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Using Electronic Educational Games to Enhance Achievement and Retention of learning in Mathematics for Primary Stage Pupils

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Abstract:

This study aimed at investigating the effectiveness of using electronic educational games to enhance achievement and retention of learning in mathematics for primary stage pupils. A quasi- experimental design was used. The study sample consisted of (62) participants from sixth grade primary school, which was distributed into two groups: experimental group (N=32), and control group (N=30). Data was collected through Ratio test. Study results revealed that:

- There is a statistically significant difference at level ($\alpha \leq 0.05$) between the mean scores of the pupils of the experimental and control groups in the post-application of the achievement test in ratio unit in favor of the experimental group.
- There is a statistically significant difference at level ($\alpha \leq 0.05$) between the mean scores of the pupils of the experimental and control groups in the delayed application of the achievement test in ratio unit in favor of the experimental group.

Keywords: electronic games, feedback in games, retention of learning

Introduction:

Technologies have an essential role in teaching and learning mathematics; they influence what is taught and improve pupils' learning. Mathematics is more than just a subject; it relates to many things in human's daily life.

Despite the critical role mathematics plays in technology, primary school pupils' performance in mathematics is still below average. Kushwaha (2014, 53-54) mentioned various factors that influence mathematics achievement, including internal and external factors.

- Internal factors include health, intelligence, interest, talent, and motivation.
- External factors include family, school, community, teaching strategies, insufficient qualified mathematics teachers, inadequate instructional materials.

Pupils have a strong ability to retain given information in their memories until they enter exams. Afterwards, most information is lost. This inability to retain information is the result of a teaching culture that emphasizes memorization for the sake of pouring information on exam papers only to get grades (Hakky, 2016, 22).

Retention issues among pupils might make it difficult for them to recall class lectures. Moreover, they have trouble in solving multi-step mathematics problems. In order to solve those problems, pupils must recall math knowledge from long-term memory while remembering what they have just finished and what they need to do.

According to Atomafa (2013, 82), teaching methods used to teach a subject can have an impact on pupils' achievement and retention. As a result, a teacher must choose good teaching strategies that bring out the essence of the lesson.

Nowadays, advances in science and technology greatly influence our lifestyles, impact our lives, and cause changes in all aspects of them. These developments have an impact on how we teach and learn. As a result, technological innovations have revealed a new generation of education tools designed to help pupils to learn in non-traditional ways and improve their learning.

Electronic games have become one of the most important entertainment tools for children, teenagers and even adults all over the world. Allowing access to the virtual world with unlimited possibilities, computer games compulsively attract many people. In fact, games have become an integral part of human society. (Mahmoudi, 2015, 420).

Educational Games can be used as an alternative approach to generate learner’s understanding besides of traditional books in achieving learning objectives. Games integrate both intrinsic and extrinsic motivational components to create an environment where players feel more motivated to engage in the target activities (Hartt, 2020, 4).

Most Mathematics educators agree that teaching and learning mathematics requires different skills compared with that of other subjects. As a result, games designed and used for mathematics education can differ from those used for other subjects (pan et al., 2022, 1).

People learn effectively when they have a strong and immediate motivation to acquire new knowledge, and when they are having fun. When teaching a difficult subject, using games in class is a great way to warm up the pupils before the lesson or to give them a break during or after the lesson.

Statement of the problem:

The research problem can be formulated in the following main question:

"What is the effectiveness of using electronic educational games in developing achievement and retention of learning in Mathematics for primary school pupils?"

The main question is subdivided into the following sub-questions:

1. What is the effectiveness of using electronic educational games in developing achievement in Mathematics for primary school pupils.
2. What is the effectiveness of using electronic educational games in developing retention of learning in Mathematics for primary school pupils.

