken what is required, and combined them with other variables (Matsika & Zhou, 2021).

In conclusion, the variables of this study are virtual reality features, motivation, cognitive benefits, technical usefulness, and ease of use see Appendix A.

2.7.1 VR features

The presentation is an important and essential part of virtual reality because it represents the three-dimensional models and objects displayed during virtual reality and images and videos that can be added to the virtual reality display(Hanson et al., 2020). So, the quality of these three-dimensional models and objects affects how the user feels, just as the way

formats and names are shown on objects based on their density or location affects the user's feelings (Y. Shi et al., 2020).

As for control, it assesses participants' perceptions of their capacity to control items in the VR experience. For example, the ability to manipulate objects in the virtual environment, such as zooming in, zooming out, rotating, disassembling, and other things required by the virtual environment (Makransky & Petersen, 2019).

2.7.2 Usefulness

"Usefulness" refers to the extent to which an individual considers that using a certain technology result in enhanced performance (Kwegyir-Afful, 2022b). In this study, the perceived benefit is the desired benefit of virtual reality in improving the students' technological skills.

2.7.3 Ease of Use

Refers to a user's assessment of a system that requires effort or no effort to utilize. Andcertain the user's intention to apply technology (Makransky & Petersen, 2019).

2.7.4 Motivation

This variable connects students' pleasure and playfulness to the efficiency and efficacy of their technology experience, and pleasure describes how much fun a person gets from utilizing technology (Shen et al., 2022a).

2.7.5 Cognitive benefits

Learning is seen through the lens of cognitivism, which places emphasis on higher-order mental operations, including analysis, synthesis, idea generation, and retrieval. The problems of how the mind takes in, sorts, stores, and retrieves data are tackled (Makransky & Petersen, 2019).

2.8 Virtual Reality Environment Design

The 3D models on which the application was applied were determined based on the prescribed academic curriculum, as the models included the internal combustion engine with all its elements and details. The models were selected from the used platform database (EON-XR); after that, they were modified by naming all annotations in Arabic

and adding the necessary auxiliary explanations such as (audio, identify, locate, quiz, pdf, and image) see Appendix B. Also, four classes were built and modified, and the necessary features were added according to the content of the class, as more than 120 features were added to all classes to ensure that everything was explained in detail. All of this was under the supervision of the responsible engineers and within their directions.

2.9 Application requirements

The students applied for the virtual reality classes through each student's mobile phone, where an account was created for each student on the EON-XR platform, and they were provided with the internet to ensure that they entered the platform correctly so that it would be easier for the researcher to collect data from the platform, as the platform provides large amounts of statistical data such as entry time, total application duration, application duration for each item, number of entry times, quiz score, and more see Appendix C.

2.10 Teaching style

Traditional education relies heavily on the teacher, and the method used is usually the lecture, where the student is a recipient of information only, and the discussion is very limited. Also, if the teacher needs additional explanations, he uses only explanatory pictures or videos, and sometimes, a picture or video is not enough. For this reason, virtual reality provides great advantages that enhance traditional learning and the educational process.

2.10.1 Traditional Teaching Methods

It is difficult for the teacher to be present in the traditional way of demonstration, explanation, and education, where he has pictures or videos to explain, and it is difficult for him to be dynamic during the explanation (Ya & Xing, 2013).

- Communication method:

  The style of the teacher is usually a demonstration, an explanation, and then an explanation, respectively, as there is no direct bi-communication between the teacher and the student, as the teacher cannot understand the student at that moment when the student inquiries about the preceding explanation (Ya & Xing, 2013).

- Weak visual effect:

  Because the teacher's presentation is devoid of vitality, it is difficult to highlight the fine points and also the disconnection between time and space .It is, therefore, difficult to explain a demo and highlight all the sensitive details through it (Ya & Xing, 2013).

2.10.2 Advantages of using virtual reality in education

The advantage of using virtual reality is somewhat similar to using a computer. The use of virtual reality makes a difference in education in terms of new discoveries in education, encouragement, and excitement as the learner becomes part of the educational environment (Pantelidis, 2009), and these are some of its features (Pantelidis, 2009):

1. Virtual reality provides a real experience that is customized for the educational material.
2. Some experiences cannot be obtained through traditional education, even e-learning.
3. This type of "virtual reality" learning is very relevant to today's technology-related lives.
4. The perimeter can be built with all its details by a competent person
5. It achieves a higher rate of memorization and comprehension.

2.11 Z generation

Age has a major role in accepting technology and dealing with it in a big way, and this study deals with students between the ages of 16 and 18 years. These ages are classified within the Z generation, and this generation is known as the most affected by technology because they were born with technology and raised in its presence, such that they are closely connected to digital life in some capacity in their daily lives (Berfin Ince et al., 2023). Therefore, this generation must be taken into account, as well as what it may affect in this study.

2.12 Mobile education

The term "mobile education" using mobile devices is associated with education that allows for flexible learning through space and time and also because it provides faster access to information. It also increases cooperation between learners because it facilitates

their communication and exchange of information and makes learning more widespread (Ekici & Erdem, 2020).

2.13 Platform description

The EON-XR platform was created by EON Reality, a global company with more than 20 years of experience working in the field of virtual reality and augmented reality, providing solutions for academic and industrial training through AR and VR.

The EON-XR platform offers versions that work on all mobile devices and computers, and it also works on developing head-mounted displays. The platform provides a library of over 8,000 models and applications and over 40 million users worldwide.

More than 1,000 companies and institutions worldwide use the platform to benefit from these services to advance the level of academic or industrial training. Among these institutions is An-Najah National University, which started using the EON-XR platform at the beginning of 2022 to keep pace with technological development.

The EON-XR platform contains thousands of 3D models in various fields, allowing the teacher to choose what he wants and modify it based on his preferences and the prescribed curriculum. The platform provides additions that make the lessons integrated, such as adding annotation, audio, video, PDF, image, quiz, locate, identify, and 3D recording.

- Annotation: the teacher can edit the annotation and add the annotation wherever he wants on a 3D model.
- Audio: where audio clips can be uploaded or recorded directly by the teacher, speech can also be added to this audio as a caption.
- The video enables the teacher to add explanatory videos to the class. The platform also enables him to edit the video in order to choose the appropriate clip.
- PDF files can be added to the classes to benefit from them, such as adding the curriculum during the class.
- Image: The platform allows adding illustrations.
- Quiz: the platform provides a "multiple-choice" quiz for the question during the application of the 3D class, and it is possible to set a timer to answer the question.

- Locate is an activity that tests the user's skills in identifying the pieces or the locations of the pieces in the three-dimensional space, and it is possible to specify a timer to locate the specific pieces.
- Identify is an activity that tests the user's ability to write the names of the pieces or their definitions during the class, and it is possible to add a timer for writing.
- 3D recording allows the teacher to record audio, and during this recording, there is a pointer that follows the 3D stereogram during the explanation.

The platform also has a lot of tools for exploring that make the application easier and help it work better. The most important of these tools are the different viewing modes, like the touch/AR mode icon that lets you switch between augmented reality and virtual reality. The label icon allows an annotation to appear or be hidden. Unassemble the icon to allow it to explode and separate the components and subcomponents of the model. Use the X-ray icon to view the inner details of the model. Animation icons are displayed if any animation sequences are associated with the model.

Chapter Three
Methodology

In this study, the researcher aims to understand the impact of virtual reality on vocational education through quantitative and qualitative scientific research methods. The beginning of this is through the educational attainment of students in "pre- and post-examinations," as well as knowing the impact on students' skills and benefits through questionnaires and interviews.

3.1 Hypotheses

As mentioned previously, the aim is to study whether virtual reality affects students' cognitive skills and motivation through hypothesis H and what emerges from it from hypotheses from "H1 to H6" and hypothesis H7.

Firstly, hypothesis H, which is concerned with knowing the effect of using virtual reality on students' cognitive and technical skills and their motivation for learning, was done by defining the study variables in accordance with hypothesis H, and they are 1- ease of use; 2- usefulness; 3- VR features; 4- motivation; and 5- cognitive benefits. These variables were linked, and the relationship between them was determined based on the Structural model (see Figure 3.1), which illustrates this relationship and their effect on each other.

Based on the relationship between variables and depending on the model (see Figure 1.3), six hypotheses have been developed as follows: H1, H2, H3, H4, H5, and H6 (see Figure 3.1).

H1: There is no statistically significant effect at P<= 0.05 between the ease of use of virtual reality and the motivation.

H2: There is no statistically significant effect at P<= 0.05 between the ease of use of virtual reality and the usefulness.

H3: There is no statistically significant effect at P<= 0.05 between the usefulness of using virtual reality and the motivation.

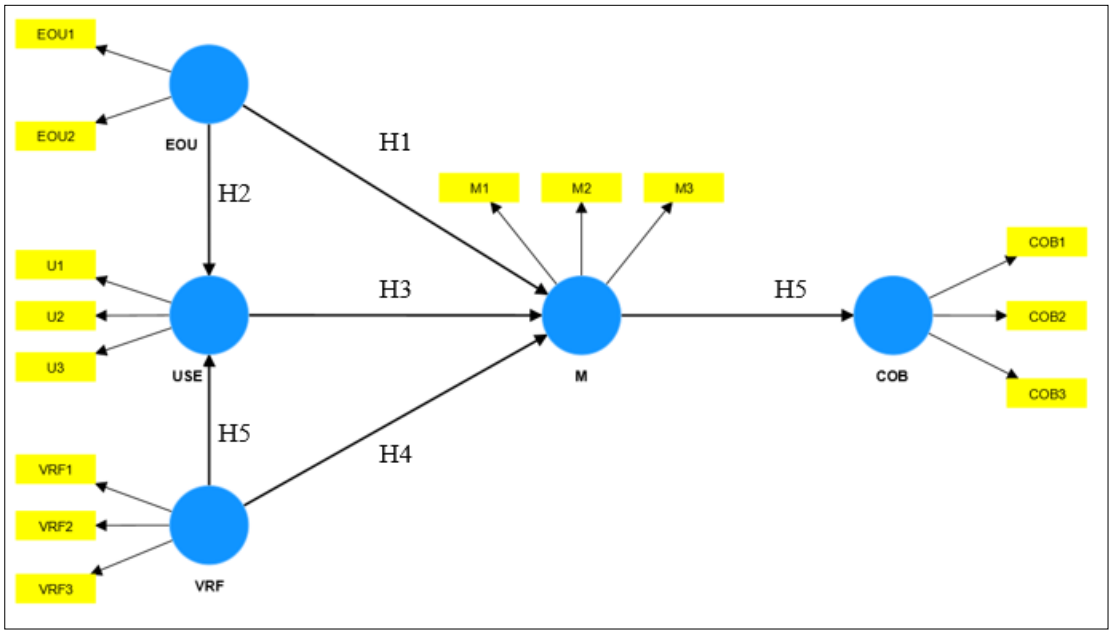
H4: There is no statistically significant effect at P<= 0.05 between the features of virtual reality and the motivation.

H5: There is no statistically significant effect at P<= 0.05 between the features of virtual reality and the usefulness.

H6: There is no statistically significant effect at P<= 0.05 between the motivation of using virtual reality and the cognitive benefits.

Figure 3. 1

Model to find out the effect of virtual reality education on students' cognitive skills



Note: EOU: ease of use, USE: usefulness, VRF: virtual reality features; M: motivation, COB: cognitive benefits

Secondly, with hypothesis H7, which is concerned with academic attainment, researchers want to examine whether there is a positive effect of the hypothetical reality on students' academic achievement by comparing students' scores using a pre-exam and a post-exam. This was expressed through the null hypothesis.

H7: There is no statistically significant effect at $\alpha <= 0.05$ between the average scores of students in the traditional exam and the virtual reality exam for academic achievement.

3.2 Application approach

After the students finished the pre-exam, preparing for the post-exam questionnaire and interviews began by preparing an experimental session for virtual reality to train students to deal with the virtual reality platform (EON-XR). First, the researcher explained to the students how to enter the platform using their email, then moved on to explain how to enter the class and explain all the icons of the platform and their use, as well as how to zoom in, zoom out, disassemble, and everything else related to the platform see Appendix B. During this, some problems appeared among the students, but they were all resolved, and the student's readiness to start applying virtual reality classes was ensured see Appendix D.

After the students finished the training session and made sure that they were ready, they started applying the lessons according to the teacher's plan in sequence (see Figure 3.2), and during that time, they were followed up by the teacher, who dealt with any problems that appeared to the students.

Figure 3. 2

Students apply virtual reality classes

The lessons were based on the prescribed curriculum, as the internal combustion engine class was divided into two parts, 1 and 2, due to the large size of the lesson, where it talks about the engine parts in detail and the function of each part. The moving parts lesson talks about the moving parts inside the engine, including the camshaft and connecting rod, and how the pistons move inside the engine. The lesson on the piston and the connecting rod explains how to connect the piston and the connecting rod, all their parts, and their respective rings. Finally, the lesson on the four-stroke engine shows the movement of the pistons inside the engine and all the engine strokes.

