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The effect of blended learning on the achievement of ninth grade students in science and their attitudes towards its use

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ABSTRACT

This study aimed to investigate the effects of blended learning on ninth grade students' achievement in science and their attitudes towards using it. It compares the results of various ways of teaching science topics, and students' attitudes towards their use. The study was conducted using a quasi-experimental design case study. The participants of the study were 112 students, divided into two groups: one an experimental group (n = 61) and the other a control group (n = 51). An achievement test and questionnaire were designed to confirm the study's validity and reliability. SPSS was used to analyze the data. The findings revealed that there were statistically significant differences between the experimental and the control groups, in favor of the experimental group, and the experimental group's attitudes were also more positive towards the using of blended learning. Their attitudes were in favor of students with academic performance in a science subject of the Performance level (Pass). The study recommends further research into the use of blended learning in higher education institutions.

1. Introduction

Over the present century, the world has witnessed revolution and rapid changes in information technology (ICT) and the internet in all aspects, particularly in the education sector. This has prompted educational institutions and experts in curricula to introduce radical changes in their policy and educational planning to respond and align with this change and development (Choshin and Ghaffari, 2017; Lim and Morris, 2009; Vella- Brodrick and Klein, 2010). Today web applications are widely used by various stakeholders, including students, trainers, and academic staff and ICT staff (Alsabawy et al., 2016; Islam, 2016). Furthermore, Aparicio et al. (2017) point out that access to the internet now guarantees access to universal education at the lowest cost, if not for free.

E-learning refers to the use of advanced information communication technology in the learning process, where advanced technology consists of electronic media (Thomas & Graham, 2019). It is a new pattern of education imposed by the new scientific and technical changes taking place in the world today due to the inability of traditional teaching strategies and teaching methods to keep pace with these changes, given the changing role of both teacher and student (Harandi, 2015; Gorbi, 2013). According to Zare et al. (2016), e-learning is now considered one of the most important educational environments in the information age. Research findings have supported the use of technology in teaching, and the advantage educational institutions like universities and schools stand to gain from the use of technology and the internet (Bøe, 2018). This has promoted a shift from a teacher-centered approach to learning to a more student-centered one (Bøe, 2018).

1.1. E-learning (online learning)

E-learning has become a popular approach to effective learning within the wider academic community. One consequence of this has been a shift in the focus in education, from teaching itself to learning and student skills (Keržič et al., 2018). E-learning has become a popular approach to effective learning within the wider academic community because of the extensive use of web systems in learning. There are a range of benefits of learning supported by technology, or e-learning. It is largely flexible, allowing learning to occur at a distance, at a time and pace appropriate to the needs of the students (Allan and Lawless, 2005; Kimathi and Zhang, 2019). Suresh, Priya, and Gayathri (2018) pointed out that updating electronic content is easier than updating printed material: e-learning technologies allow educators to review their content quickly and easily. E-learning began in the 1980s and 1990s as computer-based courses provided on stand-alone disks. In the late 1990s, such educational courses came to be hosted on internal networks, and

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after that they were put on learning management systems (LMSs) in the late 1990s (Abdullah and Ward, 2016; Hubackova, 2015). E-learning now refers to anything that is offered, enabled, or mediated by electronic technology for the clear purpose of learning. With the advent of smartphones and tablets and other devices, e-learning has gained great popularity in the various countries due to diverse social and economic standards and increasing demand for education (Sekhon and Hartley, 2014).

Aristovnik et al. (2017) pointed out that e-learning is effective because it removes distance and subsequent changes. This term presently includes stand-alone computer-based training, online or web-based learning, and learning mediated by mobile phones, tablets and other devices. E-learning is a comprehensive term that describes learning done on a computer, usually connected to a network, giving students' opportunity to learn anytime, anywhere (Aleksander et al., 2017; Oye et al., 2010). E-learning also includes learner–learner interactions, such as those that may occur in the online learning society (Al-Hariri and Al-Hattami, 2017). On the other hand, some researchers consider e-learning simply as a form of training to learn and communicate across computers, networks or other electronic sources (Lin et al., 2017; Roffe, 2002; Schank, 2002; Sambrook, 2003). Further, various studies have shown the benefits and advantages from the application of e-learning technologies into schools. Some of these include: e-learning is flexible when taking the time and place of learning into account as an issue; it enhances the effectiveness of knowledge through easy access to a vast amount of information; it is cost-effective because students are not required to travel; it takes into account individual differences among students; and the use of e-learning allows self-advancement (Algahtani, 2011; Klein and Ware, 2003; Marc, 2002; Nichols, 2003; Umek et al., 2015). Arkorful and Abaidoo (2016) refer to model for using e-learning in education as shown in Fig. 1.

1.2. E-learning in UAE schools

Gone are the traditional classroom days: one teacher, dusty classrooms, stifling walls in the classroom, and teacher-centered education. The Federal Government of the UAE has developed a very clear strategy to implement the latest educational techniques to improve teaching and learning methodologies at all levels of schools in the Ministry of Education. Schools of the Ministry of Education in the UAE now use technology in the classroom by employing the virtual classroom. An increasing number of schools in the UAE depend on e-learning programs in order to improve the quality of student education. This means that students can learn better through interaction with the computerized educational programs for the topics textbooks, get their homework and activities online, interact with other students and take part in educational discussions. In October 2018, the UAE Ministry of Education launched a free e-learning platform. This platform provides free educational multimedia in the form of videos, in the Arabic language, in general science, math, biology, chemistry, and physics. It also provides nearly 11 million words of educational content to students in all educational stages in UAE schools (Official Portal of the UAE, 2018).