Research Significance:

In the light of the current study findings, it's expected that the following will benefit from it:

- **Primary school pupils:**
  1. Enabling pupils to be an active part of the teaching/ learning process makes learning more effective and leads to the transfer of learning.
  2. Helping sixth grade pupils to improve their achievement in Mathematics using new teaching methods that differ from the traditional teaching methods.
- **Teachers:**
  1. Developing teaching methods for Mathematics teachers to teach using electronic educational games besides developing techniques to attract pupils' attention, motivate them and create an interactive environment for them.
  2. Encouraging teachers to design new electronic educational games that motivate pupils to learn Mathematics.
- **Parents:**
  1. Parents direct their children to use electronic educational games in a way that supports ethics and avoids the drawbacks of games.
  2. Using educational e-games helps parents to follow their children's activities which makes them contribute to their children's achievement.
- **Researchers:**
  1. Providing specialists and researchers with experimental results for employing electronic games.
  2. This research provides a set of recommendations and suggestions that help new researchers in conducting many studies and research related to the field of research.

3. Opening the way for researchers to conduct future studies dealing with the retention and transfer of learning.

Research Limitations:

The current study was limited to:

1- **Content**: "Ratio" and "Proportion" unit in mathematics textbook of the sixth-grade primary.

2- **Place:** Two schools, Al-Ferdous experimental language school and Nasser experimental language school in west Mansoura Educational administrative zone.

3- **Time:** the experimental conducted at first semester of the academic year 2022/2023.

Research Instruments:

1. Achievement test in "ratio" unit (Prepared by the researcher).

Research Materials:

1. Electronic educational games (Prepared by the researcher).

2. Pupil's activity book (Prepared by the researcher).

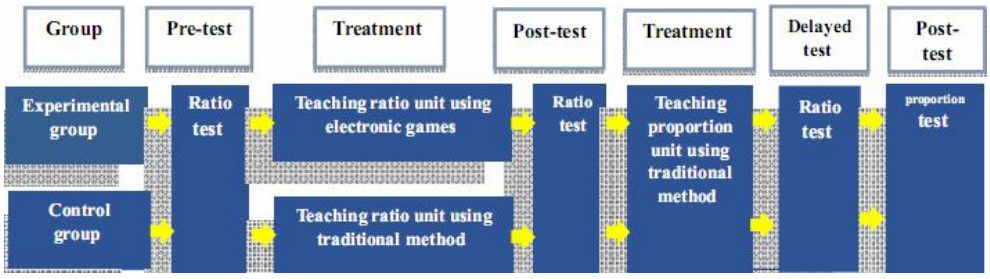
3. Teacher's guide (Prepared by the researcher).

Research design:

The current research followed the Experimental method through a quasi-experimental design of two equivalent experimental and control groups.

Figure (1)

Quasi- experimental design



Procedures:

To answer the research questions and verify the validity of its hypotheses, the researcher followed the following procedures:

1. Reviewing the literature and previous studies related to:
   - electronic educational games.
   - Retention of learning.

2. Analyzing the content of "Ratio" unit to determine the concepts, generalizations, and skills; to be used in the preparation of research materials and its instruments.
3. Preparing research materials:
   - Designing electronic educational games in "Ratio" unit and presenting them to a group of jury members.
   - Preparing the pupil's activity book in the "Ratio" unit and presenting it to a group of jury members.
   - Preparing the teacher's guide in the "Ratio" unit in the light of electronic educational games and presenting it to a group of jury members to make appropriate adjustments.
4. Preparing research instruments:
   - Preparing the "Ratio" test in its initial form, presenting it to a group of jury members to ensure its validity, adjusting and modifying it in the light of their opinions, and then preparing it in its final form.
5. Apply research instruments to an exploratory sample (other than the research sample) to calculate:
   - The appropriate time for the test.
   - The internal consistency of the test.
   - The test reliability coefficient.
   - The coefficients of ease, difficulty, and discrimination.
6. Selecting the research sample randomly divided into two groups, experimental and control.
7. Pre-Application of "ratio" test to the pupils of experimental and control group to verify the equivalence of the two groups.
8. Teaching the ratio unit as follows:
   - Teaching to the experimental group using electronic educational games.
   - Teaching to the control group using traditional methods.
9. Post -Application of the "ratio" test to the pupils of experimental and control group.
10. Delayed application of the ratio test to the two groups after a period (three weeks) to verify learning retention.
11. Analysis and discussion of results.
12. Presenting recommendations and proposed research in the light of the results of the research.