3.3 Quantitative approach

3.3.1 Academic achievement

The experimental approach was used to judge the academic achievement of students by comparing the students' grades with traditional education and then comparing them with the grades of students with virtual and traditional education together.

Experimental research is a method of scientific research in which the researcher relies on studying independent variables and their impact on dependent variables by examining the surrounding conditions and observing the effect on the results. The most important reason for using experimental research is to know the relationship between cause and effect on variables, and the types of experimental research include true experimental design, quasi-experimental design, pre-experimental, laboratory experiments, factorial experiments, time-series experiments, comparative experiments, and pilot experiments (Lavrakas et al., 2019).

The pre-experimental method was used in this study. There are three types of this method:

1- One group.
2- one group pretest, and posttest study (OGPS).
3- group comparison, the OGPS research method was adopted in this study, where the students underwent a pre-exam and then a post-test (Cash et al., 2016).

Students' academic achievement was measured by an exam that tested their practical knowledge of several lessons from the required curriculum. 50 students took the exam from the eleventh vocational grade, divided into three divisions:

- The first division, Vocational Stream, specializes in auto mechanics; its shift is in the morning, and the number of students is 17.
- The second division, Vocational Stream, specializes in auto mechanics. Its evening hours have 15 students.
- The third division, Apprenticeship Stream, specializes in auto mechatronics; its shift is in the morning, and the number of students is 18.

The results of traditional education were compared to the results of education through virtual reality. The students took a pre-exam (Appendix E) to test their academic achievement from the traditional learning method. They applied the lessons through

virtual reality. Finally, they took a post-exam (Appendix E) to test their practical achievement after applying the lessons to virtual reality. Attached is a link to the classes on the platform (Appendix F).

It is mentioned that the pre- and post-exams are different, and the order of the questions shuffles between them. The exams were made by the curriculum teacher in line with all educational standards.

Experts reviewed the exam to make sure it was valid and in line with the lesson goals (Appendix G) and the final exam specifications table (Appendix H), and also, the test was corrected according to the standard answer (Appendix I) without bias. The experts are a number of university professors who specialize in the field of study and scientific research. They checked and judged all the study tools (Appendix J).

3.3.2 Cognitive and behavioral benefits

This was done through a post-questionnaire that was distributed to the students after they finished the study through virtual reality. The questionnaire was divided into two parts: the first part was to collect personal and general data about the student, and the second part was related to variables see Appendix K. The variables and all the indicators for each variable were identified through research in the literature review and in accordance with the research objectives see Appendix L.

3.4 Contents of the Structural Model

The variable quantifies abstract, complicated notions that cannot be immediately seen using things and are depicted as circles or ovals in the path structural model and are also known as a construct (Hair et al., 2017), as shown in (Figure 3.1).

Variables (construct) in this study, two types of variables were adopted, namely:

- Independent variables: are not affected by any other variable in the structural model and remain independent only. The independent variables in this study are VR features and ease of use.
- Dependent variables are those affected by other variables in the structural model, and they can be independent or dependent. The dependent variables in this study are motivation, cognitive benefits, and usefulness.

Indicators are directly observed observations, also known as items, and are represented as rectangles in structural models, as shown in (Fig. 3.1). Data on the indicators is collected directly, either through questionnaires by individuals or by institutions. In this study, all indicators are reflexive, as there are two to four indicators through which the variables can be measured so that the question is an indicator.

Model analysis:
After building the model through the variables, linking them, and identifying the indicators, there must be data in order to know the results of this model and to judge the hypotheses through it.

This is done by entering and giving data to the indicators, and the data is collected through a questionnaire, where each indicator has a corresponding question in the questionnaire, and the question is answered with a specific number according to each case.

In this study, a Linkert scale of 1–5, with one strongly disagreeing and five strongly agreeing, was used in this questionnaire to measure each question so that a student gives a value to each question from 1–5 according to one point of view.

After obtaining this data, statistical programs are used in order to obtain a complete analysis of the model.

The number of samples required for compatibility with the structural model and statistical analysis of the Smart-PLS program was determined through the sample size recommendation in the PLS-SEM table, at a significance level of 5% and a minimum R^2 of 0.25, and at the number of independent variables 3, the table indicates a minimum of 37 samples is needed (Hair et al., 2017); see Appendix M.

3.5 Qualitative method

Qualitative approach: is described as an investigation approach for studying a social or human issue that is focused on constructing a comprehensive, holistic picture using words, relaying specific viewpoints of informants, and taking place in a natural context. Among the methods used in qualitative studies are observation, interview, questionnaire, and historical and interactive texts.

In this study, interviews were used for the qualitative approach, where a number of students were interviewed randomly (within the study sample), and the interview was recorded in audio in order to refer to and analyze it. The duration of the interview was 3-5 minutes per student, and the interview questions were prepared in advance; the number of questions was 7. See Appendix N.

The same conditions were also provided for the rest of the students in order to ensure accurate information was obtained and the students' permission to record was taken. The entire dialogue was about the prepared interview questions only to know their impressions and opinions about the virtual reality experience in vocational education and all its aspects.

3.6 Population of the Study

The study population consists of all 11th-grade vocational students in the West Bank; their number is 1587 male students only; their ages range from 15 to 17 years, and they are distributed among 17 vocational schools and 39 vocational units (Ministry of education, 2022).

3.7 Sample size

This study was conducted on eleventh-grade students at Hebron Industrial Secondary School and Hebron Industrial Secondary Evening School for specializations in automobile mechanics. This sample consists of one group of 50 students from three different classes: two classes in the vocational stream of auto mechanics and one class for apprenticeships in auto mechatronics.

3.8 Data analysis

The data were analyzed through statistical analysis programs, where the results of the pre-exam and post-exam were analyzed and compared between them through the SPSS version 26 program. As for the model analysis of behavioral and cognitive benefits, the Smart-PLS version 4 program was used because it is a program that specializes in the model analysis and the analysis of the relationship between variables. It also provides a statement of the reliability and validity of the data, and this program also has an advantage in the case of a small sample size (Hair et al., 2017).

According to the interview questions (Appendix N), 17 students were interviewed after they finished their virtual reality classes. The first question revolves around the students' opinions about their experience with virtual reality, and the students unanimously agreed that their experience with virtual reality was unique and wonderful. There were many different answers to the second question about the benefits of virtual reality. The most important was what most of the 12 students said, which was that virtual reality explains the parts and shows all their exact details. Three students said that virtual reality makes learning easier, and two talked about the importance and benefits of virtual reality in the case of a switch to distance education.

In response to the third question, which was about whether education should use traditional methods or virtual reality, seven students said they liked traditional methods, six said they liked virtual reality, and four said they didn't care either way. The fourth question refers to the preference for the traditional method or virtual reality in education from several aspects: Beginning with the aspect of participation, 11 students prefer virtual reality, four students prefer traditional learning, and two students are neutral; secondly, in the aspect of fun and suspense, 12 students believe that virtual reality is better, while three students believe that traditional learning is better, and two students are neutral. Thirdly, in the aspect of memorization and understanding, ten students believe that virtual reality is better, two students believe that traditional learning is better, and five students are neutral. The fifth question is about the existence of problems or malfunctions. Everyone answered that there was no problem, except for some technical problems. The sixth question talks about motivation related to virtual education. Fifteen students answered that it was encouraging them to study and learn, while there were two students who were neutral. On the seventh question, regarding the generalization of this experiment to other subjects, all students unanimously agreed and supported this approach.

Chapter Four
Result

This study included 50 students, and it was confirmed that the students had completed all virtual reality classes through the platform (EON-XR) on which they applied. Personal and general information were collected from the students through the questionnaire; the results are attached to Table 4.1, where the table shows the number of students from each specialization, owning a mobile phone, mobile phone usage, level of experience in virtual reality, number of hours of mobile phone use, and prior experience in auto mechanics.

4.1 Quantitative analysis

As mentioned previously, the appropriate "asset" model was chosen for each lesson from the EON-XR platform, and then modifications were made in accordance with the objectives and requirements of the lesson, as well as adding the features "Audio, PDF Image, Locate, Identify, Quiz, and 3D Recording" to the model in order to clarify all the details.

4.1.1 Platform analysis

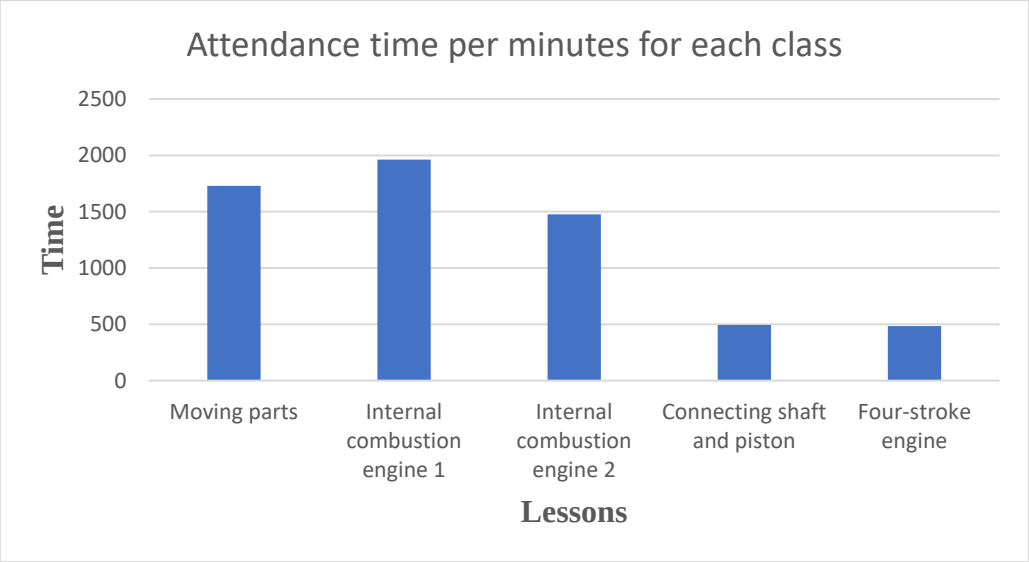
The EON-XR platform provides detailed statistical analysis for each lesson, allowing students to be monitored and ensuring that they use the platform and study correctly. One of the most important statistics that we will talk about is attendance time, as Figure 4.1 shows the number of minutes spent by students in each class, where the X axis indicates the lessons that the student studied through the EON-XR platform, and the Y axis indicates the number of minutes spent by the students in each lesson. It shows that the number of minutes spent by the students in the "four-stroke engine" training session is 458 minutes, the "internal combustion engine 1" session is 1963 minutes, the "internal combustion engine 2" session is 1476 minutes, the "moving parts" session is a time of 1730 minutes, and finally the "Connecting Column and Piston" class is a time of 495 minutes. That is, the attendance time for all classes for all students constitutes a time of 6149 minutes, which is equivalent to 123 hours and approximately 153 classes in the traditional mode.

As for the most important features, the following are listed: Audio, PDF Image, Locate, Identify, quiz, and 3D recording. The attachment Appendix O indicates the number of features that were used to build the classes.

Another important aspect is the number of login attempts. The total number of login times for all classes exceeded 1,408 logins, and the attachment Appendix O indicates the number of logins for each session separately.

Figure 4.1

Attendance time in minutes for each lesson



4.1.2 Educational attainment

Results evaluated the effect of using virtual reality on academic achievement; the results of the pre- and post-exams were analyzed using the SPSS program to view the scores of the two exams.

The results were analyzed using the IBM SPSS Statistics 26 program. A normal distribution test was made for both exams. The Shapiro–Wilk test was used because it is intended for samples less than 200 (Tietjen, 1987). Therefore, it was used in this study, whose sample size was 50, and their distribution was as follows: the value of the Shapiro test for the marks of the pre-exam is 0.017 (see table 4.2), which is less than 0.05 (Tietjen, 1987), and the value of the Shapiro test for the marks of the post-exam is 0.00 (see table 4.3), which is less than 0.05. This means that all the data are normal, and other statistical tests can be used.

