Developing a Multimedia Program to Enhance Concepts on Physics and Problem-Solving Skills among Students with Disabilities in the Intermediate Stage

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Abstract

This investigation explored the effect of a multimedia program on developing physics concepts and physics problem-solving skills among ninth-grade students with learning disabilities. The study implemented the experimental method and built a multimedia program to develop concepts and physics problem-solving skills among ninth-grade students. The experiment was applied to 37 students from the ninth grade, who were selected from 5 different schools in Irbid, Jordan. The findings showed that the size of the effect of the program was large, as using the multimedia program helped students develop physics concepts properly because the program was designed according to organized and easy steps. It is clear from the results the effective impact of using multimedia in developing concepts and physics problem-solving skills, as the results indicated the superiority of the experimental group over the control group, even though the two groups were originally equal. The study recommends frequent use of multimedia effectively during the educational process because of its effective impact on students' academic achievement and the creation of multimedia programs in all curricula, provided that these programs address the student, motivate him, and arouse his motivation to learn.

Keywords: multimedia, physics concepts, problem-solving skills, students with LDs.

1. Introduction

We live today in an era of cognitive and information acceleration that is based on the progress of science, especially physics, which is considered one of the branches of natural science that specializes in studying natural phenomena and everything related to matter and what happens around us (Komaro et al., 2021). Physicists have worked hard since ancient times to try to understand and explain natural phenomena and the laws that govern this universe and then come up with theories that are subject to modification. As a field of study, physics has been around for a long time. Its origins are in the Middle Ages, but it wasn't until the 17th century that it was officially recognized as a contemporary scientific discipline (Dawal, 2023). Therefore, physics has a distinguished place in human thought, because of its decisive impact on some other

cognitive and scientific fields, such as philosophy and mathematics. And the living. Most of the developments it brought about were embodied in practice in several sectors of technology and medicine. For example, progress in understanding electromagnetism led to the widespread use of electrical devices such as televisions and computers, as well as applications of thermodynamics to the amazing development in the field of motors and modern means of transportation (Chatzivasileiou & Drigas, 2022).

Due to the importance of this science and its teaching, the process of developing the learner himself has become a necessary matter, especially in light of the enormous and increasing technological development. It has become necessary to pay attention to technology in education to keep pace with this tremendous development and the great explosion of knowledge (Alqahtani & Alsalem, 2023). Hence, the development of the use of modern technology came in line with modern educational theories, such as constructivist theory, which helped to develop educational models and strategies that help the teacher effectively carry out the roles assigned to him. These models also provide the student with opportunities for active learning, true integration, and responsibility through key roles assigned to it, and these structural models are consistent with modern trends in this era (Moraiti et al., 2022).

We see a tangible development in the teaching of science. Everyone, including researchers and local, international, and international organizations, has linked the teaching of science with scientific progress, especially physics, as physics education in the Arab world cannot remain untouched by future scientific and technological changes that affect the human lifestyle, leading to a better future (Alkhawaldeh & Kha-sawneh, 2020). This will only be achieved through distinguished learning in a world full of changes and in which information, inventions, and discoveries flow every day. The application of advanced technology in the field of education is extremely important for the educational process, as it pushes towards a bright future. Therefore, the educational institution must shake off the dust of the traditional method and replace it with modern means and methods, of which multimedia programs are among the most prominent (Roberts-Yates & Silvera-Tawil, 2019). Many researches and studies have confirmed the effectiveness of using multimedia in education and the effectiveness of multimedia programs and computer programs in developing concepts, including some that have studied the impact of multimedia in teaching courses.

1.1. Problem statement

The task of keeping up to date with developments constitutes a heavy burden for teachers in developing countries and several regions of the developed and slightly developed world, but it is not an impossible task. We hope, then, that every teacher feels that he is personally responsible for progress, that he should not expect outside help, and that he can take some initiative. Therefore, the teacher must spare no effort in overcoming the obstacles facing the students so that they can face scientific difficulties, especially solving the physics problem. The teacher must present the problems to the students in a way that stimulates their motivation to think and solve the problem. We should not forget that developing scientific concepts requires the teacher to plan well for teaching so that it includes scientific knowledge and educational situations that allow the student to identify things with ease and then classify them so that he can form the concept correctly. From the above, and through the researcher's feeling of the problem of the study, the

researcher found it necessary to study the effect of a multimedia program on developing problem-solving skills among students with disabilities in the intermediate stage.

1.2. Questions of the study

1- What is the effect of a multimedia program on developing physics concepts among ninth-grade students with LDs?

2- What is the effect of a multimedia program on developing physics problem-solving skills among ninth-grade students with LDs?