Literature review:

Play is an important human activity that is involved in learning as well as the generation and transmission of culture. Play is a necessary activity for a child's maturity and development in all aspects.

Learning through play is not just for pre- schoolers. In the primary grades, play opportunities enhance children's mastery of academic concepts and develop motivation to learn.

Primary school education provides fundamental skills that will be quite important for pupils' future learning. When a pupil fails to acquire these skills in primary education, the secondary level will be difficult to pursue due to previous gap.

Definitions of electronic games:

Amani Abd El Tawab Saleh (2017, 234) defines electronic games as a type of games that are displayed on a TV screen, a computer screen or a smart device that provide the individual with fun through his interaction and response to game's content. They are characterized by many audio-visual effects that create a virtual interaction between the player and the game.

Zirawaga et al. (2017, 55) defined electronic game as a support tool to complement traditional teaching methods to improve learners' learning experience while also teaching other skills such as following rules, adaptation, critical thinking skills, problem solving, interaction, creativity, and teamwork.

Game elements:

According to Prensky (2001, 11), electronic games can be distinguished by six key structural elements that, when combined together, strongly engage the player. These six elements are:

1. Rules.
2. Goals and objectives.
3. Outcomes and feedback.
4. Conflict/competition/challenge/opposition.
5. Interaction.
6. Representation or story.

These various elements combine to create an event that is larger than the individual elements. A player becomes engrossed in a game because the instant feedback and constant interaction are related to the game's challenge, which is defined by the rules, which all work within the system to elicit an emotional reaction. finally, result in a quantifiable outcome within an abstract version of a larger system (kapp, 2012, 9).

Feedback in Electronic Games:

Feedback is an essential mechanism to increase learning effectiveness. During play, it helps the learner to identify his mistakes and take corrective action.

The purpose of feedback in games is to direct learners to improve their performance, motivation, or learning outcomes by various methods of providing information to learners about the correctness of their responses (Shute, 2008, 158).

Immediate feedback in computer games provides players with information regarding the correctness of their actions and decisions and thus gives them the opportunity to correct inaccurate information.

Johnson et al. (2017,124) defines types of feedback in games:

1) **Outcome-based feedback**, which is mostly summative and functions to inform the learner about the correctness of their response.
2) **Process-based feedback** which directs learners to the processes and strategies used to reach the correct answer or action in the game.

Electronic games may provide both outcome and process feedback by informing the learner that his or her response is incorrect and explaining the steps needed to arrive at the correct answer.

Criteria of choosing and designing electronic games:

The game must be specifically designed and chosen with the appropriate criteria in order to be effective and achieve its goal.

- **Educational criteria:** game must:
  - Achieve the desired educational objectives.
  - Be appropriate for learners' age and their levels.
  - include new and creative activities.
  - Enhance transfer of learning and provide pupils with meaningful learning.
  - take into account the individual differences among the learners.
  - Provide immediate feedback to direct learners to improve their performance and motivation.
- **Technical criteria:** game must:
  - Have a set of specific rules.
  - Involve suspense and excitement.
  - Be less detailed so as not to distract children.
  - Be easy to use in terms of operating, entering, and exiting them, and dealing with them.
  - use audio-visual effects such as graphics and music.

Advantages of electronic games:

Hershkovitz et al. (2021, 4), Beak (2008, 665), Ahmad & Jaafar (2012, 516), Protopsaltis et al. (2011, 1).

- Electronic educational games aim at achieving an effective balance between gaming elements and learning goals in order to provide pupils with a meaningful experience.
- Electronic games are effective educational tools that provide an alternative way of presenting educational content.
- Electronic games increase motivation, engage players with learning and support collaboration and communication.
- They encourage learning by making it more enjoyable.
- Electronic games encourage active learning (learning by doing).
- Electronic games allow opportunities for self-assessment through the mechanisms of scoring and reaching different levels.
- They provide immediate and elaborative feedback which helps pupils to learn from their actions.