Table 4.1

Personal and general information data

Personal and general data	
Number of participants	50
Data	Percentage
Academic specialization	
Auto mechanics	64%
Auto mechatronics	36%
Prior experience in auto mechanics.	
Yes	44%
No	56%
Owning a mobile phone.	
Yes	96%
No	4%
The number of hours of mobile phone use.	
less than an hour	16%
From one to two hours	42%
Two to three hours	24%
Three to four hours	6%
More than four hours	12%
Mobile phone uses	
Study	40%
Social media	70%
Games	30%
Internet	36%
Work	14%
Level of knowledge about virtual reality.	
No knowledge of virtual reality	50%
Little knowledge about virtual reality.	38%
Lots of knowledge about virtual reality.	10%
Experience in virtual reality	2%

To prove that there is a difference between the two exams and that there is a positive effect, the Paired Samples T-Test was used because the sample remained the same. The null hypothesis is that there is no positive effect of virtual reality on students' academic achievement. The average mark for the pre-exam was 18.7, and the value of the standard

deviation was 6.323. and Appendix P shows the distribution of students' scores, where the highest score was 28, and the lowest score was 4. The average mark for the post-exam was 21.6, and the value of the standard deviation was 6.737. and Appendix P shows the distribution of students' scores, where the highest score was 30, and the lowest score was 6. The paired test showed that the correlation coefficient was 0.835 (see Table 4.3). This expresses the strength of the relationship between the pre- and post-tests and the existence of a strong relationship between them, as the value of 0.835 is close to 1. Also, the significance coefficient is 0.00, which is less than 0.05, and the T value from the paired samples test is -6.465, which is less than 0.05; see (Appendix Q). This means rejecting the null hypothesis and proving the alternative hypothesis that there is a positive effect of virtual reality on educational attainment.

Table 4.2

Tests of Normality for pre-exam & post exam

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Traditional education	.128	50	.041	.943	50	.017
Virtual reality education	.166	50	.002	.891	50	.000

a. Lilliefors Significance Correction

Table 4.3

Paired Samples Correlations

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Traditional education & Virtual reality education	50	.835	.000

4.1.3 Cognitive and behavioral benefits

The results were collected through the post-questionnaire after the students finished the virtual reality lessons, and the number of students reached 50.

This questionnaire aims to know the effect of virtual reality on the cognitive benefits of the student by examining the hypotheses that were developed and explained previously,

H1, H2, H3, H4, H5, and H6, depending on the variables mentioned: ease of use, usefulness, VR features, motivation, and cognitive benefits.

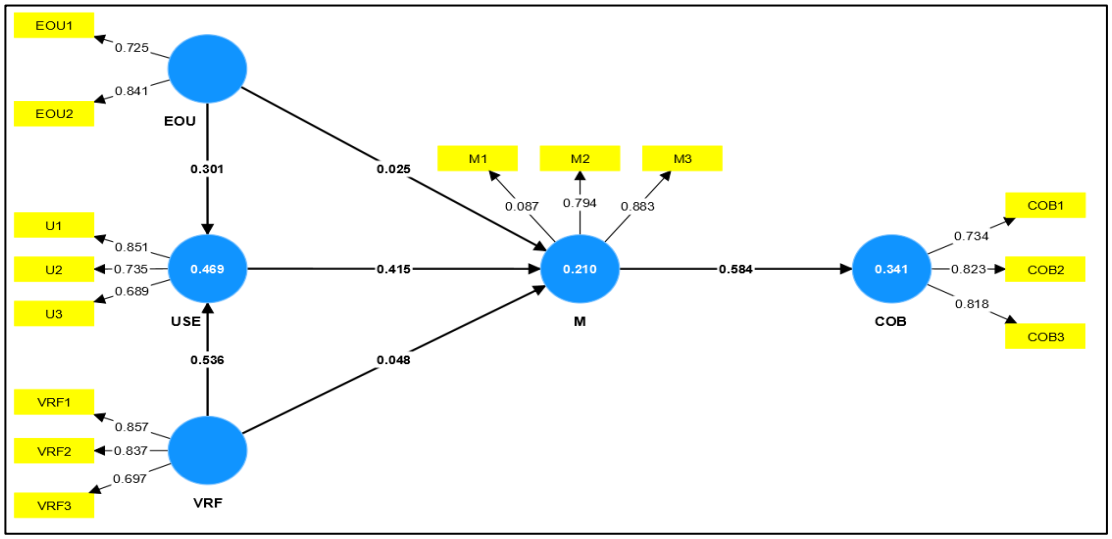
4.2 The Outer model

Outer loading is the relationship between the indicator and the variable; it measures the effect of the variable on the indicator, so outer loading is important in evaluating the model (Hair et al., 2017).

The results were analyzed by Smart-PLS 4 software based on the built model. A PLS-SSEM algorithm test was conducted for the model; see Figure 4.2. The outer model must first be validated, and all indicator outer loading values must be greater than 0.7 (Hair et al., 2017). This model contains 14 indicators distributed over the five variables. Structural model: It shows the representation of the variables and indicators and their relationship through the arrows on the structural model.

Figure 4.2

Preliminary result from the model analysis



Note: EOU: ease of use, USE: usefulness, VRF: virtual reality features; M: motivation, COB: cognitive benefits

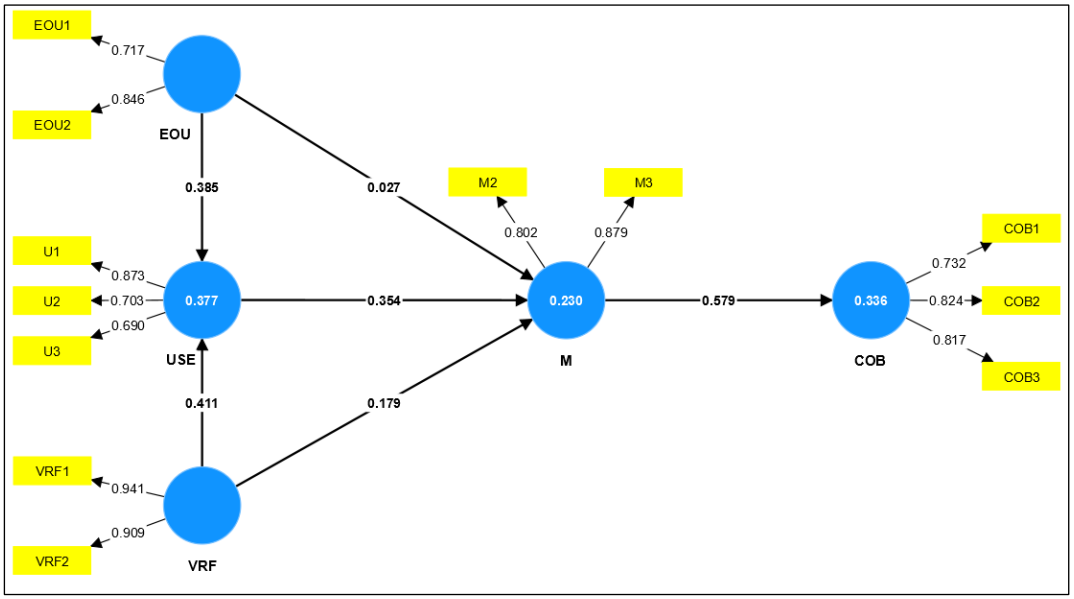
Figure 4.2 depicts some indicators that do not achieve the outer loading value. The required outer loading value p is > 0.7, so the following indices, VRF3 and M1, were omitted.

U3, with a value of 0.690, was not deleted. However, it is less than 0.7 because its value is very close to 0.7, and keeping it did not affect the results significantly, and because some references consider this value acceptable.

After that, the PLS-SSEM algorithm test was re-tested, and the results are shown in Figure 4.3, where all indicators' outer loading values achieved the value of P > 0.7, except U3 equals 0.690. This indicates that the external model is correct within the research foundations see Appendix R.

Figure 4.3

The model result after eliminating some indicator



Note: EOU: ease of use, USE: usefulness, VRF: virtual reality features; M:motivation, COB: cognitive benefits

4.3 Reliability and Validity

Reliability: Data are reliable when the results are reliable under similar conditions (if a repeat study gives the same results).

Validity: shows how well a set of indicators measures the construct as a whole so that statistical analysis can be done with this data.

The reliability of the collected data and their validity reliability are measured through composite reliability. Composite reliability is a reliable indicator of internal consistency, and the value should be greater than 0.7. Table 4.4 shows the composite reliability value

for each variable. As indicated in Table 4.4, the reliability value for all variables is greater than 0.7, which indicates that the composite reliability of the model has been achieved.

Also, Table 4.4 refers to the "Average Variance Extracted (AVE), which is a measure of the validity of the variance, as this measure interprets the variance value of the indicators through the variable. The value of this scale ranges from 0-1, but in order for the results to be considered acceptable, the AVE value must be greater than 0.5. In this study, all variables are greater than 0.5.

Table 4.4

Reliability and Validity Analysis

Reliability and Validity Analysis		
	Composite reliability	Average Variance Extracted (AVE)
COB	0.835	0.628
EOU	0.760	0.615
M	0.828	0.707
USE	0.811	0.685
VRF	0.923	0.857

4.4 Discriminant validity

Discriminant validity is a measure of validity that shows how different two variables are from each other. It looks for overlap between the variables. The Smart-SPLS program used the heterotrait - monotrait ratio of correlation tests. This test adopts a value less than 0.80 in order to adopt the results and judge that there is no conflict between the variables. This test adopts a value of 0.90 or less so that the values are correct and there is no overlap between the variables. Table 4.5 shows that all values are less than 0.90 and achieved what is required; this means that there is no overlap in the variables and that each variable achieved its goal.

Table 4.5

Discriminate validity

	Discriminate validity				
	COB	EOU	M	USE	VRF
COB					
EOU	0.770				
M	0.881	0.422			
USE	0.831	0.885	0.783		
VRF	0.612	0.305	0.504	0.744	

4.5 The Inner model

The inner model is an essential part of the statistical analysis because it shows the relationship between variables, the impact of these relationships, and the effect of each variable on the other. The P-value judges the relationship between the variables, proving or denying hypotheses. The statistical analysis of the Inner model is obtained by performing the bootstrapping test for the model.

A bootstrapping test with subsamples of 5000 and a significance level of 0.05 was carried out in order to test the hypotheses, depending on the P value, where the P value should be < 0.05. Bootstrapping is a method of estimating models by drawing several subsamples from the original data.

Table 4.6 shows the P values after the bootstrapping test, where the P value between EOU and USE is 0.004, the P value between M and COB is 0.000, the P value between USE and M is 0.044, the P value between VRF and M is 0.340, and the value for VRF and USE is 0.001.

T statistics, or T-value, also determine the relationship between variables and the validity of hypotheses, and the value of T enhances the value of P to confirm the validity of hypotheses and relationships.

And the T value, whose value must be greater than 1.98 when confidence levels 95% (Hair et al., 2017), the value of T between the variables is as follows: EOU and M = 0.151, the T value between EOU and USE = 2.879, the T value between M and COB = 4.749, the T value between USE and M = 2.012, the T value between VRF and M = 0.995, and the value for VRF and USE = 3.281, see table 4.6.

Table 4.6

Path Coefficients - Hypotheses TEST

Path Coefficients - Hypotheses TEST		
	T statistics	P values
EOU-> M	0.151	0.880
EOU-> USE	2.879	0.004
M-> COB	4.749	0.000
USE-> M	2.012	0.044
VRF-> M	0.995	0.340
VRF-> USE	3.281	0.001

4.6 Coefficient of determination (R^2)

It is the structural model's index of internal variance, and it only has to do with variables that are not independent. It is interpreted based on its correlation with the structural model. Table 4.7 refers to the R^2 values. The R^2 value for COB = 0.336, which means that 33.6% of the variance is explained by the variable (M), and the R^2 value for (M) = 0.230, as 23.0% of the variance is explained by the variables (EOU), (USE), (VRF), and the R^2 value of the variable (USE) = 0.377, this indicates that 37.7 % is explained by the variables (EOU) and (VRF).

Table 4.7

Coefficient of determination (R^2)

R- Square		
	R- Square	R- Square adjusted
COB	0.336	0.32
M	0.230	0.176
USE	0.377	0.349

4.7 Total indirect effects

Total indirect effects checks if there is a relationship between the variables other than the ones specified in the model. Table 4.8 shows the relationships between the variables, and the P value indicates that there is no relationship between any of these variables because it did not meet the conditions, which is that the P value is less than 0.05.

Table 4.8

Total indirect effects

Total indirect effects		
	T statistics	P values
EOU-> COB	0.864	0.387
EOU-> M	1.487	0.137
USE->COB	1.803	0.071
VRF-> COB	1.767	0.077
VRF-> M	1.813	0.070

4.8 F-Square "Coefficient of Determination."

F-Square measures the independent variable's effect on the dependent variable, and Table 4.9 indicates the values of F^2 for each dependent variable, which are EOU, USE, and M.

Table 4.9

Coefficient of Determination F-Square

F-Square					
	COB	EOU	M	USE	VRF
COB					
EOU			0.001	0.229	
M	0.506				
USE			0.101		
VRF			0.032	0.262	

4.9 Collinearity Statics VIF

Variance Inflation Factor (VIF) is a linear measure to measure the independent variable and whether it has a relationship with other independent variables. Table 4.10 refers to the value of the VIF for the variables, as all values are greater than 1, and this achieves the specified value of greater than one. Also, this measurement is used as an indicator with the rest of the indicators. Appendix S indicates the values of the indicators, all of which are greater than 1.