1.3. Significance of the study

The study provides a multimedia program that may benefit officials in the Ministry of Education to work on improving and developing the new Jordanian curricula and employing computerized programs in their implementation. The study provides a method for building educational programs according to organized standards, which may benefit researchers and educational program designers. The study provides a set of problem-solving skills that may help students with disabilities overcome some of the difficulties they face. The study provides a test of physics concepts and a test of physics problem-solving skills that physics teachers may benefit from.

1.4. Study limitations

The study was limited to building a multimedia program for the mechanics unit from the physics textbook in the first semester of the ninth grade. The study was applied to a sample of ninth-grade students with LDs from schools in Irbid, Jordan, in the first semester of the year 2022-2023.

2. Literature Review

Schools are one of the most important institutions that need to use multimedia to help convey information with greater accuracy and depth, thus leading to increased efficiency and performance levels. On the other hand, multimedia finds no limits in the areas of application in school, and the matter is wide open for creativity and innovation (Suherman et al., 2023). By using multimedia in the classroom, the role of the teacher moves from the basic element of teaching to guiding and supervising the presentation process of multimedia systems, in addition to commenting and consolidating (Aji et al., 2023). The truth is that if it were not for computers, multimedia would not have spread so widely, and entered into all fields, as is evident. Given the ability of personal computers (in particular), starting with their small size, reasonable cost, powerful processing, and the availability of reasons and factors for creating a fertile environment in which to grow. Research and development fields for the benefit of the multimedia field, both hardware and software components, have become a real partner in every field and a common denominator for success that cannot be underestimated (Azizah et al., 2023).

Multimedia has become an integral part of the educational process. Multimedia helps in solving many problems, such as overcoming the problem of the large number of students in classrooms, and the problem of the difficulty of some courses (Herlina, 2023). Researchers have worked hard

to define multimedia. It has been defined as the complex in which two or more media are combined well so that they can be displayed through a single interface in a digital image (Rumiantseva et al., 2023). It is also defined as a group of media combined to produce an integrated medium that is distinguished when compared to a single medium by increasing its positive impact that cannot be provided through a single medium. Each system contains two or more media, such as sound, image, text, or moving images. Multimedia is the merging of more than one medium with each other, such as (sound, image, video, or text), to be presented through one medium (Lorenzo & Lorenzo, 2018). Accordingly, the researcher defines multimedia as a modern technology that combines sound, image, text, and video to present it within a specific framework so that it achieves the goal for which it was set and achieves a kind of communication between the learner and the educational program.

Multimedia consists of visual, audible, and temporal elements. Multimedia is of great importance in improving education, as it transfers education from tradition to modernity. It helps students to link information by presenting it in various forms, including written text, drawings, pictures, video clips, and sound effects (Rivas, 2021). It also facilitates the learning process and joint thinking processes for students. It is concerned with cooperative learning between students and faculty members and helps students think beyond thinking. Using multimedia leads to fun and attractive learning for the student (Dembek & Kubina Jr, 2018). Employing multimedia helps the teacher organize the flow of the lesson plan, and makes it clear and tangible. It contributes to the teacher's good selection of the questions he presents to the students makes them logical and develops some desirable attitudes and behaviors in students. It contributes to shortening the explanation and avoiding confusion and diversion around the same topic.

There is no doubt that concepts are of great importance in building scientific knowledge, and they are the beginning of the learner's personal and intellectual development. Scientific concepts are the basis for understanding science and its development. To the extent that we can find ways in which students' learning can be improved, we will have succeeded in creating an impetus for them to discover more of the same scientific concepts (Ying et al., 2020). Understanding the concept leads to understanding other new concepts, and for this reason, it is necessary to ensure that learning the concept proceeds following its requirements and the requirements of the students' mental development. Our teaching methods often greatly affect students' level of understanding of scientific concepts. The difficulties in learning scientific concepts lie in the scientific concept (Ankeli, 2020). It is represented by the extent to which the learner understands abstract or complex scientific concepts and the confusion in the meaning of the concept or in the verbal significance of some scientific concepts, especially concepts that are used as scientific terms and as spoken language among people, such as the concepts of flower and atom. Students also lack the scientific background and find difficulty learning previous scientific concepts necessary to learn new scientific concepts (Alias et al., 2022; OGAH, 2023).

Previous studies

Umarella et al. (2019) designed optical equipment-based interactive multimedia using the Lectora Inspire platform and the Problem-Based Learning paradigm. The research and development process is structured according to Borg and Gall's steps. According to the product validation findings, 87% of material specialists, 93% of media experts, and 87% of instructors

think the product is feasible. Subsequently, 83% of the goods were found to be interesting after small-scale testing. In addition, 80% attraction is achieved in field experiments. These findings provide support for the potential use of the interactive multimedia platform Lectora Inspire, which is based on the Problem-Based Learning approach, as a teaching tool for eleventh-grade optical equipment content.