The importance of electronic games:

- The importance of electronic games lies in strengthening mathematical, arithmetic, and geometric concepts.
- Electronic games assist pupils to memorize what they have learned by encouraging them to participate actively.
- Electronic games increase the level of remembering, understanding and achievement in mathematics.
- Educational computer games develop students' skills of observation, analysis, classification, deduction, and synthesis.
- The game enhances pupils' interaction and collaboration during class activities, develops stronger relationships with team members and colleagues.
- Electronic games develop mental skills of children. Additionally, they improve their ability to organize thinking, help them to think abstractly, and make them more aware of how they think and learn.
- develop attention, focus, and activate intelligence because they use exploring games that help children to participate in the games as well as, they lead to enlarging the child's imagination.

Disadvantages of electronic games:

Despite all the benefits of using electronic educational games in the classroom, Mohamed sweilam Al-Bassiouny (2013,180), Rawan bint Abdullah Al-Qahtani (2020, 800), Dimitriadou et al. (2021, 141), Obaid Bin Mizal Alharbi (2010, 147) stated that:

- Electronic games negatively affect children's social interactions through introversion and isolation.
- Game design is labor-intensive and requires funding, subject matter experts, time, and administrative hassles.
- Lack of appropriate electronic educational games and resources.
- Not all games are appropriate for the classroom environment, as well as the ages and levels of the pupils.
- Some games are complex, which leads to the need for great effort and time from the teacher to explain them, and for the learner to understand them.

Retention of learning:

Learning retention is one of the most complex issues for pupils and teachers. Retention refers to pupils' ability to retain knowledge after they have completed the learning process. Retention is important for learning, comprehension, and application of mathematical concepts.

Lomibao & Ombay (2017,2133) defined Retention as the ability of the pupils to retain things in mind, preserve information about the concept discussed as aftereffects of learning experiences that makes recall or recognition possible after a period of time.

Factors that enhance Retention of learning:

Ayandele (2016, 57-58), Mathur (2018, 119-132), Ofoha (2022 ,106), Misra (2019, 99) Mentioned factors that enhance retention of learning:

- Allow students to make concept maps.
- Use Mnemonic aids or acronyms. Mnemonics is a method of remembering items by imposing a structure of organization on the information to be memorized.
- Repetition and practice: Continuous rehearsal and practice of the information learned helps in easy recall. Things that are repeated and practiced frequently are retained in memory for a long time.
- Provide positive Reinforcement: positive reinforcement is the process of encouraging kids by awarding them for their accomplishments.
- Distributed learning or practice: Cramming should be avoided because it is an inefficient method of learning. Distributed practice helps in memory efficiency.
- Promote Video-Based Learning, visual representations make learners easily perceive and store the information in their memory longer.
- Reviewing previously taught information at regular intervals.

Research hypotheses:

In the light of literature reviews and previous studies the current research hypotheses can be formulated as follows:

1. There is a statistically significant difference at level ($\alpha \leq 0.05$) between the mean scores of the pupils of the experimental and control groups in the post-application of the achievement test in ratio unit in favor of the experimental group.
2. There is a statistically significant difference at level ($\alpha \leq 0.05$) between the mean scores of the pupils of experimental group in the pre- and post-application of the achievement test in ratio unit in favor of the post-application.
3. There is a statistically significant difference at level ($\alpha \leq 0.05$) between the mean scores of the pupils of the experimental and control groups in the delayed application of the achievement test in ratio unit in favor of the experimental group.
4. There is no statistically significant difference at level ($\alpha \leq 0.05$) between the mean scores of the pupils of experimental group of the post and delayed application of the achievement test in ratio unit.

Statistical methods used in the research:

The researcher used the following statistical method in analyzing and processing data:

- Pearson's correlation coefficient.
- Cronbach's alpha equation to calculate the reliability of the ratio test.
- T-test for two independent groups.
- T-test for two dependent groups.
- The effect size (η^2) for measuring the experimental effect (effectiveness) of the experimental treatment (electronic games) on the dependent variables to the experimental group.

Methodology:

Research population:

Research population consists of all the sixth-grade pupils in the Dakhalia governorate during the first semester of the academic year (2022/2023).