Table 4.10

Collinearity statics VIF inner model

Collinearity statics VIF inner model					
	COB	EOU	M	USE	VRF
COB	-	-	-	-	-
EOU	-	-	1.242	1.038	-
M	1.00	-	-	-	-
USE	-	-	1.597	-	-
VRF	-	-	1.336	1.038	-

4.10 Qualitative result

The qualitative analysis of the interviews was done through thematic analysis, where the most important themes were identified in accordance with the study and its objectives.

- **Participation**

  Participation is an important part of the educational process, as it has had a positive impact on students during learning through virtual reality because the platform provides tools that take into account all levels and different learning methods of students, as the student finds himself in harmony during the class and interacting with it to a greater extent than in traditional education. Where Stu1 said both methods are good, each method has its own advantages. Stu2: Virtual reality is better; all information is clearer, and classes are available at all times for study. Stu3: traditional learning because I can ask the teacher directly. (Matsika & Zhou, 2021) The study is consistent with this study in that participation in virtual reality is high, and teachers prefer learning through virtual reality. (Matsika & Zhou, 2021) Reported that three-fourths of the participants preferred virtual reality over traditional methods of education.

- **Benefit**

  The results showed the benefit of virtual reality during learning because of the interactive features it provides and showing the smallest details, as well as providing classes all the time so that the student can study at any time and review his lessons and also exploit it in the distance education process, and this is what the students confirmed and talked about. Stu1: In the event of trouble in face-to-face education (such as the Coronavirus), it will be taken advantage of and will continue to communicate in education. Stu 2: Learning has become easier with access to the smallest details and parts of the lessons. Stu3: Learning becomes entertainment, and you see all the parts. (Matsika & Zhou, 2021) The study confirmed that virtual reality has great benefits for users. The study also showed that virtual reality enables teaching and learning tasks to be completed quickly.

- **Use of virtual reality**

  Ease of use has a significant impact on the adoption of technological platforms, as the ease of use of the virtual reality platform in this study reflected the positive impact on

the students and their interest in repeating the experience, their interaction with all the platform's icons, and repeating the lessons more than once. This is what the students expressed, as Stu1 said: in terms of studying excellently and in terms of ease of studying excellently. Stu2: It is excellent and flexible. I can make an explosion of the body and see the details. Stu3: It's beautiful and simple; you can see the piece more clearly. This result is contrary to what was expected from the (Matsika & Zhou, 2021) study, which showed that there is difficulty in using virtual reality. Perhaps this difference is due to the platform used.

- **Excitement**

  The students integrated and interacted with learning in virtual reality, as they felt excited through their application of virtual reality and their breaking of the routine that occurs during traditional education, as everyone agreed on this. Stu1: Virtual reality is fun for me while I study. Stu2: Virtual reality is possible because I can control 3D objects. Stu3: Virtual reality is fun. (Makransky & Petersen, 2019) The study showed consistency with students' enthusiasm for virtual reality, and the study indicated that this can be seen through the students' engagement and enjoyment in the class.

- **Understand**

  The students integrated and interacted with learning in virtual reality, as they felt excited through their application of virtual reality and their breaking of the routine that occurs during traditional education, as everyone agreed on this. Stu1: Virtual reality is fun for me while I study. Stu2: Virtual reality is possible because I can control 3D objects. Stu3: Virtual reality is fun. (Y. Shi et al., 2020) the study showed that it is consistent with understanding, as virtual reality helps with understanding and also performs tasks faster because it affects and enhances short-term memory.

- **Influence**

  The results showed that students were influenced by virtual reality, as students preferred education through virtual reality over traditional education because some of the features of virtual reality make it compatible with the needs of students in the current period and their demand for technology. They emphasized this during their speech. Stu1: Studying through virtual reality is faster and shows more detail. Stu2: Studying through virtual reality and traditional learning are the same for me, but in

virtual reality, I can return to the class at any time. Stu3: Virtual Reality I repeated the lesson more than once, and I understood more. (Shen et al., 2022a) the study showed that virtual reality has an impact on the student through the features that it offers that develop his skills.

- **Motivation**

  Motivation affected the students positively, as students showed increased interest in virtual reality classes and waiting for their time, as well as completing all class requirements accurately. As the students said, Stu1: Yes, I am encouraged to study. Stu2: Yes, I am more attracted to learning. Stu3: Yes, I was very motivated while learning, and I had fun while learning. (Makransky & Petersen, 2019) Study showed that virtual reality increases motivation during learning, especially when the user knows that his self-efficacy will increase.

- **Generalizing**

  Virtual reality has shown its flexibility in dealing with each lesson according to its special requirements and goals. Therefore, virtual reality can deal with any lesson through its own features, and it can also be generalized for use in other courses. This is what the students said. Stu1: continue with the rest of the materials in the same way. Stu2: Introducing virtual reality to the rest of the subjects. Stu3: Yes, I prefer the teacher to increase the number of classes through virtual reality. (Matsika & Zhou, 2021) Study showed that there is fear among students and teachers about adopting virtual reality as a basis in educational science, especially in developing countries, because it is relatively new to them. This is somewhat consistent with the study and the presence of a little fear among some students.

- **Compensate for the lack of tools.**

  Virtual reality has made it possible to compensate for the lack of tools and equipment due to the characteristics and advantages it provides, providing the user with a simulation that is very similar to reality. Virtual reality adds some features that are superior to real models in terms of accuracy of access and visibility of some hidden objects, which is what was agreed upon. According to what the students said, Stu1: I can easily see all the fine details that cannot be seen through models with high clarity. Stu2: Virtual reality can be used as an alternative to parts that are not available in

school. Stu3: Yes, it has become possible to rely on virtual reality for this. Virtual reality can be adopted in the event of a lack of tools, as indicated by the (Y. Shi et al., 2020) study, as training through virtual reality is useful and reliable.

- **Difficulties**

  There must be some difficulties in any new experience, but most of the difficulties were overcome as a result of the teachers' diligent follow-up with the students. However, there are some difficulties in the infrastructure, such as weak internet and the lack of special devices for the application, and this is what the students pointed out during their talk. Stu1: At the beginning, there were some difficulties, but after the experience, everything was fine. Stu2: There were no difficulties, but there was a problem with the Internet. Stu3: No, the device just sticks sometimes. (Lacka et al., 2021) study agreed with the results of the study that technology needs infrastructure, including computers and the Internet, in order to ensure the best use of it.

In this chapter, the researcher will discuss the results of the study and the conclusions drawn from them and ensure that the study's objectives have been achieved, i.e., that virtual reality positively impacts academic achievement and students' cognitive and technical skills.

4.11 Discussion

The researcher discusses the results of the hypotheses in this study and compares these results with literature studies to see the compatibility of this study with other studies and what is new in this study.

H1: There is no statistically significant effect at P<= 0.05 between the ease of use of virtual reality and the motivation.

During this study, the value of P = 0.880 was greater than 0.05, so the null hypothesis H1 was met, meaning that there is no relationship between ease of use and motivation. However, some students indicated during interviews that ease of use encouraged them to learn. The researcher believes that ease of use has no effect on motivation because this study was conducted on the Z generation, and this generation can deal with technology in all its forms easily.

Literature studies did not directly indicate the effect of ease of use on motivation but rather the link between them through a mediating variable (Ai-Lim Lee et al., 2010). The researcher wanted to link ease of use directly with motivation in order to know whether there is a direct effect between ease of use and motivation and also because this sample of students is in close contact with technology and is surrounded by many technological things.

H2: There is no statistically significant effect at P<= 0.05 between the ease of use of virtual reality and the usefulness.

The results showed that the P value for the relationship between the two variables, ease of use and usefulness, was 0.004, which is less than 0.05. This means that the null hypothesis that there is no relationship between the two variables is rejected, and the alternative hypothesis is accepted, meaning that there is a relationship between ease of use and usefulness. This is consistent with (Hamidi & Chavoshi, 2018) study, which indicates a relationship between ease of use and usefulness.

The researcher believes that this positive effect of ease of use on usefulness is expected because ease of use motivates the student to continue applying, which increases the usefulness and skills of the student. During the interview, many students also supported this claim.

H3: There is no statistically significant effect at P<= 0.05 between the usefulness of using virtual reality and the motivation.

Hypothesis H3 examined the relationship between interest and motivation during virtual education, and based on the results, the value of P = 0.044. This indicates that the null hypothesis of the absence of the relationship is not met, as the alternative hypothesis is accepted, meaning that there is a positive relationship between interest and motivation. The researcher is consistent with the alternative hypothesis that there is a positive effect of usefulness on motivation through what the student is experiencing after the coronavirus pandemic in terms of losing motivation in learning, especially with new technology.

Studies have looked at how usefulness affects motivation, but not in a direct way. It was either through a mediating variable (Makransky & Petersen, 2019) or through an indirect relationship between usefulness and motivation (Hamidi & Chavoshi, 2018). However,

(Matsika & Zhou, 2021) study indicated that the benefit positively affects the virtual reality experience as the users' effectiveness increased, and this indicates that the user's motivation has been positively affected.

H4: There is no statistically significant effect at P<= 0.05 between the features of virtual reality and the motivation.

Hypothesis H4 indicates that there is no relationship between the VR feature and motivation. After reviewing the results, it was found that the value of P was 0.340. This value is greater than 0.05. This means that the null hypothesis is accepted, meaning that there is no relationship between the VR feature and motivation. This result is not consistent with (Ai-Lim Lee et al., 2010) study, which indicated that there is a positive relationship between the VR feature and motivation. The researcher discussed that the reason for the lack of a positive effect of the VR feature on motivation is the same reason for the failure of the first hypothesis (H1): that these features are normal for the Z generation.

H5: There is no statistically significant effect at P<= 0.05 between the features of virtual reality and the usefulness.

Effect of the VR feature on usefulness Previous studies (Makransky & Petersen, 2019) indicated that there is a strong positive relationship between the VR feature and usefulness because of the advantages of the VR feature that enhance the usefulness and abilities of students. The results of this study showed that the P value for the relationship between the VR feature and usefulness is equal to 0.001, and this value is less than 0.05. That is, the null hypothesis is rejected, which indicates that there is no relationship between the two variables, and the alternative hypothesis is accepted, meaning that there is a positive relationship between the VR feature and its usefulness. The researcher confirms the strong effect between the VR feature and the benefit due to the skills provided by the virtual reality platform and the feature that enhances the benefit.

H6: There is no statistically significant effect at P<= 0.05 between the motivation of using virtual reality and the cognitive benefits.

The results of this study showed that the P value for the relationship between motivation and cognitive benefits is 0.000, and this value is less than 0.05. That is, the null hypothesis, which indicates that there is no relationship between the two variables, is rejected, and the alternative hypothesis is accepted, meaning that there is a positive relationship between motivation and cognitive benefits. Some studies have shown a positive relationship between motivation and cognitive benefits because of the stimulation and the existence of new ways and methods of education (Gunnars, 2021),(Makransky & Petersen, 2019). This study showed the validity of this hypothesis that there is a positive relationship between motivation and cognitive benefits.

H7: There is no statistically significant effect at α<= 0.05 between the average scores of students in the traditional exam and the virtual reality exam for academic achievement.

The educational level of students was looked at before and after they used virtual reality. Many studies adopted this approach to prove the validity of the model. This study proved that there was a clear improvement in the scores before and after the application, and the T-test showed that as well. The researcher confirms these results and says that there is a clear improvement, especially since virtual reality and its features directly affect students' cognitive skills. These results were also consistent with (Lee & Wong, 2014) study, which showed a difference in educational achievement between traditional education and education via virtual reality.

4.12 Quantitative conclusion

Based on the objectives of the study and what was mentioned previously, to study the impact of virtual reality on vocational education and how this will be reflected in the student's academic achievement and motivation, and to develop special hypotheses for each aspect and use different research methods in order to prove this. The study showed the positive impact of virtual reality and students' interactions with it. This was done through the structural model with the first hypothesis, which is that there is a positive effect of ease of use on motivation. Find through statistical analysis of the value of P that there is no positive effect of EOU on M, contrary to what is expected. The researcher believes that the reason for this result is that the study was conducted on Generation Z, who grew up in the light of technology and is accustomed to it. As for the second

hypothesis, the relationship between ease of use and its positive impact on usefulness, the statistical analysis showed the existence of a positive relationship between them and proved the validity of the hypothesis. As for the relationship between usefulness and positive effect on motivation, which appeared through the third hypothesis, the positive relationship between them has been proven. The fourth hypothesis, which states that there is no positive effect between the features of virtual reality and motivation, has also been proven. As for the relationship between usefulness and motivation, the positive effect between them was proven in the fifth hypothesis. The last theory related to the structural model is the sixth hypothesis, where there is a positive effect between cognitive benefits and motivation. As for academic achievement, the effect of virtual reality on academic achievement was studied through the seventh hypothesis, which states: There is no statistically significant effect at $\alpha <= 0.05$ between the average scores of students in the traditional exam and the virtual reality exam for academic achievement. The T-test showed that the alpha value was less than 0.05, and therefore, the null hypothesis was rejected, and the alternative hypothesis was accepted that there is a positive effect of virtual reality on academic achievement. In light of these hypotheses, see the positive impact of virtual reality on students' skills and also the positive impact on academic achievement. The application of virtual reality in vocational education will increase students' skills, develop their technological skills, and raise their academic achievement.