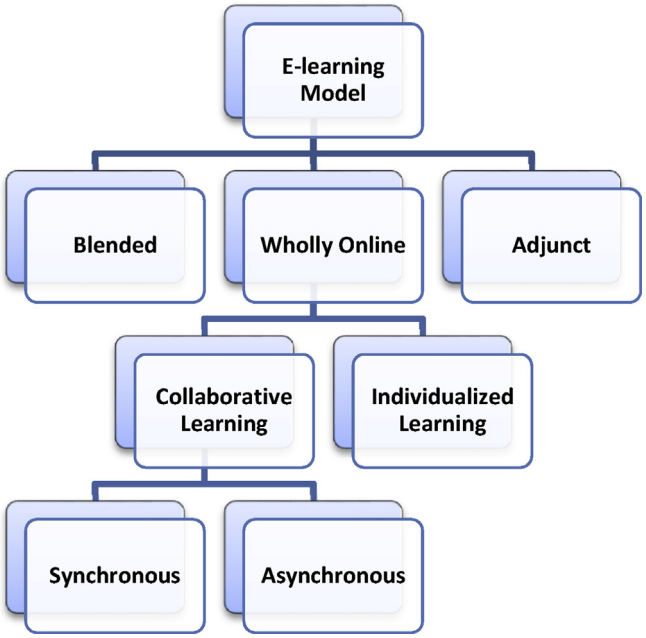

Fig. 1. Model for using E-learning in education (Arkorful and Abaidoo, 2016).

1.3. Blended learning

In the late 1990s, blended learning (or mixed or hybrid learning) emerged as a new teaching method for distance learning through the application of technology and the internet to improve students' learning and encourage teachers' to change their methods of education, and therefore to shift learning to a more student-centered model rather than a teacher-centered learning model (Taylor, 1995). There are many definitions of blended learning, but most have in common that they point to the combination of virtual and physical environments. In spite of the multiplicity of blended learning definitions, all emphasize that it is a learning strategy that integrates various models of traditional and distance learning and uses multiple forms of technology (Akbarov et al., 2018; Clark and Mayer, 2003). Volchenkova (2016) pointed out that blended learning is a form of learning that combines the best of direct classroom learning and learning through the internet by using its applications. Also, blended learning has been defined as a program that uses more than one method to communicate information in order to activate learning outcomes by the interaction between both student and teacher (Clark and Mayer, 2003; Dziuban et al., 2018). Khamis (2003) confirmed that blended learning is known as an integrated system designed to help students during each stage of their learning by using of traditional learning with e-learning in its different forms inside the classroom. According to Kavitha and Jaisingh (2018) and Singh (2003), blended learning is one of the forms of e-learning in which e-learning is integrated into traditional classroom learning, using a computer, intranet or smart classroom, where the teacher meets the student face-to-face and interaction between students and teachers is built into the course design. It arose as a natural development of programmed and electronic learning. From the previous definitions of blended learning, the researchers identified blended learning as a new learning strategy that blends traditional learning in its various forms and e-learning in its various models, in order to increase student motivation and improve their learning achievement, as shown in Fig. 2.

Additionally, the characteristics of blended learning are summarized as follows (Driscoll, 2002; Graham, 2006; Whitelock and Jelfs, 2003):

- Blended learning strategy combines different types of internet-based technology to achieve educational goals.
- The blended learning strategy is a hybrid of traditional methods of education with technology and the internet.
- Blended learning integrates different teaching methods based on multiple theories such as Constructivism and Behavioral theory.
- Blended learning is an education program that consists of in-person classroom time as well as individual study online through e-learning applied and the internet.

In addition, Susan and Chris (2015) point out that the most salient benefits of blended learning are: it is more effective in its use of classroom time, students are more active, students will be more creative, students are better prepared, it is more interesting for students, and it provides the possibility of offering many educational resources for students. Further Bersin and Associates (2003) suggest that the best way to implement

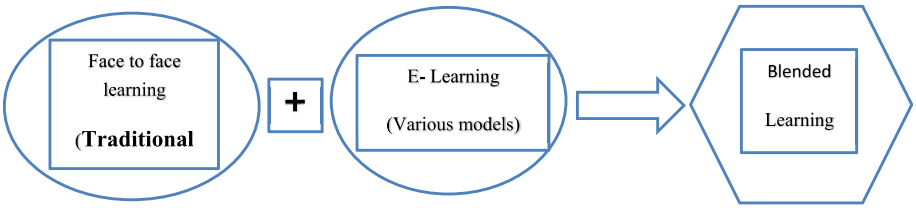

Fig. 2. Meaning of blended learning.

blended learning correctly is to choose the right component or media package that will deliver the highest efficiency at the lowest possible cost.

Valiathan (2002) identified a number of blended learning models, as follows:

- Skill-driven learning model: This combines self-learning with the support of a teacher or facilitator to develop specific knowledge and skills of students in the classroom.
- Attitude-driven model: It mixes different media to improve new attitudes and behaviors for students, prioritizing peer-to-peer interaction and a risk-free environment.
- Competency-driven learning model: This learning model mixes the tools of supporting performance with knowledge management resources and mentoring aiming to improve workplace competencies.

On the other hand, Ross and Gage (2006, p.156) identify three main types of blended learning in institutions of education, as illustrated in Fig. 3.

Khan, Shaik, Ali, and Bebi (2012) pointed out the differences between traditional learning and blended learning as shown in Table 1.