Research sample:

The sample includes 62 participants of sixth grade at both of:

- Nasser experimental language school (control group).
- Al-Ferdous experimental language school (experimental group).

Table (1)

Description of research sample

Research group	School	Class	Number
Experimental	Al-Ferdous experimental language school	6C	32
Control	Nasser experimental language school	6C	30
Total			62

Preparing research materials:

The researcher prepared research materials according to the following steps:

1. Choosing the content:

After revising the content of the mathematics textbook for sixth grade pupils for the first semester of the academic year (2022/2023), the "ratio" unit was chosen as the experimentation unit for the current study.

2. Analysis of the unit content:

After choosing "Ratio" unit, the researcher analyzed the content of the unit into the elements of mathematical knowledge that it contains, which are (mathematical concepts, generalizations, and skills).

3. Determining the unit objectives:

After analyzing the content of Ratio unit into elements of mathematical knowledge that it contains, the researcher determined Ratio unit objectives.

4. Design Electronic Games:

After analyzing the content of the ratio unit and determining the general objectives in it, the appropriate electronic educational games have been designed for ratio unit.

Electronic Games validity:

After designing electronic games, they were judged by some jury members to express their opinions. All recommendations and modifications proposed by the jury members were taken into consideration. Therefore, electronic games became in their final form valid to be used for the experimental group.

5. Preparation of the Activity Book:

The researcher prepared the activity book in "Ratio" unit to enhance achievement and retention of learning for sixth grade pupils.

After preparing the activity book, it was judged by some jury members and specialists in curricula and teaching methods of mathematics to express their opinions. All recommendations and modifications proposed by the jury members were taken into consideration. Therefore, the final form of the pupil's activity book can be used for the experimental group.

6. Preparation of Teacher's Guide:

The teacher's guide was prepared in order to help the teacher during the teaching process of "ratio" unit for the sixth-grade pupils according to electronic educational games; the teacher's guide included the following:

- An introduction.
- Teacher's guide objectives.
- The importance of a teacher's guide.
- The time plan of teaching "Ratio" unit.
- General objectives of teaching "Ratio" unit.
- Steps of teaching include learning strategies, educational tools, electronic educational games, and activities.
- The role of the teacher and the pupils during using electronic educational games in the classroom.
- Evaluation.

After preparing the teacher's guide, it was judged by some jury members and specialists in curricula and teaching methods of mathematics. All recommendations and modifications proposed by the jury members were taken into consideration. Therefore, the teacher's guide got its final form and could be used in teaching "ratio" unit for the experimental group.

Preparing Research Instruments:

1. Preparing the Achievement Test in Ratio unit:

To prepare the achievement test in Ratio unit, the researcher followed the following steps:

a. Determining the purpose of the test:

The researcher prepared the achievement test of the "ratio" unit in mathematics for sixth grade pupils to:

- Measure the extent to which sixth grade pupils have acquired information through their study "ratio" unit using electronic educational games, by applying the Post-test.
- Measure the extent to which six grade pupils retain the information they gained from studying ratio unit using electronic educational games, by applying the test after 3 weeks.

b. **Preparing table of specification**:

The table of specifications for "Ratio" test was designed according to the following steps:

- Determine the relative weight of content according to number of sessions.
- Determine the relative weight of objectives.
- Determine the number of test questions.

- Determine the number of questions in each lesson.

Prepare ratio test in its initial form:

It included determining the type of test items, formulating its instructions and its questions; to be prepared in its initial form.

- **Determining type and distribution of the test items:**

The ratio test items were determined to be MCQ-questions; and the test included (40) questions.

- **Test Instructions:**

The test instructions were formulated to clarify the test's purpose to the pupils, guide them to answer questions in an organized way, as well as the time required to answer the questions.

- **Answer key:**

The answer key was made for ratio test, showing the correct answer for each item of the test.

- **Test validity:**

After preparing the test in its initial form, it was presented to a group of jury members and specialists in curricula and teaching methods of mathematics to express their opinion.

some jury members and specialists indicated that the number of questions should be reduced from (40) to (30) items.