4.13 Qualitative conclusion

First question: What is your opinion on using virtual reality while you study?

The answer of most students is that it is an excellent and useful experience, and this enhances the hypotheses and goals of the study that talk about the effect of virtual reality in vocational education: that it has a positive impact on the students and is truly achieved.

Second question: In your opinion, what are the benefits of using virtual reality in education?

The most important benefits that students mentioned for virtual reality are distance education, which is easier, encourages learning, is clearer in showing parts and three-dimensional objects, and helps students understand. All these benefits are consistent with the previous literature and some variables in the same study, which confirm these benefits.

Third question: What is the difference between studying using virtual reality and studying in the traditional way in terms of:

a) Participation and positivity in learning.

Almost everyone agreed that learning through virtual reality was better than learning through traditional education. In terms of participation, most students prefer virtual reality because it interacts with the class (through the icons provided by the platform), but few students prefer traditional education because it is familiar to them, and they are afraid of the change.

b) Fun and excitement while learning

As for the fun and suspense, everyone is unanimously in favor of virtual reality because it breaks the routine and increases interaction during the lesson.

c) Learning to understand and memorize

As for comprehension and memorization, most of the students agreed on virtual reality because it provides the advantage of recording, and the student can access the class whenever he wants, and also because three-dimensional models help in that.

Fourth question: Do you prefer to study using virtual reality or traditional methods? Why?

The majority of students answered virtual reality, and this enhances the effectiveness of virtual reality and helps improve students' academic levels, benefits, and skills. A few mentioned that they preferred traditional learning.

The rest of the questions are as follows:

Fifth question: Did studying through virtual reality motivate you to study?

Sixth question: Do you recommend generalizing the experience to other lessons?

Seventh question: Do you think that virtual reality is enough in the event of a lack of equipment?

Eighth question: Did you encounter problems while studying using virtual reality? If yes, what are these problems?

Students' unanimous answer was biased towards virtual reality for its advantages and because it helps students' study and understand. It also motivates them to study more. All this is compatible with previous literature and what has been stated about virtual reality and its advantages. It also achieved all the basic study goals, from raising the level of academic students to motivating them to learn.

4.14 Limitations

1. The weakness of the internet in the school and the lack of some technological equipment

   Despite the great technological progress and the Fourth Industrial Revolution, the Internet is its main nerve, and without the Internet, nothing can be done, so it is necessary to provide an appropriate and good Internet in order to properly benefit from technology, and here it must be noted the need to provide the Internet to schools in general and vocational schools in particular. Paying attention to the technological infrastructure of schools and providing computers that serve the largest number of students.

2. The study included only males because there are no similar majors for females.

   Here, it should be noted that females constitute 20% of vocational education students, but the specialty of auto mechanics is not available in Palestine for females, and they were not subjected to this study. There is no doubt that there is a need to apply the study to females in order to know the impact of virtual reality on female vocational students because there is a physiological difference between males and females that may affect the course of study.

3. Dependence on their own laptops, as some of them are of poor quality.

   Schools in Palestine do not provide smart tablets for students, so students depend on their own devices, and these devices vary in quality and suitability for education due to the varying financial income of students and also because some students do not have devices in the first place.

4. This study did not address the negatives of virtual reality.

   But there are positives and negatives, so just as technology has many benefits, there are also negatives, for example, its effect on eyesight when used for a long time, but this study did not address them. Another study can be devoted to examining these effects.

4.15 Recommendations

1. Application of virtual reality in vocational education.

   In light of this study and its results, virtual reality can be applied in vocational education because it has positive effects on students and their skills, such as motivation, cognitive benefits, and usefulness. It also emphasizes enhancing students' technological skills and keeping them in constant contact with technology.
2. Use virtual reality to compensate for the lack of tools and equipment in industrial schools.

   The study also indicated the possibility of using virtual reality in the event of a lack of equipment and tools because of the features it provides that simulate education in the workshops to a large degree. It is also possible to adopt virtual reality in the case of distance education and the absence of workshops and tools.

3. Pay attention to the technological infrastructure of schools to facilitate the application of virtual reality.

   The technological infrastructure represents the main artery of virtual reality to ensure its ideal use. Attention must be given to the school's infrastructure, including the Internet that meets the school’s needs and the provision of sufficient computers commensurate with the number of students and the size of the school.
4. Support professional teachers and provide them with an opportunity to train and deal with virtual reality.

   The teacher is an essential part of the educational process, and he is the facilitator of the educational process. The teacher must be constantly aware of technology and how to deal with it, especially virtual reality, and the special skills it needs. Therefore, it is necessary to provide training for teachers to deal with virtual reality in a distinct manner in order to reflect this on the student and ensure that he gets the desired benefit from virtual reality.

5. Building partnerships with various institutions, such as educational and university institutions and the private sector.

   Schools must have an ongoing relationship with universities and the local market because schools are considered a link between all sectors and an important part of the educational process. To know the needs of the local market or universities and provide them to their students, and to stay in constant contact with the current rapid developments in the markets and promote them among students.

6. Study the impact of virtual reality on each category of Bloom's Taxonomy.

   Studying the effect of applying virtual reality to the six Bloom Taxonomy categories so that the category is identified and the appropriate testing method is chosen for it in order to accurately know the effect of applying virtual reality to each category and to know the extent of this effect for each category, as the categories are knowledge, comprehension, application, analysis, synthesis, and evaluation.

List of Abbreviations

Abbreviation	Meaning
AR	Augmented reality
ETF	European Training Foundation
XR	Extended reality
HISS	Hebron Industrial Secondary School
MoE	Ministry of Education
TVET	Technical and vocational education and training
UNESCO	United Nations Educational, Scientific and Cultural Organization
VR	Virtual Reality
OGPS	One group pretest and posttest study

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Appendices

Appendix A

Table of sources for variables

References	Variables
(Salzman et al., 1999)	Motivation, virtual reality features
(Ai-Lim Lee et al., 2010)	cognitive benefits, motivation
(Makransky & Lilleholt, 2018)	virtual reality features, motivation, cognitive benefits
(Davis, 1989) , (Sun et al., 2008)	Usefulness, ease of use

Appendix B

Illustrations of the platform and what it contains

Figures 1, 2, and 3 show a lesson of the lessons that were created and modified in accordance with the curriculum, as well as the addition of explanations.

Figure 1

The main interface when opening the class and showing the tasks column and icons is "annotation, exploded, transparency, and play animation"

Figure 2

Three-dimensional model with annotations and exploded

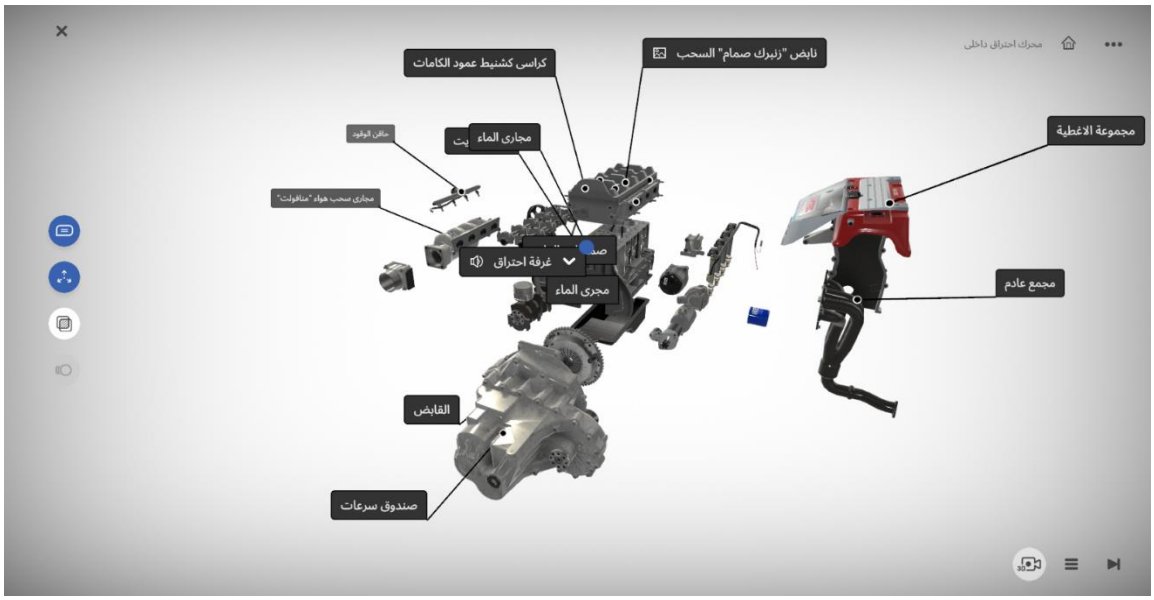
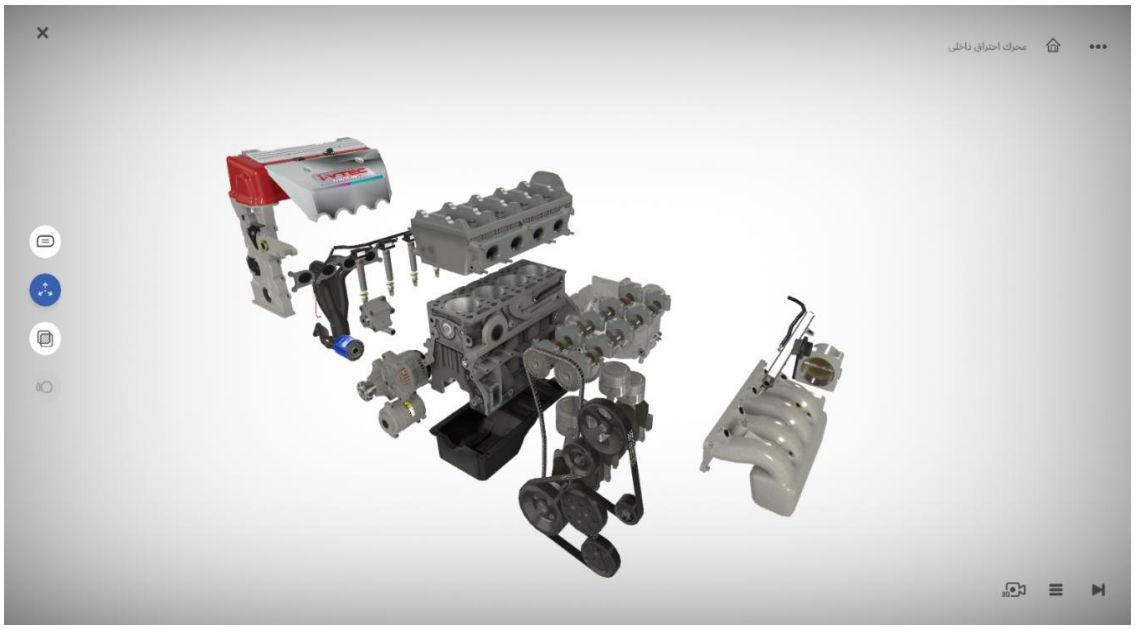


Figure 3

Three-dimensional model with annotations and exploded



Appendix C

Statistical report

9/26/2022, 12:23:05 AM	Youssef Abu Qwaider	3	19:37	69%	Complete

DATE	ACTIVITY	TIME SPENT	SCORE	STATUS
9/26/2022, 12:40:55 AM	*Identify*	*00:26*	*5 / 5*	*Complete*
9/26/2022, 12:34:40 AM	*Quiz*	*00:51*	*5 / 5*	*Complete*
9/26/2022, 12:41:20 AM	*Locate*	*00:05*	*5 / 5*	*Complete*
9/26/2022, 12:40:42 AM	*Locate*	*00:04*	*5 / 5*	*Complete*
9/26/2022, 12:40:06 AM	*Locate*	*00:27*	*0 / 5*	*Complete*
9/26/2022, 12:35:43 AM	*Locate*	*00:29*	*0 / 5*	*Complete*
9/26/2022, 12:29:20 AM	*3D Recording*	*00:29*	*N/A*	*Complete*
9/26/2022, 12:34:29 AM	*Quiz*	*00:05*	*5 / 5*	*Complete*
9/26/2022, 12:34:23 AM	*Quiz*	*00:02*	*5 / 5*	*Complete*
9/26/2022, 12:34:10 AM	*Image*	*00:03*	*0 / 0*	*Complete*
9/26/2022, 12:33:50 AM	*Image*	*00:02*	*0 / 0*	*Complete*
9/26/2022, 12:33:23 AM	*Image*	*00:20*	*0 / 0*	*Complete*
9/26/2022, 12:33:01 AM	*Image*	*00:08*	*0 / 0*	*Complete*
9/26/2022, 12:32:52 AM	*Image*	*00:06*	*0 / 0*	*Complete*
9/26/2022, 12:32:06 AM	*Audio*	*00:35*	*0 / 0*	*Complete*
9/26/2022, 12:31:50 AM	*Audio*	*00:14*	*0 / 0*	*Complete*
9/26/2022, 12:31:00 AM	*Image*	*00:13*	*0 / 0*	*Complete*