1.4. Student achievement in science and blended learning

Extensive studies have been conducted on blended learning and its impact on students' achievement in educational institutions such as schools and universities. Although the majority of research connected to blended learning has taken place in the post-secondary stage, such as universities, some studies have found that this approach is useful for school students. According to Chen and Jones (2007), a wide range of research studies have found that the blended learning approach has positive effects on student achievement, while other studies have indicated that blended learning achieves levels of student success equivalent to traditional education. Kagohara et al. (2010) claim that using

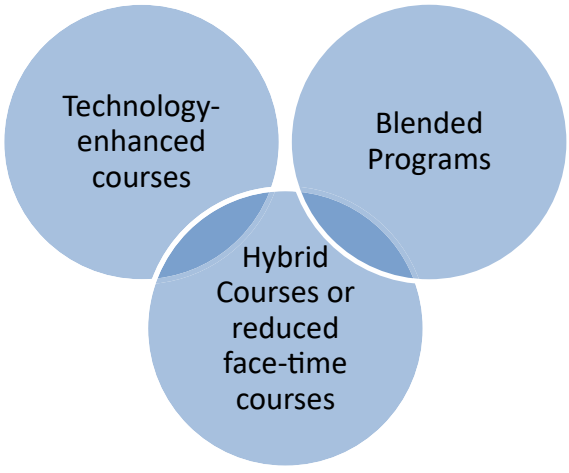

Fig. 3. Main Types of Blended Learning in Institutions of Education (Ross and Gage, 2006, p.156, p.156).

Table 1
Differences between blended learning and traditional learning.

Features	Traditional learning	Blended learning
Application Location	Fixed classrooms and not flexible	Any place and flexible
Method of Learning	Face-to-Face	Online and Face-to-Face
Time of Learning	Not Flexible and At Specific Time	Time Flexible and Any Time
Usage of Technology	Using Technology not mandatory	Using the technology is necessary and mandatory

multimedia such as video, Encarta encyclopedia, simulation software, and science dry labs may offer advantages over textbooks, especially for complex scientific topics and difficult concepts that are unfamiliar to students. Dowling, Godfrey, and Gyles (2003) confirmed that blended learning helps improve learning and teaching, which means students come to prefer blended learning over traditional learning.

Several studies have been conducted into using blended learning in teaching rather than traditional learning in educational institutions such as universities and schools (Ahmed, 2011; Al-Hasan, 2013; Ali, 2012; Almasaeid, 2014; Akbarov et al., 2018; Akkoyunlu and Soylu, 2008; AlQahtani, 2015; Bakeer, 2018; Boyle et al., 2003; Ja'ashan, 2015; Khader, 2016; Maccoun, 2016; Okaz, 2015; Pereira et al., 2007; Shahin, 2008; Vernadakis et al., 2012) confirmed that blended learning was found to be more effective than traditional learning in terms of students' grades and pass rates. On the other hand, studies such as Kazu and Demirkol (2014), Tosun (2015) and Wei et al. (2017) have found no significant effect through the use of blended learning, finding no statistically significant differences between groups taught with blended learning techniques and traditional techniques. They therefore conclude that blended learning does not have a positive impact on students' achievement.

Hence, the researchers consider it important to explore the impact of modern teaching strategies directly related to technology to support the achievement of students, especially students in the middle stage, in science. Therefore, this study differs from previous studies in that it focused on ninth grade students in the Ministry of Education schools in the United Arab Emirates. According to Piaget's theory, this age represents the fourth stage of cognitive development, formally denoted as Operational stage 12–15 years (Ahmad et al., 2016). Therefore, in the ninth grade, students will be at the end of the intermediate stage in the UAE, which means that they are at the fourth and final stage of cognitive development, in Piaget's scheme. This is a very critical stage because thinking becomes much more sophisticated and advanced. Students can think about abstract and scientific concepts and can use logic to come up with creative solutions to problems, and they begin to develop skills like logical thought and deductive reasoning.

1.5. Study purpose

The study was conducted with the purpose of examining the effect of teaching science using blended learning on the achievement and attitudes of ninth grade students in the intermediate stage, United Arab Emirates. The researchers chose the ninth grade because, according to

Piaget's theory, this age represents the fourth stage of cognitive development, formally referred to as the operational stage 12–15 years (Ahmad et al., 2016). The students in the ninth grade in the UAE will be at the end of the intermediate stage, which means they are in the fourth and final stage of cognitive development, in Piaget's scheme.

1.6. The significance of the study

The importance of the study can be characterized as in the following points:

- Provide science planners and experts with a modern strategy to teach science, and employ them in the planning and development of science curricula.
- Address the scarcity of educational research in science teaching that deals with similar problems.
- Develop teaching methods for science teachers using modern teaching strategies, such as blended learning, to substitute for traditional methods that are still common in teaching.
- Develop the ability of ninth grade students in the intermediate stage to understand the topics of science by integration of technology with traditional learning.
- Encourage science teachers to employ blended learning during the teaching process to improve the quality of education.
- Provide recommendations to curriculum developers as well as those who are interested in science education on the use of modern strategies in science teaching.

1.7. Study problem and questions

Blended learning is an important method in education in this century generally, and particularly in science branch subjects such as science, physics, chemistry, biology, geology, and environment. Nevertheless, there is a lack of studies that deal with the reality of the use of blended learning in the teaching of natural sciences. In addition, the Ministry of Education in the UAE has an interest in the importance of teachers using modern methods of education that have a direct relationship with technology, such as blended learning.