After reducing the number of test items from (40) to (30) items, the "Ratio" test became in its initial form.

c. Pilot study:

After confirming the validity of Ratio test, the test was administered in its initial form on an exploratory sample of (24) pupils in the primary sixth grade at Temai El Amdeed language school affiliated to Temai El Amdeed administration (not involved in the basic research sample), in the first week of the first semester of the academic year (2022/2023), with the aim of:

- Ensuring that the questions and test instructions are clear.
- Estimating the test time.
- Calculating the internal consistency of the ratio test.
- Calculating the ratio test reliability coefficient.
- Calculating the coefficients of ease, difficulty, and discrimination for the test questions.

d. The final form of Ratio Test:

In the light of the previous procedures, and after making modifications to "Ratio" test in the light of the opinions of the jury members, "Ratio" test became in its final form and valid for application to the experimental and control group.

Research implementation procedures:

- **The first stage: preparation for the research experiment**.

After selecting the research sample, the researcher did the following:

1. Obtaining official approvals for the research application:
   - Official approvals from the Directorate of Education in Dakahlia Governorate.
   - Official approvals from the educational administration to which the two research schools belong to it.

- **The second stage: the pre-application of the ratio test.**

The ratio test was applied to the pupils of the experimental and control groups at the beginning of the first semester on Wednesday 5/10/2022, after that the test was corrected and the scores were recorded and analyzed statistically; to verify the equivalence of the two groups.

Table (2)

T-values and its statistically significant difference between the mean scores of the two research groups in the pre- application of ratio test

Ratio test levels	groups	n	mean	Standard deviation	t	Df	Statistical significance
Knowledge	Experimental	32	1.2500	.62217	.306	60	Not significance
	control	30	1.2000	.66436			
Comprehension	Experimental	32	3.7188	1.37335	.148	60	Not significance
	control	30	3.6667	1.39786			
Application	Experimental	32	3.8750	1.47561	.389	60	Not significance
	control	30	3.7333	1.38796			
High level	Experimental	32	2.8125	.73780	.567	60	Not significance
	control	30	2.6667	1.24106			
Total score	Experimental	32	11.6563	2.58544	.587	60	Not significance
	control	30	11.2667	2.63836			

It is clear from table (2) that all t- values of the difference between the mean scores of the experimental and control group in ratio test were not statistically significant at level (≤0.05), which mean that there was equivalence between the two groups in the levels of ratio test and t total test.

- **The third stage: implementing the research experiment (teaching the ratio unit).**

  The application of the experiment began on Sunday 9/10/2022, where the researcher taught the pupils of the experimental and control groups.

  - Teaching the ratio unit to the experimental group using electronic educational games.
  - Teaching the ratio unit to the control group using traditional method that most mathematics teachers follow in teaching.

- **The fourth stage: the post-application of the ratio test.**

  After completing the teaching of the ratio unit for the pupils of the experimental and control groups, the researcher carried out the post application of the ratio test on pupils of the two groups, on Tuesday 11/1/2022.

- **The sixth stage: the post-delayed application of the ratio unit.**

  The post-delayed application of Ratio test was carried out after (three weeks) of the post-application on the pupils of the experimental and control groups, on Wednesday 23/11/2022.

Results and Discussion:

Testing the first hypotheses

It was hypothesized that: "There is a statistically significant difference at level ($\alpha \leq 0.05$) between the mean scores of the pupils of the experimental and control groups in the post-application of the achievement test in ratio unit in favor of the experimental group".

To verify this hypothesis, the researcher used the t-test for independent groups to calculate the significance of the difference between the mean scores of the pupils of the experimental and control groups in the post application of the ratio test and its levels as follows:

Table (3)

T-values and its statistically significant difference between the mean score of the experimental and control groups in the post-application of the ratio test and its levels

Ratio test levels	groups	N	mean	Standard deviation	Df	t	Statistical significance
Knowledge	Experimental	32	2.9375	.2459	60	7.211	0.01
	Control	30	1.9667	.7184			
comprehension	Experimental	32	6.8438	1.081	60	8.966	0.01
	Control	30	4.5333	.9371			
Application	Experimental	32	7.6563	1.428	60	5.253	0.01
	Control	30	5.8000	1.3493			
High level	Experimental	32	6.5625	1.1897	60	5.758	0.01
	Control	30	4.7333	1.3113			
Total score	Experimental	32	24.000	2.3827	60	11.34	0.01
	Control	30	17.033	2.4563			

It's clear from table (3) that there is a difference between the means and standard deviations between the experimental and control group in the ratio test levels.