Appendix D

Training students on the virtual reality Eon- XR platform

Appendix E

Pre and post exam

State of Palestine
Ministry of Education
Directorate of Education – Hebron
Hebron Industrial Secondary School

دولة فلسطين
وزارة التربية والتعليم
مديرية التربية والتعليم – الخليل
مدرسة الخليل الثانوية الصناعية

الاسم:	التخصص: ميكانيك السارات	امتحان اصيل 1
التاريخ: 2022/10/10	المدة: 45 دقيقة	علامة الامتحان (30)

التعليمات

عزيزي الطالب:

- الاختبار مكون من أربعة أسئلة اجب عن جميع الأسئلة بالإجابة المناسبة.
- السؤال الأول يتكون من (10) فقرات من نوع الاختيار المتعدد، ضع دائرة حول رمز الإجابة الصحيحة منهما، كل فقرة لها إجابة صحيحة واحدة ، ووزن كل فقرة هو علامة واحدة.
- السؤال الثاني والثالث والرابع أسئلة مقالية، حيث تكون الإجابة على الأسئلة في المكان المخصص لها.
- وزن السؤال الثاني هو خمس علامات
- وزن السؤال الثالث هو خمس علامات
- وزن السؤال الرابع هو عشر علامات
- مجموع العلامات جميع الأسئلة هو ثلاثون علامة.

السؤال الأول: اضع دائرة حول رمز الإجابة الصحيحة: **(10 علامات)**

1- الجزء الذي ترتبط به كتلة الأسطوانات من الأعلى هو :

ا- راس المحرك ب- حوض الزيت ج- عامود المرفق د- غطاء رأس المحرك

2- تُصنع الصّمامات من :

ا- الفولاذ ب- الألمنيوم ج- حديد الزهر د- بلاستيك

3- من خلال دراستك لذراع التوصيل، فان نهاية الصغرى توصل مع:

ا- عامود المرفق ب- عامود الحدبات ج- المكبس د- راس المحرك

4- يفصل بين رأس المحرك وكتلة الأسطوانات:

ا- غطاء راس المحرك ب- المكبس ج- حوض الزيت د- كسكيت رأس المحرك

5- الوظيفة الأساسية لرأس المحرك هي:

ا- اغلاق غرف الاحتراق ب- زيادة وزن المحرك
ج- يثبت عليه عامود المرفق د- يثبت عليه مضخة الزيت

6- يسمى غطاء راس المحرك بِـ:

ا- غطاء قشاط التوقيت ب- غطاء الصّبابات ج- غطاء الملفات د- غطاء البكرات

7- من خلال دراستك للصمامات، ما هو الجزء الذي يعمل كقناة لعمود الصمام:

ا- ساق الصمام ب- دليل الصمام ج- زنبرك الصمام د- قاعدة الصمام

8- حركة عمود المرفق هي :

ا- ترددية ب- موجيه ج- دائرية د- خطية

9- تكون نسبة دوران عامود المرفق الى عامود الحدبات هي :

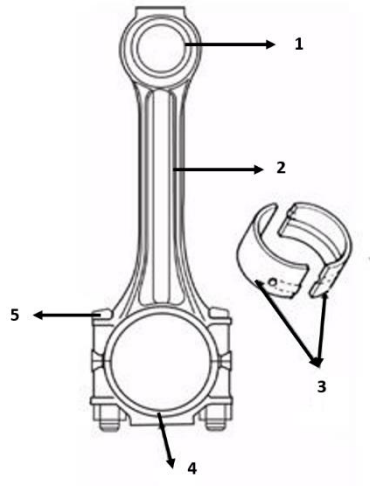
ا- 1:4 ب- 1:2 ج- 3:1 د- 1:3

10- من محتويات رأس المحرك:

ا- ذراع التوصيل ب- عامود المرفق

ج- الصمامات د- عجلة الحذافة

يتبع



السؤال الثاني: حدد أسماء القطع المشار لها في الشكل التالي: (5 علامات)

1- _____

2- _____

3- _____

4- _____

5- _____

السؤال الثالث : (5 علامات)

1- وضح مما يتكون عامود المرفق (محتوياته) . (2 علامات)

_____

_____

_____

_____

2- عدد وظائف عجلة الحذافة .

_____

_____

_____

السؤال الرابع **(10 علامة)**

1- علل ما يلي:

1- استخدام حلقات الضغط حول المكبس؟ **(علامة ونصف)**

_____

_____

2- استخدام حلقات الزيت حول المكبس؟

_____

_____

2- وضح ما هو عامود الحدبات، و طرق نقل الحركة له؟

_____

_____

_____

3- اذكر أنواع الصمامات المستخدمة في المحرك و قارن بينهما من حيث:

المقارنة من حيث / النوع	الوظيفة	القطر
صمام السحب		
صمام العادم		

مع تمنياتنا لكم بالتوفيق والنجاح

State of Palestine
Ministry of Education
Directorate of Education – Hebron
Hebron Industrial Secondary School

دولة فلسطين
وزارة التربية والتعليم
مديرية التربية والتعليم – الخليل
مدرسة الخليل الثانوية الصناعية

الاسم:	**التخصص: ميكانيك السارات**	**امتحان اصيل 1**
التاريخ: 2022/11/6	**المدة: 45 دقيقة**	**علامة الامتحان (30)**

السؤال الأول: اضع دائرة حول رمز الإجابة الصحيحة : (10 علامات)

1- الوظيفة الأساسية لرأس المحرك هي:

ا- اغلاق غرف الاحتراق ب- زيادة وزن المحرك ج- يثبت عليه عمود المرفق د- يثبت عليه مضخة الزيت

2- من محتويات رأس المحرك :

ا- ذراع التوصيل ب- عامود المرفق ج- الصمامات د- عجلة الحذافة

3- يسمى غطاء راس المحرك بِـ :

ا- غطاء قشاط التوقيت ب- غطاء الصّبابات ج- غطاء الملفات د- غطاء البكرات

4- يفصل بين رأس المحرك وكتلة الأسطوانات :

ا- غطاء راس المحرك ب- المكبس ج- حوض الزيت د- كسكيت رأس المحرك

5- تُصنع الصّمامات من :

ا- الفولاذ ب- الألمنيوم ج- حديد الزهر د- بلاستيك

6- تكون نسبة دوران عمود المرفق الى عمود الحدبات هي :

ا- 2:1 ب- 1:2 ج- 3:1 د- 1:3

7- ترتبط كتلة الأسطوانات من الأعلى بـ :

ا- غطاء راس المحرك ب- حوض الزيت ج- عمود المرفق د- غطاء رأس المحرك

8- حركة عمود المرفق هي :

ا- ترددية ب- موجيه ج- دائرية د- خطية

9- من خلال دراستك للصمامات، ما هو الجزء الذي يعمل كقناة لعمود الصمام:

ا- ساق الصمام ب- دليل الصمام ج- زنبرك الصمام د- قاعدة الصمام

10- من خلال دراستك لذراع التوصيل، فان نهاية الصغرى توصل مع:

ا- عمود المرفق ب- عمود الحدبات ج- المكبس د- راس المحرك

السؤال الثاني: عرف ما يلي (4 علامات)

3- عرف عمود الحدبات. (2 علامات)

4- عرف عجلة الحذافة . (2 علامات)

السؤال الثالث : (11 علامة)

4- ما أنواع حلقات المكبس ؟ وما وظائفها . (5 علامات)

5- ما وظيفة المكبس . (2 علامات)

6- اذكر أنواع الصمامات المستخدمة في المحرك و قارن بينهما من حيث : (4 علامات)

المقارنة من حيث / النوع	الوظيفة	القطر
صمام السحب		
صمام العادم		

السؤال الرابع:

1- حدد أسماء القطع المشار لها في الشكل التالي: (5 علامات)

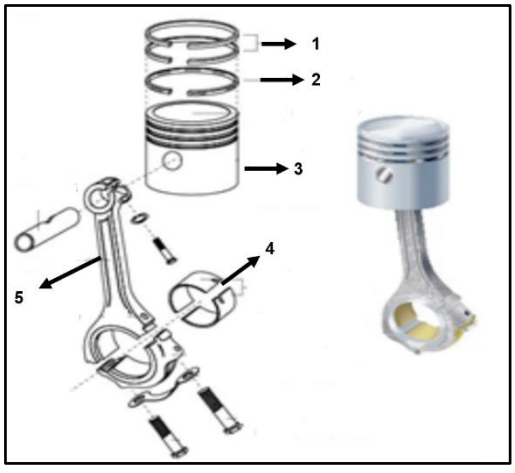
1- _____

2- _____

3- _____

4- _____

5- _____



مع تمنياتنا لكم بالتوفيق والنجاح

Appendix A

Class links on the platform

Test session link Fourth-class link

https://share.eon-xr.com/lesson/424/302226

First-class link: Internal combustion engine 1

https://share.eon-xr.com/lesson/424/302224

second-class link: Connecting shaft and piston

https://share.eon-xr.com/lesson/424/357045

Third-class link: Internal combustion engine 2

https://share.eon-xr.com/lesson/424/359222

Fourth-class link: Moving parts

https://share.eon-xr.com/lesson/424/350102

Appendix G

The intended objectives of the lessons

الأهداف :

الرقم	الأهداف	المستوى
1	**ان يعدد الطالب أجزاء محرك الرأس**	تذكر
2	**ان يبن الطالب الفرق بين أنواع الصمامات**	تقويم
3	**ان يوضح الطالب وظيفة كاسكيت الراس المحرك**	فهم
4	**ان يعدد الطالب أجزاء الصمام**	تذكر
5	**ان يلخص الطالب عمود الحدبات وطريقة نقل الحركة له**	فهم
6	**ان يكتشف الطالب عدد دورات عمود الحدبات الى عمود المرفق**	تحليل
7	**ان يعدد الطالب أجزاء كتلة الأسطوانات**	تذكر
8	**ان يوضح الطالب ما هو المكبس**	فهم
9	**ان يعلل الطالب أسباب استخدام حلقات المكبس**	فهم
10	**ان يذكر الطالب وظيفة حوض الزيت**	تذكر
11	**ان يعين الطالب أجزاء ذراع التوصيل**	تطبيق
12	**ان يوضح الطالب الأجزاء المرتبطة بعمود المكبس**	فهم
13	**ان يعدد الطالب وظائف عجلة الحذافة**	تذكر
14	**ان وضح الطالب مكونات عمود المرفق**	فهم

Appendix H

The objective of each question in the exam

جدول مواصفات الاختبار النهائي:

الفرع	السؤال الأول:	المستوى
1	الوظيفة الأساسية لرأس المحرك هي	فهم
2	من محتويات رأس المحرك	تذكر
3	يسمى غطاء راس المحرك بـ	تذكر
4	يفصل بين رأس المحرك وكتلة الأسطوانات	فهم
5	تُصنع الصّمامات من	تذكر
6	تكون نسبة دوران عامود المرفق الى عامود الحدبات هي	تحليل
7	الجزء الذي ترتبط به كتلة الأسطوانات من الأعلى هو	تذكر
8	حركة عمود المرفق هي	فهم
9	من خلال دراستك للصمامات، ما هو الجزء الذي يعمل كقناة لعمود الصمام	تذكر
10	من خلال دراستك لذراع التوصيل، فان نهاية الصغرى توصل مع	تذكر
	السؤال الثاني	
1	وضح مما يتكون عامود المرفق "محتوياته"	فهم
2	عدد وظائف عجلة الحذافة	تذكر
	السؤال الثالث	
1	علل ما يلي : استخدام حلقات الضغط حول المكبس؟	فهم
1	علل ما يلي : استخدام حلقات الزيت حول المكبس	فهم
2	وضح ما هو عامود الحدبات، وماهي طرق نقل الحركة له	فهم
3	اذكر أنواع الصمامات المستخدمة في المحرك و قارن بينهما من حيث:	فهم
	السؤال الرابع	
1	حدد أسماء القطع المشار لها في الشكل التالي	تطبيق