The study problem is the urgent need of the educational sectors to study the fact of the application of blended learning in the teaching of science, and its impact on student achievement.

Thus, this study poses the following primary research questions, which aim to clarify the effect of the use of blended learning in science teaching to improve student achievement:

RQ1. What is the effect of using blended learning in improving students' achievement in science for the ninth grade at the intermediate stage?

RQ2. What are the attitudes of students in the experimental group towards using blended learning in teaching science?

RQ3. Do attitudes towards the use of blended learning of students in the experimental group vary according to the students' gender and student academic performance in science subject?

1.8. Study hypotheses

The researcher formulated the following null hypotheses:

- *There were no statistically significant differences between the mean scores of the experimental group, who used blended learning in their studies, and the mean scores of students in the control group, who used traditional learning, in the post-achievement test.*
- *There are no significant differences in attitudes among students in the experimental group towards the use of blended learning in science teaching before and after the application of it.*
- *There are no significant differences in the attitudes of the two groups towards the use of blended learning, attributable to the variables student's gender and student academic performance in science subject.*

1.9. Study terms

- *Effect*: Nair and Bindu (2016) point out that the effect is the change that results when something happens: an event, situation, or situation resulting from a particular cause.
- *Blended learning*: learning which is facilitated by the effective combination of different delivery methods, learning models and learning methods, based on transparent communication (Heinze and Procter, 2004). Further, blended learning is also defined as a strategy that integrates two different education models, distance learning and traditional learning (Bonk and Graham, 2006).
- *Achievement*: Khader (2016) defined achievement as the result of what students learned directly after the end of the educational topics (or units or textbooks). The learning is measure by achievement tests.
- *Attitudes:* Defined by Christo-Baker (2004) as the negative or positive feeling towards a state or a fact. Attitude is also defined by Ajzan (1988, p.4) as "a disposition to respond favorably or unfavorably to an object, person, institution, or event."

2. Methods

2.1. Study approach

The quasi-experimental approach was used due to its suitability to the purposes of the study and its ability to achieve its aims by using the post-achievement test for the experimental and control groups. Fig. 4 illustrates the experimental design of the study:

In the control group, the students were taught the topics of unit 2 (Motion) of the grade nine science textbook using direct teaching (traditional teaching). The experimental group were taught the same material using blended learning. The material was taught during the second semester of the academic year of 2017/2018. The teaching topics in the unit taught during the research are detailed in Table 2:

2.2. Research participants

The sample consisted of 116 ninth grade students, divided into two groups: the experimental group consisted of 61 students and the control group consisted of 51 students. Table 3 shows the demographic information on participants and Table 4 shows the variables for the experimental group, which are students' gender and students' academic performance in the science subject at the end of first semester of the academic year 2017/2018.

2.3. Study variables

- *Independent variables*, which are the two teaching methods:
  a) Blended learning strategy
  b) Traditional method
  c) Pre-test (before intervention)
  d) Post-test (after intervention)
  e) Variables of students in the experimental group (gender, academic performance in science subject).
- *Dependent variables*: the science achievement scores of students of study groups measured on two occasions (pre-test & post-test) and responses of the experimental group on their attitudes toward learning science using blended learning.

2.4. Study tools

Study tools were derived from the researcher's own devising, and review of previous studies and literature related to the subject of the

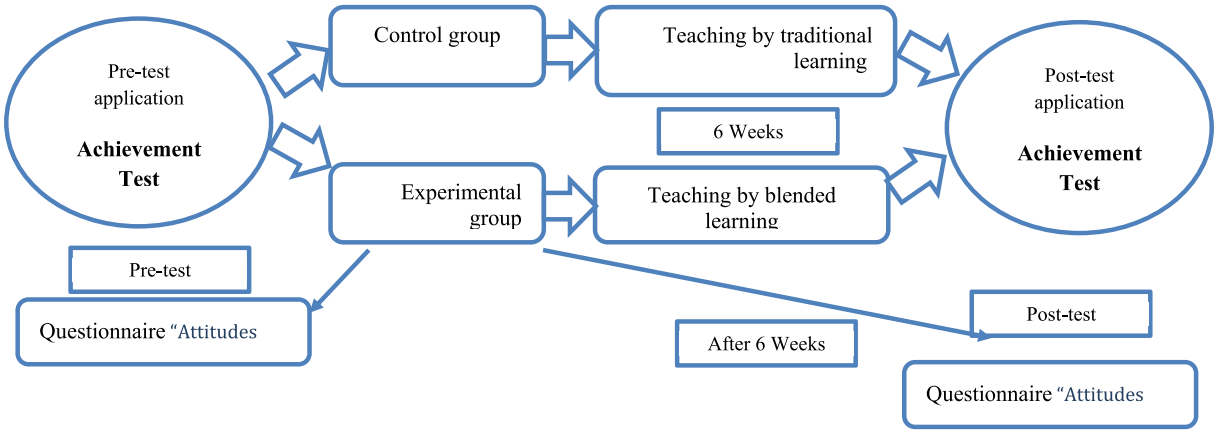

Fig. 4. Experimental design of the study (Designed by researchers).

Table 2
The teaching topics in the unit Motion.

Name of the unit	Topics	Pages
Motion	Lesson 1: Description of Motion	204–212
	Lesson 2 Velocity and Momentum	213–222
	Lesson 3: Acceleration	223–235

Table 3
Demographic information on participants.