Testing the second hypothesis:

It was hypothesized that: "There is a statistically significant difference at level ($\alpha \leq 0.05$) between the mean scores of the pupils of experimental group of the pre- and post-application of the achievement test in ratio unit in favor of the post-application".

To verify this hypothesis, the researcher used the t-test for dependent groups to calculate the significance of the difference between the mean scores of the pupils of the experimental in the pre- and post- application of the ratio test and its levels as follows:

Table (4)

T-values and its statistically significant difference between the mean score of the pupils of the experimental group in the pre- and post- application of the ratio test and its levels

Ratio test levels	Application	N	mean	Standard deviation	Df	T	Statistical significance
Knowledge	Pre-application	32	1.2500	.62217	31	14.81	0.01
	Post-application	32	2.9375	.24593			
comprehension	Pre-application	32	3.7188	1.37335	31	9.867	0.01
	Post-application	32	6.8438	1.08090			
Application	Pre-application	32	3.8750	1.47561	31	9.741	0.01
	Post-application	32	7.6563	1.42805			
High level	Pre-application	32	2.8125	.73780	31	17.048	0.01
	Post-application	32	6.5625	1.18967			
Total score	Pre-application	32	11.656	2.58544	31	18.854	0.01
	Post-application	32	24.000	2.38273			

It's clear from table (4) that there is a difference between the mean scores of the experimental group in the pre- and post- application of the ratio test and its levels.

Effect size

To calculate the effect size by calculating the (effectiveness) of the experimental treatment (electronic games) on the dependent variable (achievement), the researcher calculated the effect size by calculating the eta square as follows:

Table (5)

η^2 values and size effect of using electronic educational games in developing achievement.

Ratio test levels	T	Df	effect size (η^2)	Level of effect size
Knowledge	7.211	60	0.464	High
Comprehension	8.966	60	0.573	High
Application	5.253	60	0.315	High
High level	5.758	60	0.356	High
Total score	11.335	60	0.682	High

Eta Indicator low= 0.01 Medium= 0.06 high= 0.14

It is clear from table (5) that the effect size of the experimental treatment (electronic games) on the levels of the dependent variable (achievement) is: (0.464), (0.573), (0.315),(0.356); Which indicates that (31.5% to 57.3%) of the variance of test levels is due to the effect of the experimental treatment, and this indicates a high effect size, The effect of the experimental treatment on the total score of the test was (0.682); This indicates that (68.2%) of the variance in the total score for achievement is due to the effect of the experimental treatment (electronic games); this indicates a high effect size.

Discussion of the Achievement Results:

The previous results indicated the effectiveness of using electronic games in developing the achievement of the pupils of the experimental group, these results can be explained due to the following reasons:

- Electronic games are effective instructional methods that allow pupils to participate actively in the learning process.
- Games increase pupils' motivation to learn because they contain feedback after each response they make, which enhances achievement.

- Using electronic games in mathematics focuses on improving critical thinking skills by allowing pupils to think outside the box, and this improves the pupils' achievement.
- The scientific content is displayed on games screens that use multimedia such as attractive colors, sound effects and graphics, which stimulates the different senses of the learner and this makes the pupil active and effective in the learning process, which leads to increased achievement.
- Pupils' activity book includes various activities that enhance achievement.

Testing the third hypothesis:

It was hypothesized that: " There is a statistically significant difference at level ($\alpha \leq 0.05$) between the mean scores of the pupils of the experimental and control groups in the delayed application of the achievement test in ratio unit in favor of the experimental group".