Appendix I

The Typical answer for the pre and post test

State of Palestine
Ministry of Education
Directorate of Education – Hebron
Hebron Industrial Secondary School

دولة فلسطين
وزارة التربية والتعليم
مديرية التربية والتعليم – الخليل
مدرسة الخليل الثانوية الصناعية

الاسم: الإجابة النموذجية	التخصص: ميكانيك السارات	امتحان اصيل 1
التاريخ: 2022/10/9	المدة: 45 دقيقة	علامة الامتحان (30)

التعليمات:

عزيزي الطالب:

- **الاختبار مكون من أربعة أسئلة اجب عن جميع الأسئلة بالإجابة المناسبة.**
- **السؤال الأول يتكون من (10) فقرات من نوع الاختيار المتعدد، ضع دائرة حول رمز الإجابة الصحيحة منهما، كل فقرة لها إجابة صحيحة واحدة ، ووزن كل فقرة هو علامة واحدة.**
- **السؤال الثاني والثالث والرابع أسئلة مقالية، حيث تكون الإجابة على الأسئلة في المكان المخصص لها.**
- **وزن السؤال الثاني هو خمس علامات**
- **وزن السؤال الثالث هو عشر علامات**
- **وزن السؤال الرابع هو خمس علامات**
- **مجموع العلامات جميع الأسئلة هو ثلاثون علامة.**

السؤال الأول: اضع دائرة حول رمز الإجابة الصحيحة: **(10 علامات)**

1- الوظيفة الأساسية لرأس المحرك هي:

ا- اغلاق غرف الاحتراق ب- زيادة وزن المحرك ج- يثبت عليه عامود المرفق د- يثبت عليه مضخة الزيت

2- من محتويات رأس المحرك:

ا- ذراع التوصيل ب- عامود المرفق ج- الصمامات د- عجلة الحذافة

3- يسمى غطاء راس المحرك بِـ:

ا- غطاء قشاط التوقيت ب- غطاء الصّبابات ج- غطاء الملفات د- غطاء البكرات

4- يفصل بين رأس المحرك وكتلة الأسطوانات:

ا- غطاء راس المحرك ب- المكبس ج- حوض الزيت د- كسكيت رأس المحرك

5- تُصنع الصّمامات من :

ا- الفولاذ ب- الألمنيوم ج- حديد الزهر د- بلاستيك

6- تكون نسبة دوران عامود المرفق الى عامود الحدبات هي :

ا- 2:1 ب- 1:2 ج- 3:1 د- 1:3

7- الجزء الذي ترتبط به كتلة الأسطوانات من الأعلى هو :

ا- راس المحرك ب- حوض الزيت ج- عامود المرفق د- غطاء رأس المحرك

8- حركة عمود المرفق هي :

ا- ترددية ب- موجيه ج- دائرية د- خطية

9- من خلال دراستك للصمامات، ما هو الجزء الذي يعمل كقناة لعمود الصمام:

ا- ساق الصمام ب- دليل الصمام ج- زنبرك الصمام د- قاعدة الصمام

10- من خلال دراستك لذراع التوصيل، فان نهاية الصغرى توصل مع:

ا- عامود المرفق ب- عامود الحدبات ج- المكبس د- راس المحرك

السؤال الثاني: (5 علامات)

5- وضح مما يتكون عامود المرفق (محتوياته) . (2 علامات)

يتكون من محاور مركزية ثابتة تدور في مكانها، ومحاور أخرى لا مركزية متحركة تركب عليها اذراع التوصيل

ويحتوي أيضا مجارٍ للزيت لتمرير من المحاور الثابتة الى المحاور المتحركة كما ويحتوي اثقال للتوازن

6- عدد وظائف عجلة الحذافة . (3 علامات)

تخزين الطاقة الحركية للاستفادة منها عند انخفاض السرعة

يستخدم كترس لبدء تشغيل المحرك بتعشيقة الى بادئ الحركة

يركب عليها مجموعة القابض

نقل القدرة من المحرك الى مجموعة القابض

السؤال الثالث : (10 علامة)

1- علل ما يلي :

1- استخدام حلقات الضغط حول المكبس؟ (علامة ونصف)

منع تسرب الضغط او المزيج الى وعاء الزيت.

2- استخدام حلقات الزيت حول المكبس؟ (علامة ونصف)

منع وصول الزيت الى غرفة الاحتراق وذلك بقشط بقايا الزيت عن جدار الأسطوانة الداخلي اثناء نزول المكبس.

2- وضح ما هو عامود الحدبات، و طرق نقل الحركة له؟ (3 علامات)

هو عبارة عن عامود يحتوي نتوءات تسمى الحدبات، تُخرط مع العامود نفسه عند صنعه، ويقوم هذا العامود بالتحكم بفتح الصمامات واغلاقها بالوقت والترتيب المطلوب

قشاط مسنن

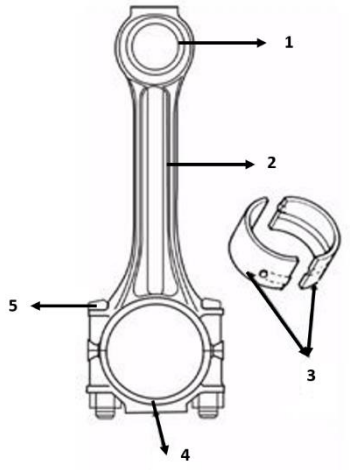
عن طريق جنزير

عن طريق مسننات

7- اذكر أنواع الصمامات المستخدمة في المحرك و قارن بينهما من حيث: (4 علامات)

المقارنة من حيث / النوع	الوظيفة	القطر
صمام السحب	تتحكم في دخول المزيج	تتحكم بخروج غازات العادم
صمام العادم	اصغر من صمام السحب	اكبر من صمام العادم

السؤال الرابع: حدد أسماء القطع المشار لها في الشكل التالي: (5 علامات)



6- النهاية الصغري

7- ذراع التوصيل

8- بطانة الاحتكاك كوشنيط

9- النهاية الكبرى

10- مسمار الربط

مع تمنياتنا لكم بالتوفيق والنجاح

Appendix J

Names of experts and specialists in the arbitration committee

Number	Name	Academic degree	University
1	Yahya Saleh	Associate Professor	An-Najah National University
2	Nabil AL-Joulani	Full Professor	Palestine Polytechnic University
3	Randa El Sheikh Najdi	Associate Professor	Al-Quds Open University
4	Raja Al-Osaily	Associate Professor	Al-Quds Open University
5	Sameer Aljamal	Full Professor	Palestine Ahliya University

Appendix K

The questionnaire

استبيان بعنوان: فاعلية استخدام الواقع الافتراضي في التعليم المهني.

The effectiveness of using virtual reality in vocational education.

يقوم الباحث بدراسة تحت عنوان**" فاعلية استخدام الواقع الافتراضي في التعليم المهني "** وذلك استكمالاً لمتطلبات الحصول على درجة الماجستير في الإدارة الهندسية من جامعة النجاح الوطنية. ولتحقيق اهداف الدراسة، قام الباحث بإعداد هذا الاستبيان معتمداً على ما جاء في أدبيات الأبحاث العملية، والدراسات السابقة. لذا يرجى منكم التكرم بالإجابة عن فقرات هذا الاستبيان بكل موضوعية وامانه لأن ذلك سوف ينعكس على نتائج الدراسة التي سيستفيد منها عدد كبير من مدرسين وطلاب التعليم المهني في فلسطين، علماً بأن البيانات هي لأغراض البحث العلمي فقط، وسيتم التعامل معها بموضوعية وأمانة وسرية تامة.

الباحث: لؤي أبو شمسية

رقم الهاتف: 0595790554

وتقبلوا فائق الاحترام

القسم الأول: البيانات الشخصية والعامة:

1- التخصص:

□ ميكانيك السيارات

□ اتوميكاترونكس

2- هل تمتلك خبرات سابقة في ميكانيك السيارات؟

□ نعم

□ لا

3- هل تمتلك هاتف محمول؟

□ نعم

□ لا

4- كم ساعة في اليوم تستخدم جهاز الهاتف المحمول؟

□ اقل من ساعة

□ من ساعة الى ساعتين

□ ساعتين الى ثلاث ساعات

□ ثلاث الى اربع ساعات

□ اكثر من اربع ساعات

5- بماذا تستخدم هاتفك المحمول؟

□ الدراسة

□ وسائل التواصل الاجتماعي

□ الألعاب

□ الانترنت

□ أخرى، _____

6- هل كنت تعلم شيء عن الواقع الافتراضي قبل هذا الدرس؟

□ لم أكن أعرف شيئًا عن الواقع الافتراضي

□ كان لدي بعض المعرفة عن الواقع الافتراضي

□ كان لدي الكثير من المعرفة حول الواقع الافتراضي

□ كانت لدي بعض الخبرات مع برامج كمبيوتر الواقع الافتراضي

القسم الثاني: عملية التعلم

	العناصر	موافق بشدة	موافق	محايد	غير موافق	غير موافق بشدة
	ميزات الواقع الافتراضي VR features					
VRF1	المجسمات ثلاثية الأبعاد تجعل التعلم أكثر إثارة للاهتمام.					
VRF2	القدرة على تغيير موضع الاجسام ثلاثية الأبعاد تجعل التعلم أكثر إثارة للاهتمام.					
VRF3	القدرة على التعامل مع الأشياء خلال البيئة الافتراضية تساعد في تعزيز فهمي.					
	الفائدة التقنية Usefulness					
U1	استخدام هذا النوع من محاكاة الواقع الافتراضي يؤدي إلى تعزيز فعالية التعلم.					
U2	ساعدني هذا النوع من المحاكاة في تطوير مهارتي التقنية					
U3	استطيع التعامل مع برامج المحاكاة المشابهة دون تردد.					
	سهولة الاستخدام Ease of use					
EOU1	تعلم وتشغيل هذا النوع من برامج الواقع االافتراضي أمر سهل بالنسبة لي					
EOU2	من السهل عليّ العثور على معلومات باستخدام برنامج الواقع الافتراضي.					
	الدافعية Motivation					
M1	اجد متعه في استخدام محاكاة الواقع الافتراضي					
M2	أشعر بالتسلية عند استخدام محاكاه الواقع الافتراضي.					
M3	اشجع الطلاب الاخرين على التعلم من خلال محاكاه الواقع الافتراضي					
	الفوائد المعرفية Cognitive benefits					
COB1	برامج الواقع الافتراضي تجعل الفهم أسهل.					
COB2	برامج الواقع الافتراضي تجعل الحفظ أسهل.					
COB3	ساعدني هذا النوع من برامج الواقع الافتراضي على تطبيق ما تم تعلمه بشكل أفضل.					

Appendix L

Table of sources for each question in the questionnaire

Name in the questionnaire	The question	References
VRF1	3D objects make learning more interesting.	(Ai-Lim Lee et al., 2010)
VRF2	The ability to change the position of 3D objects makes learning more interesting.	(Dhinakaran, 2017)
VRF3	Being able to manipulate things through the virtual environment helps enhance my understanding.	(Ai-Lim Lee et al., 2010)
U1	The use of this type of virtual reality simulation leads to enhanced learning effectiveness.	(Shen et al., 2022a)
U2	This type of simulation helped me develop my technical skills.	Self-develop
U3	I can handle similar emulators without hesitation.	(Ai-Lim Lee et al., 2010)
EOU1	Learning and running this kind of virtual reality software is easy for me.	(Shen et al., 2022a)
EOU2	It's easy for me to find information with virtual reality software.	(Shen et al., 2022a)
M1	I find it fun to use virtual reality simulators.	(Shen et al., 2022a)
M2	I am entertained when using the virtual reality simulator.	(Shen et al., 2022a)
M3	I encourage other students to learn through virtual reality simulations.	(Ai-Lim Lee et al., 2010)

COB1	Virtual reality software makes understanding easier.	(Ai-Lim Lee et al., 2010)
COB2	Virtual reality software makes memorization easier.	(Ai-Lim Lee et al., 2010)
COB3	This kind of virtual reality program helped me better apply what I learned.	(Ai-Lim Lee et al., 2010)

Appendix M

Table for sample size recommendation in PLS-SEM for a statistical

Maximum Number of Arrows Pointing at a Construct (Number of Independent Variables)	Significance Level											
	10%				5%				1%			
	Minimum R^2				Minimum R^2				Minimum R^2			
	0.10	0.25	0.50	0.75	0.10	0.25	0.50	0.75	0.10	0.25	0.50	0.75
2	72	26	11	7	90	33	14	8	130	47	19	10
3	83	30	13	8	103	37	16	9	145	53	22	12
4	92	34	15	9	113	41	18	11	158	58	24	14
5	99	37	17	10	122	45	20	12	169	62	26	15
6	106	40	18	12	130	48	21	13	179	66	28	16
7	112	42	20	13	137	51	23	14	188	69	30	18
8	118	45	21	14	144	54	24	15	196	73	32	19
9	124	47	22	15	150	56	26	16	204	76	34	20
10	129	49	24	16	156	59	27	18	212	79	35	21

Appendix N

Interview questions

Interview questions

أسئلة المقابلة

The effectiveness of using virtual reality in vocational education

فاعلية استخدام الواقع الافتراضي في التعليم المهني.