Group	N	Level	Learning method
Experimental	61	Intermediate	Blended Learning
Control	51	Intermediate	Traditional Learning
Total	112		

Table 4
Variables of students in the experimental group.

Study variables	Variable levels	Frequency (f)	Percentage (%)
Gender	Male	31	50.8
	Female	30	49.2
	Total	61	100%
1st Semester academic performance in science subject	Excellent (A) 90–100	11	18.03
	Very good (B) 80–89	19	31.15
	Good (C) 70–79	16	26.23
	Pass (D) 60–69	12	19.67
	Fail (F) < 60	3	4.92
	Total	61	100%

research (Ahmed, 2011; Maccoun, 2016; Al-Hasan, 2013).

2.4.1. Educational material

- The teacher took an active part in preparing the computerized educational program for the topics of unit 2 (Motion) and the activities incorporated within it to use blended learning in teaching the experimental group.
- Online science learning was facilitated by using the online learning platform, such as the site of https://www.talentlms.com
- A webpage was created by the researchers (https://najehscience.talentlms.com/index) through which activities were implemented online, and which provided content about main topics and subtopics of the unit, such as Description of Motion, Average Speed, Momentum and Acceleration. The material is loaded as the content is presented in face-to-face instructions.
- The PowerPoint presentations used in the classroom, illustration animations, and other relevant video clips were also uploaded using the provision 'upload'. At the same time, lectures, explanations, and experiments were conducted in the classroom according to the content request.
- Students were also directed to watch the uploaded video on the webpage, and a critical review of the video was posted by students who were very active.
- For example, students were asked to go through the Motion unit on the platform and the web links available on the webpage to study how to calculate the acceleration from Velocity-time graphs. This allowed additional discussions to be held and ideas to be raised by students in the classroom (see Fig. 5).
- In addition, students interacted with the researcher online on various issues relating to the topic of Motion to get more clarity.
- Computerized educational program topics were designed and developed to adhere to the following structure:
  a) Recall previous knowledge of the new lesson.
  b) View educational objectives and outcomes of the new lesson.
  c) Teacher presents activity and allows students to work with him.
  d) Independence is represented by students carrying out educational tasks on their own, through their use of blended learning during the performance of the activities.
  e) The process includes interaction between teacher and students, and motivation of students by teacher.
  f) The lesson also includes worksheets and activities that will be used by students to give the answers related to activities.

2.4.2. Achievement test

The researchers prepared an achievement test to measure the effectiveness of blended learning in improving students' results in science. The test in its final form consisted of 20 multiple-choice questions. Each item of the questions was given one mark for the correct answer and zero for the wrong answer; the maximum mark of the test was 20 and the testing time was 45 min.

- *Validity of Achievement Test*

The research tool was confirmed by the virtual validity method for the test by presenting it in its initial form with a list of behavioral objectives, to ten members of the teaching staff of universities, all of whom were doctorate and master's degree holders in curricula and methods of teaching science, and education of technology. The content was adjusted according to their recommendations.

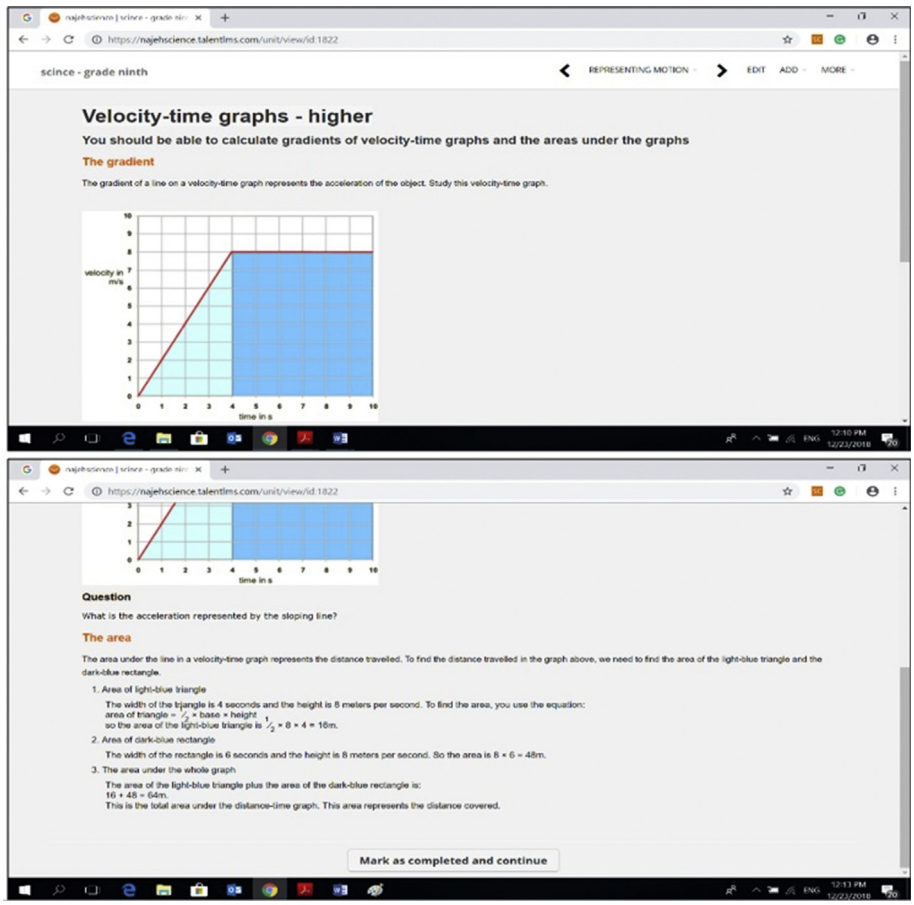

Fig. 5. The Motion unit platform in the ninth grade science textbook.