Yafie et al. (2020) examined how a scientific approach to learning via multimedia impacts students' cognitive development. The results demonstrate that the two treatments in the experimental and control groups can enhance children's cognitive development, as there is a difference in the mean scores of symbolic thinking, problem-solving, and logical thinking between the pre-and post-tests, with higher post-test scores. The experimental group outperformed the control group, as shown by the greater gain score value, which further supports this conclusion. This is shown by the t-test, which reveals that the experimental class, which received multimedia learning with a scientific approach, outperformed the control class, which received simply scientific learning.

Ovadiya (2023) provided a framework for creating activities that promote critical thinking and problem-solving for high school students who were having difficulty with mathematics. Throughout the school year, she analyzed her data after meticulously documenting and planning 300 lessons for two high school courses (one in 11th grade and one in 12th grade) based on the principles to enhance her students' ability to work together to solve problems. Awareness of how to encourage active and meta-cognitive thinking, the use of practical examples, and explicit heuristic procedures for problem-solving are the primary elements that have been established. This is all to help students, especially those who are having difficulty, develop a framework within which they may more effectively tackle problems. Two real-life classroom situations show how certain ideas were used and how they improved the effectiveness of class problem-solving. These results point to the potential of incorporating these ideas into classroom culture as a powerful tool for enhancing group problem-solving abilities and, more specifically, for including students who are having difficulty participating in class discussions.

Yulina et al. (2021) helped students become better analysts by creating an interactive multimedia that uses an HPLC simulator. Students' analytical abilities within the framework of Marzano's taxonomy are discussed in this qualitative research study. We used the Microsoft Sway app to build IMM HPLC. It has a short video and picture explanation of the material, questions to practice for each unit, and group discussions where we analyze journals, make videos, and solve problems with HPLC simulators. Applications of IMM with the help of the HPLC simulator have positive effects on students' analytical thinking abilities when it comes to matching, classifying, analysing mistakes, and specifying; however, students still have room to grow when it comes to generalizing, specifically when it comes to drawing conclusions that do not draw on prior knowledge. IMM HPLC suggested using it as a teaching tool to help students develop their analytical thinking abilities.

3. Methodology

The researcher used the experimental method, which studies a phenomenon in which the researcher introduced a change or new variables, or made changes in one or more factors. It is an approach based on the design of the experimental and control groups so that the equality of the two groups is ensured before the study. The method of designing the equal control and experimental groups was followed, such that the experimental group studied the mechanics unit using a multimedia program, while the control group studied the unit in the normal way. The researcher was keen to verify the equality of the two groups in age, general achievement, and science achievement.

3.1. Sampling

The researcher chose the study sample using a purposive method, as the experiment was applied to 37 students from the ninth grade, who were selected from 5 different schools in Irbid. The students were divided into a control sample (18) and an experimental group (18). All students were male students with LDs.

3.2. Instruments

The study built a multimedia program to develop concepts and physics problem-solving skills among ninth-grade students and determined the effectiveness of this program for a sample of students on their achievement and compared that with students who traditionally study the unit. The study also developed tests to measure the progress of students before and after the implementation of the program.

The researcher prepared a test to measure the effect of multimedia on developing physics problem-solving skills. Items for the physics problem-solving test were prepared to determine a list of physics problem-solving skills for some physics problems in the “Mechanics” unit from the physics book for the ninth grade and by referring to previous studies. The test included 24 questions, which were presented to a group of specialized arbitrators. Their opinions and observations were taken, and the necessary amendments were made by rephrasing some questions to be clearer.

The internal consistency of the exam was confirmed by administering it to a survey sample of 20 students who were not part of the research sample. The Pearson correlation coefficient was computed between each item's score on the test and the overall score of its corresponding dimension, as shown in the table below.

Table 1. The Pearson correlation coefficient for the items of the test

Number	correlation coefficient	Number	correlation coefficient	Number	correlation coefficient
1	0.947	9	0.555	17	0.934
2	0.780	10	0.763	18	0.650
3	0.947	11	0.934	19	0.485
4	0.882	12	0.893	20	0.895
5	0.640	13	0.613	21	0.614
6	0.672	14	0.947	22	0.749
7	0.682	15	0.831	23	0.731
8	0.609	16	0.493	24	0.749

The previous table shows that all test items are statistically significant at (0.05). This confirms that the test has a good score, except for items 16 and 19, which means that the test has a good score of stability to apply to the study sample.