1- ما رايك في استخدام الواقع الافتراضي خلال دراستك ؟

2- في رايك ما هي فوائد استخدام الواقع الافتراضي في التعليم؟

3- هل تفضل الدراسة باستخدام الواقع الافتراضي ام الطريقة الاعتيادية؟ لماذا؟

4- ما الفرق بين الدراسة باستخدام الواقع الافتراضي والدراسة بالطريقة الاعتيادية من حيث:

- المشاركة والإيجابية في التعلم
- المتعة والتشويق خلال التعلم
- التعلم "الفهم والحفظ"

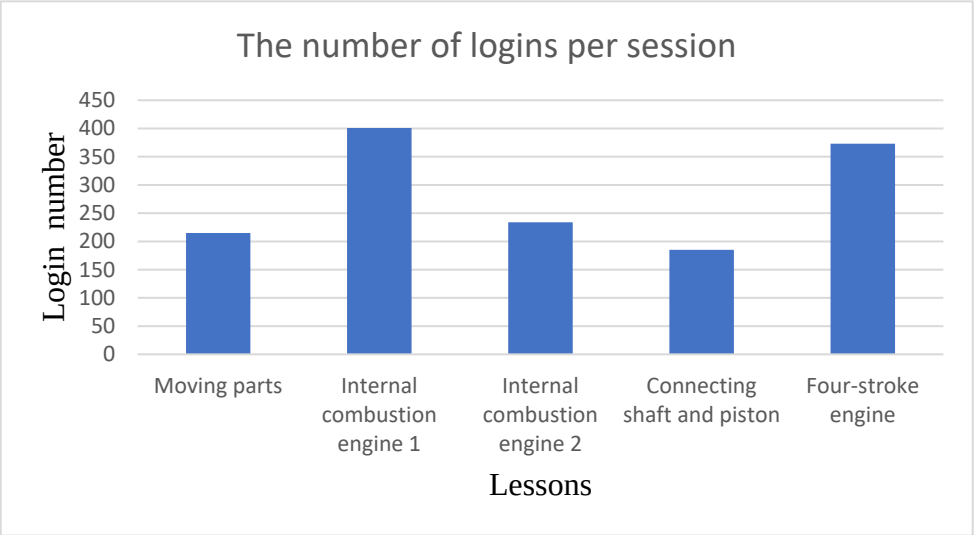
5- هل واجهتك مشكلات اثناء الدراسة باستخدام الواقع الافتراضي؟ في حال الإجابة بنعم، ما هي هذه المشكلات؟

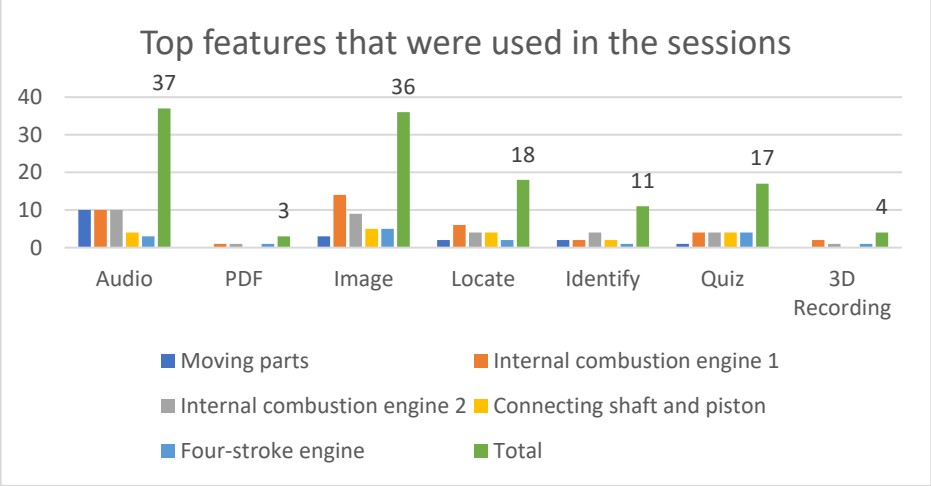
6- هل كانت الدراسة من خلال الواقع الافتراضي محفزاً لك للدراسة؟

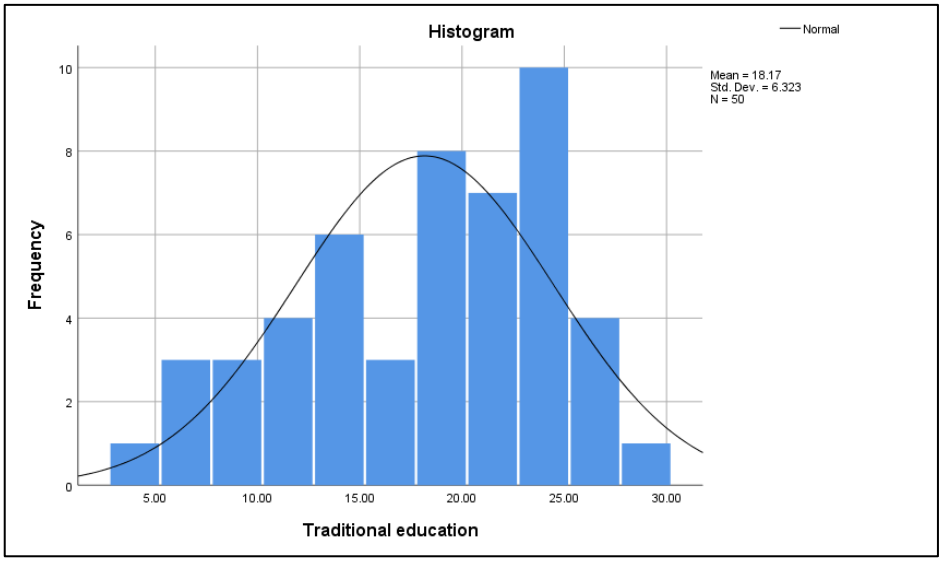
7- هل تنصح بتعميم التجربة على دروس أخرى؟

Appendix O

Platform Analysis "Number of logins & Top features".







Appendix P

Distribution of pre and post exam marks

Distribution of pre-examination marks.

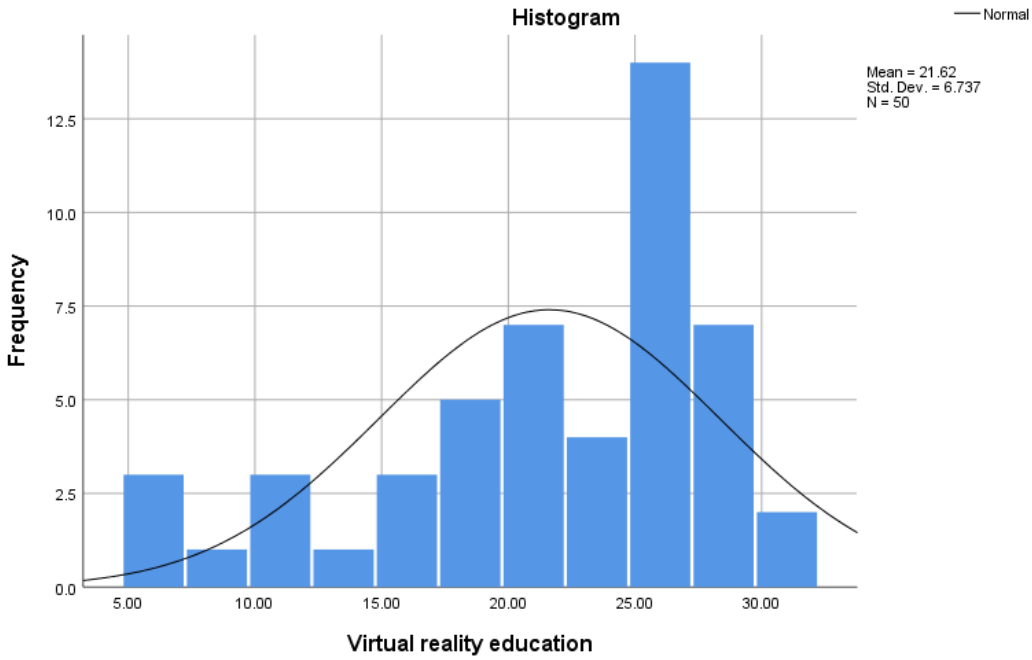
Distribution of post-examination marks.

Appendix Q

Paired Samples Test

Paired Samples Test

		Paired ... 95% Confidence Interval of the ... Upper	t	df	Sig. (2-tailed)
Pair 1	Traditional education - Virtual reality education	-2.37766	-6.465	49	.000



Appendix R

Outer Loadings

Outer Loadings					
	COB	EOU	M	USE	VRF
COB1	0.732				
COB2	0.824				
COB3	0.817				
EOU1		0.717			
EOU3		0.846			
M2			0.802		
M3			0.879		
U1				0.873	
U2				0.703	
U3				0.690	
VRF1					0.941
VRF3					0.909

Appendix S

Collinearity statics VIF

Collinearity statics VIF	
	VIF
COB1	1.321
COB2	1.411
COB3	1.409
EOU1	1.059
EOU3	1.059
M2	1.213
M3	1.213
U1	1.174
U2	1.174
VRF1	2.044
VRF2	2.044

جـامعـــة النجاح الوطنية

كليـــة الدراســـات العليـــا

فاعلية استخدام الواقع الافتراضي في التعليم المهني

إعداد

لؤي لطفي أبو شمسية

إشراف

أ.د علام موسى

قدمت هذه الرسالة استكمالا لمتطلبات الحصول على درجة الماجستير في الإدارة الهندسية، من كلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس– فلسطين.

2023

فاعلية استخدام الواقع الافتراضي في التعليم المهني

إعداد
لؤي لطفي أبو شمسية
إشراف
أ.د علام موسى

الملخص

هدفت هذه الدراسة لمعرفة اثر استخدام الواقع الافتراضي في التعليم المهني، من اجل رفع مستوى التحصيل الدراسي للطلبة وتعزيز مهارتهم وزيادة الدافعية للطلاب نحو التعلم، وشملت هذه الدراسة طلاب الصف الحادي عشر في الفرع المهني تحصص ميكانيك السيارات واتوميكاترونكس السيارات في فلسطين. استخدم الباحث المنهجين الكمي والنوعي في جمع المعلومات وتحليلها حيث بلغ حجم العينة المحددة ٥٠ طالب.

وللتأكد من رفع مستوى التحصيل الدراسي لدى الطلبة، استخدم الباحث الامتحان القبلي والبعدي من اجل مقارنة التعلم التقليدي مع التعلم من خلال الواقع الافتراضي، وكانت نتائج التحصيل الدراسي ايجابية حيث بلغ قيمة الاختبار الثنائي للامتحان البعدي0.835 وقيمة معامل الأهمية =0.00 وهذا يدل على تحسن المستوى الدراسي للطلبة.

واثبت الواقع الافتراضي كفاءته في تعزيز مهارات الطلبة ورفع الدافعية للتعلم لديهم من خلال عدة متغيرات شملتها الدراسة وهم: سهولة الاستخدام، الفائدة التقنية، الدافعية، مميزات الواقع الافتراضي، الفوائد المعرفية. تم بناء استبيان وفقاً لهذه المتغيرات، وتم تحليل النتائج باستخدام برنامج Smart–PLS، واكدت النتائج على وجود اثر ايجابي للفائدة التقنية على الدافعية وايضا اثر ايجابي لسهولة الاستخدام على الفائدة التقنية، كذلك الامر كان لخصائص الواقع الافتراضي اثر إيجابي على الفائدة التقنية، وأيضا وجود اثر ايجابي قوي للدافعية على الفوائد المعرفية، اما سهولة الاستخدام ومميزات الواقع الافتراضي لم يكن لهم تأثير ايجابي على الدافعية.

واطلاقاً من هدة النتائج، اوصى الباحث استخدام الواقع الافتراضي في التعليم، لما له من اثار ايجابية في رفع مستوى الطلبة، وتعزيز مهارتهم وزيادة الدافعية لدى الطلا للتعلم، مما ينعكس ايجاباً على قدراتهم ومهارتهم، ويسهل عملية انخراطهم في سوق العمل.

الكلمات المفتاحية: تحفيز؛ تكنولوجيا؛ الواقع الافتراضي؛ التعليم المهني.