- *Reliability of Achievement Test*

The researchers verified the reliability of the achievement test by using the test-retest method. The test was applied to a sample not included in the sample of the study, and two weeks after the test was re-applied to the same sample of ninth grade students. After that, the Pearson correlation coefficient between the two applications was calculated. The total reliability coefficient of 0.88 was considered appropriate for the purposes of this study.

2.4.3. Questionnaire (attitudes towards the blended learning)

The questionnaire was designed and used to collect data from 61 students of the experimental group about their attitudes toward using blended learning in teaching science. It consisted of 20 item focusing on the purpose of the study. The researchers used closed-ended Likert scale statements for responses to questionnaire items. To test validity and reliability, the questionnaire was given to experts from various universities, who then provided written feedback, in response to which the researchers modified some items to fulfill the purpose of the study. The reliability of the questionnaire was also determined using Cronbach's Alpha. The value was 0.91, which indicated a high level of internal consistency.

- *Data Analysis Measures*

A five-dimensional Likert scale is adopted as follows: very high (5), high (4), moderate (3), small (2) and very little (1), as shown in Table 5 with the options used to evaluate counting periods.

2.5. Pre-test

In order to compare the two groups in the study in terms of achievement in science, the researchers used a t-test to compare the two groups' results in the pre-test on the topics of the science textbook unit, before applying the blended learning. Results are shown in Tables 6 and 7:

As shown in Table 7, since the obtained p (.106) is greater than 0.05, the test is not significant at the 0.05 level, which indicates that there is no significant difference between the two groups of the study (experimental group and control group). This revealed that the experimental and control groups were equivalent before the study could be applied.

2.6. Procedures

- Prepare lesson plans using blended learning in science teaching.
- Prepare computerized educational program for the subjects of the Motion unit and its activities to use blended learning in the teaching the experimental group.
- The two researchers trained the science teacher on how to use blended learning in science teaching.
- The two researchers taught students how to deal with the relevant technological items required for the blended learning.
- The achievement test was prepared according to the students' level, the required material, and the educational objectives in the science textbook for ninth grade.
- Obtaining the consent of, and coordinating with the administration of Al-Hikmah private school to conduct study and implementation of the experimental group lessons through blended learning and implementation of the control group in the traditional method.
- The study participants were divided into two groups: the experimental group consisting of 58 students, who were taught through blended learning, and the control group, consisting of 58 students who were taught in the traditional method.

- The implementation for both the experimental group and the control group involved a period of six weeks, with four periods of 45 min each per week.
- The following test (post-test) was applied to the two groups (experimental and control), in order to measure the improvement of students in the experimental group immediately after completing the educational aspects of the material.
- The results were collected and analyzed statistically.

2.7. Statistical treatment

The researchers used the SPSS program to answer the research questions. Through calculating the arithmetic means and standard deviations, an independent sample t-test was used to measure the statistical differences in means between the experimental and the control groups in the results of the post-test. In addition, paired samples t-test was used to compare the experimental group's pre-application and post-application scores for the blended learning attitudes scale.

2.8. Ethical considerations

This study was approved by Research Ethics Committee/Deanship of Graduate Studies and Research of Ajman University (Reference Number: F - H - 1 8 - 1 - 0 1)

3. Results

3.1. Findings related to RQ1

The question was: What is the effect of using blended learning in improving students' achievement in science for the ninth grade at the intermediate stage?

In order to answer the first question of this study, the following null hypothesis was tested:

There were no statistically significant differences between the mean scores of the experimental group, who used blended learning in their studies, and the mean scores of students in the control group, who used traditional learning, in the post-achievement test.

In order to verify the hypothesis, the difference between the mean scores of students in the experimental group and the control group in the post-test was calculated using the t-test for two independent samples. The results are shown in Table 8.

As shown in Table 9, since the obtained p-value (0.000) is smaller than 0.05, this means there are significant differences at the significance level of 0.05, which indicates that there is significant difference between the two groups of learners with regard to their understanding and knowledge of the science topics covered after 6 weeks. This means the null hypothesis is rejected. Based on the test results, it can be inferred that teaching the students' the Motion topic unit in the science textbook through blended learning had a positive effect on the science test scores of intermediate school students.

3.2. Findings related to RQ2

The question was: What are the attitudes of students in the experimental group towards using blended learning in teaching science?.

Table 5
The evaluation of scale data based on the options of scale and score intervals.

Options	Scores	Score intervals
Very high	5	4.21–5.00
High	4	3.41–4.20
Moderate	3	2.61–3.40
Little	2	1.81–2.60
Very little	1	1.00–1.80

Table 6
Means and standard deviations of pre-test scores for two groups.

Group	N	Mean	Std. deviation
Experimental	61	14.82	1.76
Control	51	14.29	1.63

Table 7
T-test results of pre-test between the experimental and the control groups.

	Levene's test for equality of variances		t-test			
	F	Sig.	t	df	Sig. (2-tailed)	Mean difference
Equal variances assumed	2.031	.157	1.630	110	.106	.52555
Equal variances not assumed			1.641	108.791	.104	.52555

* Statistically significant at (p 0.05 ≥).

In order to answer the second question, the following null hypothesis was tested.

There are no significant differences in attitudes among students in the experimental group towards the use of blended learning in science teaching before and after the application of it.