Using the split-half method, the scores of the exploratory sample were utilized in order to determine the reliability of the test. This method involved calculating the score for the first half of the test, as well as the score for the second half of the scores, by calculating the correlation coefficient between the two halves of the scores. Following that, the length was modified by using the Spearman-Brown equation, which resulted in the reliability coefficient being 0.962 prior to the alteration. The reliability coefficient after modification was 0.980. This indicates that the test has a high degree of reliability that reassures the researcher about its application to the study sample.

4. Results and discussion

4.1. The first question

To answer the first question on the physics concepts, a t-test for two independent samples was used to illustrate this, after ensuring the normal distribution and homogeneity according to the results of the Fisher test. The following table presents the results for the two groups.

Table 2. The t value to identify the differences between the average scores of students in the control and experimental groups

Dimension	Group	Number	Mean score	Standard deviation	F value	T value	Sig.
The test	Control	18	22.944	4.007	0.398	6.144	0.532
	Experimental	19	15.526	3.323			

*significant at 0.05

The above table makes it abundantly evident that the computed "t" value is higher than the tabulated "t" value in every dimension, and that the overall score on the post-test is statistically significant at the significance level of (0.01) and (0.05). The fact that this is the case suggests that there are differences between the experimental group and the control group that are statistically significant. In the post-application, the differences were found to be in favor of the experimental group, which indicates that the program had an effect on the development of the students' physical notions. The researcher calculated the effect size using the eta square equation as shown in the following table.

Table 3. The t value and the effect size

Dimension	T value	Eta square	Effect size
Total score	6.144	0.510	High

It is clear from the previous table that the size of the effect is large, and this indicates that the impact of the program is large. The researcher attributes this result to using the multimedia program helped students develop physics concepts properly because the program was designed according to organized and easy steps. The control group students relied on the traditional

method, which is the teacher's explanation alone, without using other means. The program contains additional examples not found in the textbook, that explain the concept smoothly and clearly. The program contains explanatory activities for abstract concepts that help students understand them well. The program contained bright colors and animation, which raised students' motivation to learn. The multimedia program linked theoretical material to practical material.

4.2. The second question

To answer the second question on solving problem skills, a t-test for two independent samples was used. The following table presents the results for the two groups after the implementation of the program.

Table 4. The t value to identify the differences between the two groups in problem-solving skills

Dimension	Group	Number	Mean score	Standard deviation	F value	T value	Sig.
The test	Control	18	17.944	5.000	1.048	7.212	0.313
	Experimental	19	7.105	4.122			

*significant at 0.05

There is a statistically significant difference between the tabulated "t" value and the computed "t" value in the total score of the post-test, which is significant at the level of significance (0.01). The fact that this is the case suggests that there are differences that are statistically significant between the experimental group and the control group and that these differences were favorable to the experimental group when the post-test was administered. To determine the magnitude of the impact, the researcher used the eta square equation, which is shown in the table that follows.

Table 5. The t value and the effect size

Dimension	T value	Eta square	Effect size
Total score	7.212	0.598	High

It is clear from the previous table that the size of the effect is large, and this indicates that the impact of the program is large. The researcher attributes this result to using the multimedia program, which helped students develop sound problem-solving skills because the program was designed according to organized and easy steps. The program contains additional problems not found in the textbook. The program contains basic problem-solving skills that help students understand it well. The program contains bright colors and animation, which arouse students' motivation to learn.

5. Conclusion

The purpose of this investigation was to study the effect of a multimedia program on developing problem-solving skills among students with disabilities in the intermediate stage. It is clear from the results the effective impact of using multimedia in developing concepts and physics problem-solving skills, as the results indicated the superiority of the experimental group over the control

group, even though the two groups were originally equal, but the use of the multimedia program contributed to developing concepts and problem-solving skills. The gradual explanation of the concept helped to develop it, and following the steps to solve the problem in the program helped the students to develop the skills of solving the problem correctly. The researcher also noticed when applying the program to the experimental group that the students' motivation to learn increased.

6. Recommendations

The study recommends frequent use of multimedia effectively during the educational process because of its effective impact on students' academic achievement and the creation of multimedia programs in all curricula, provided that these programs address the student, motivate him, and arouse his motivation to learn. The study also recommends organizing workshops for teachers so that they are trained to produce educational multimedia programs. It is important to emphasize teachers' use of problem-solving skills when solving problems, regardless of whether they are physical or mathematical. It is also recommended to follow up with the students and urge them to employ the steps to solve the problem, step by step, so that they can reach the sound and correct solution, and develop students' concepts gradually, from easy to difficult. The teachers are advised to use animation and illustrations to help form the concept, as it has a significant impact on students' understanding and developing their abilities to remember, interpret, and translate concepts.

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