To determine whether there is a difference in the experimental group's attitudes towards the use of blended learning in science before and after application, paired samples t-test was applied to the pre-application and post-application scores of the blended learning attitude scale. The results obtained are shown in Table 10 below.

According to the results shown in Table 11, it is seen that there was a significant difference ($t(60) = 4.666$, $p < .05$) between the experimental group students' post-application mean (3.58) and their pre-application mean (2.93). This means the null hypothesis is rejected.

Based on this finding, it can be confirmed that the experimental group developed a more positive attitude towards the use of blended learning in science after they had experience its application.

3.3. Findings related to RQ3

The question was: Do attitudes towards the use of blended learning of students in the experimental group vary according to the students' gender and student academic performance in science subject?

In order to answer the third question, the following null hypothesis was tested:

There are no significant differences in the attitudes of the two groups towards the use of blended learning, attributable to the variables student's gender and student academic performance in science subject.

We calculated the mean scores and standard deviations to answer the study's third research question. The independent t-test and variance test were conducted to find out the significance of differences between averages. We carried out one-way ANOVA testing to discover the significance of any differences between the averages. An LSD test, for post-hoc comparisons, was also conducted to find the significance of differences between means. The results related to the responses to questions about the study subjects and are detailed below, according to the study variables.

3.3.1. First: student gender

The independent sample test (T) was used to find out the significance of the differences between averages towards the use of blended learning from the perspective of students, according to gender (see Table 12).

The results reported in Table 12 indicate that the obtained p (0.271) is less than 0.05. Therefore, the test is not significant at the 0.05 level, which indicates that there is no significant difference in attitude to

Table 8
Means and standard deviations of post-test scores for two groups.

Group	N	Mean	Std. deviation
Experimental	61	16.11	1.67
Control	51	14.12	1.60

As displayed in Table 8, the students who were taught with blended learning had different scores (M = 16.11, SD = 1.67) to those who were taught through traditional, face-to-face teaching (M = 14.12, SD = 1.60).

Table 9
The independent sample t-test results of post-test.

	Levene's test for equality of variances		t-test			
	F	Sig.	t	df	Sig. (2-tailed)	Mean difference
Equal variances assumed	0.347	0.557	6.422	110	0.000	1.99711
Equal variances not assumed			6.450	108.094	0.000	1.99711

* Statistically significant at (p 0.05 ≥).

blended learning according to the variable of gender among students in the experimental group.

3.3.2. *Second: student academic performance in science subject*

Concerning the variable of student academic performance in science subject, Table 13 shows the results of the one-way ANOVA test of their responses for this variable.

The results reported in Table 13 indicate that there are statistically significant differences in students' perspectives according to the variable student academic performance in science subject, at the level of 0.026, which is lower than the required statistical significance level (0.05).

To determine the source of the differences, an LSD test was used for the following comparisons, and the results are shown in Table 14 below.

4. Discussion

The obtained results concerning the first research question, regarding the effect of the use of blended learning in improving students' achievement in science subject for the ninth grade, indicated that there was a significant difference between students of the experimental and the control groups, in favor of the students in the experimental group. If we examine the results shown in Table 8, we find that the average of post-test scores for students in the experimental group is 16.11, compared to 14.12 for the control group. This means we can conclude that blended learning has a positive impact on the achievement of students of the experimental group when compared to the traditional learning of the students of the control group. Also, the results showed that, as demonstrated in Table 9, there are significant differences at the level of significance of 0.05 (p = 0.000), which indicates that there is a significant difference between the two groups of learners with regard to their understanding of the topics being taught.

The finding is consistent with several earlier studies that also confirmed blended learning's increased positive effect on the achievements of students (compared to traditional learning) (Ahmed, 2011; Al-Hasan, 2013; Ali, 2012; Almasaeid, 2014; AlQahtani, 2015; Bakeer, 2018; Dowling et al., 2003; Kagohara et al., 2010; Khader, 2016; Maccoun, 2016; Okaz, 2015; Pereira et al., 2007; Shahin, 2008; Vernadakis et al., 2012). However, the results of this study did not agree with the results of other studies, which found that the use of blended learning had no significant effect (Kazu and Demirkol, 2014; Lin et al., 2017; Tosun, 2015; Wei et al., 2017).

Table 10
Means and standard deviations of pre-application and post-application for experimental group on attitudes scale towards using blended learning.

Experimental group	N	Mean	Std. deviation
Post-application	61	3.58	1.11871
Pre-application	61	2.93	.84081

Table 11
Comparison of experimental group students' pre-application and post-application scores of the blended learning attitude scale via the paired samples t-test.

Experimental group	N	Mean	Std. deviation	t	df	Sig. (2-tailed)
Post-application	61	3.58	1.11871	4.666	60	0.000
Pre-application	61	2.93	.84081			

* Statistically significant at (p 0.05 ≥).

The second research question concerned the attitudes of students of the experimental group towards the use of blended learning. To answer this question, the null hypothesis was tested.

Firstly, we postulated that there would be no statistically significant differences between the mean scores of the experimental group, and those of the students in the control group, in the post-achievement test. We applied a scaled questionnaire to the students in the experimental group before they began using the blended learning (pre-application) and re-applied it again, after 6 weeks of training (post-application). We applied a paired samples t-test to the pre- and post-application scores of the blended learning attitude scale.

The results shown in Tables 10 and 11 show that the average of pre- and post-applications was 3.58, compared to the pre-application scale (where the average was 2.93). Additionally, there was a significant difference ($t(60) = 4.666$, $p < .05$) between the experimental group students' post-application mean (3.83) and their pre-application mean (2.54). The null hypothesis was therefore rejected and our results confirmed that the experimental group's attitudes towards the use of blended learning showed a statistically significant improvement after the application of the approach. This finding is consistent with prior studies (Akbarov et al., 2018; AlAbdulkarim and Albarrak, 2015; Akkoyunlu and Soylu, 2008; Almasaeid, 2014; Ja'ashan, 2015). Conversely, the study's results contradict some other earlier studies, whose results found no significant differences in attitudes towards the use of blended learning among students (Hinkhouse, 2013; Kazu and Demirkol, 2014; Tosun, 2015; Wei et al., 2017).

The third research question focused on determining whether the attitudes of students of the experimental group towards the use of blended learning varied according to two elements: student's gender and academic performance in a science subject. To answer this question, we postulated a null hypothesis that there would be no significant difference in the attitudes of students of the experimental group toward the use of blended learning, attributed to a variable of student gender and academic performance in a science subject. The results reported as shown in Table 12 show that there is no significant difference in attitudes towards the use of blended learning from the perspective of students in the experimental group according to the variable gender, where the p (0.271) value is less than 0.05. Our results in Tables 13 and 14 implies that the attitudes of the students of the experimental group did vary

Table 12
Means and SD of the students' responses according to gender variable.

Gender	N	Mean	Std. deviation	T. value	Sig. (tailed)	Sig. level
Female	30	3.933	0.7397	1.044	0.301	Not Significant
Male	31	3.710	0.9199			

* Statistically significant at (P 0.05 ≥).

Table 13
One-way ANOVA test for variable student academic performance in science subject.

		Sum of squares	df	Mean square	F	Sig. (tailed)	Sig. level
Student Academic Performance in Science Subject	Between Groups	7.524	4	1.881	3.054	0.024*	Significant
	Within Groups	34.493	56	.616			
	Total	42.016	60				

* Statistically significant at ($p < 0.05$).

Table 14
Additional LSD test results concerning the variable student academic performance in science subject.

(I) Academic score	(J) Academic score	Mean difference (I-J)	Sig.
Excellent	very good	-.73206-*	.017
	good	-.76989-*	.015
	pass	-.94697-*	.005
	fail	-1.36364-*	.010
Very good	excellent	.73206*	.017
	good	-.03783	.888
	pass	-.21491	.461
	fail	-.63158	.201
Good	excellent	.76989*	.015
	very good	.03783	.888
	pass	-.17708	.557
	fail	-.59375	.234
Pass	excellent	.94697*	.005
	very good	.21491	.461
	good	.17708	.557
	fail	-.41667	.414
Fail	excellent	-1.36364*	.010
	very good	.63158	.201
	good	.59375	.234
	pass	.41667	.414

The results in Table 14 confirm that the source of the differences in the students' perspectives in terms of the variable student academic performance in science subject was in favor of the performance level (pass).
* This means that there is statistical significance.

according to student academic performance in a science subject, in favor of the performance level (pass).

5. Conclusion

Education in the United Arab Emirates is witnessing rapid positive changes and developments in all areas, in way that reflect broader life in the UAE. The UAE Ministry of Education is trying to use modern methods of education and technology to teach students in its public and private schools, and encourages its teachers to develop their teaching skills in order to increase the educational attainment of the students. The aim of this study was to determine the effect of blended learning on ninth grade students' achievement in science and their attitudes towards using it.

The results of this study show that the application of blended learning had a positive impact on students' achievement. There was a statistically significant difference between the experimental and the control groups, in favor of the experimental group, who were taught using blended learning. Moreover, the students in that group had positive attitudes toward the use of blended learning. In addition, our results indicated that the attitudes of the students towards the use of blended learning varied depending on the student academic performance in a science subject, in favor of the performance level (pass). No statistical significance was found in this respect with regard to the variable of students' gender.

These results were in agreement with previous studies that confirmed the positive impact of blended learning on the achievement of students and their positive attitudes towards its use (Ahmed, 2011; Al-Hasan, 2013; Akbarov et al., 2018; Akkoyunlu and Soylu, 2008; AlAbdulkarim and Albarrak, 2015; Ali, 2012; Almasaeid, 2014; AlQahtani, 2015; Bakeer, 2018; Bradley, Chalk, Jones, & Pickard, 2003; Chen and Jones, 2007; Dowling et al., 2003; Ja'ashan, 2015; Kagohara et al., 2010; Khader, 2016; Maccoun, 2016; Okaz, 2015; Pereira et al., 2007; Shahin, 2008; Vernadakis et al., 2012).

This study is important because it shows that blended learning is effective in education, especially in higher education. This means education can be more effective if the advantages of a web environment are blended with face-to-face interaction in courses that contain more visual elements. In light of the results, the study provides recommendations. On recommendation is to encourage teachers to employ the blend between the technology and direct teaching through the use of blended learning. The activities in science textbooks should be adapted and designed according to blended learning. This can be done by applying similar studies that reflect the views and experiences of learning practitioners' blended learning into science teaching, and improving teacher's abilities in teaching science by holding training courses to motivate the use of modern and innovative strategies such as blended learning.

Declarations

Author contribution statement

Najeh Rajeh Alsalhi: Conceived and designed the experiments; Performed the experiments; Wrote the paper.

Mohd. Elmagzoub Eltahir: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Sami Sulieman Al-Qatawneh: Contributed reagents, materials, analysis tools or data; Wrote the paper.

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