To verify this hypothesis, the researcher used the t-test for independent groups to calculate the significance of the difference between the mean scores of the pupils of the experimental and control groups in the post-delayed application of the ratio test and its levels as follows:

Table (6)

T-values and its statistically significant difference between the mean scores of the pupils of the experimental and control groups in the post-delayed application of the ratio test and its levels

Ratio test levels	groups	N	mean	Standard deviation	Df	T	Statistical significance
Knowledge	Experimental	32	2.875	.33601	60	12.184	0.01
	Control	30	1.233	.67891			
comprehension	Experimental	32	6.688	.82060	60	12.349	0.01
	Control	30	3.600	1.13259			
Application	Experimental	32	7.531	.87931	60	13.688	0.01
	Control	30	4.167	1.05318			
High level	Experimental	32	6.344	.86544	60	14.527	0.01
	Control	30	3.000	.94686			
Total score	Experimental	32	23.438	1.64488	60	27.068	0.01
	Control	30	12.000	1.68154			

It's clear from table (6) that there is a difference between the means and standard deviations between the experimental and control group in the ratio test levels.

Testing the fourth hypothesis:

It was hypothesized that: "There is no statistically significant difference at level ($\alpha \leq 0.05$) between the mean scores of the pupils of

experimental group in the post and delayed application of the achievement test in ratio unit".

To verify this hypothesis, the researcher used the t-test for dependent groups to calculate the significance of the difference between the mean scores of the pupils of the experimental in the post and delayed application of the ratio test and its levels as follows:

Table (7)

T-values and its statistically significant difference between the mean score of the experimental group in the post and delayed application of the ratio test and its levels

Ratio test levels	Application	N	mean	Standard deviation	Df	t	Statistical significance
Knowledge	Post	32	2.9375	.24593	31	.812	.423
	Delayed	32	2.8750	.33601			
comprehension	Post	32	6.8438	1.08090	31	.560	.580
	Delayed	32	6.7188	.81258			
Application	Post	32	7.6563	1.42805	31	.235	.815
	Delayed	32	7.5938	.83702			
High level	Post	32	6.5625	1.18967	31	.624	.537
	Delayed	32	6.4063	.91084			
Total score	Post	32	24.000	2.38273	31	1.075	.291
	Delayed	32	23.594	1.64335			

It's clear from table (7) that there is no difference between the mean score of the experimental group in the post and delayed application of the ratio test and its levels.

In the light of these results, the fourth hypothesis of the research was accepted.

Effect size

To calculate the effect size by calculating the (effectiveness) of the experimental treatment (electronic games) on the dependent variable (retention of learning), the researcher calculated the effect size by calculating the eta square as follows:

Table (9)

η^2 values and size effect of using electronic educational games in developing retention of learning.

Ratio test levels	T	Df	effect size (η^2)	Level of effect size
Knowledge	12.184	60	0.712	High
Comprehension	12.349	60	0.718	High
Application	13.688	60	0.757	High
High level	14.527	60	0.779	High
Total score	27.068	60	0.924	High

Eta Indicator low= 0.01 Medium= 0.06 high= 0.14

It is clear from table (9) that the size of the effect of the experimental treatment (electronic games) on the levels of the dependent variable (retention of learning) is: (0.712), (0.718), (0.757), (0.779); Which indicates that (71.2% to 77.9%) of the variance of test levels is due to the effect of the experimental treatment, and this indicates a large effect size, The effect of the experimental treatment on the total score of the test was (0.924); This indicates that (92.4%) of the variation in the total score for retention of learning is due to the effect of the experimental treatment ; this indicates a large effect size; Which indicates the effectiveness of electronic games in developing retention of learning of the research sample. Thus, the current research has answered the second question, "What is the effectiveness of using electronic games in developing retention of learning in mathematics for primary school pupils?".

Discussion of learning retention results:

The previous results indicated the effectiveness of using electronic games in developing retention of learning for pupils of the experimental group, these results can be explained due to the following reasons:

- Because electronic educational games employ both audio and visual effects, they engage more than one human sense, which makes learning the most effective and long-lasting.
- Searching through memory for the correct answer activates other related information and enhances long-term retention.
- Electronic games made pupils more interested in learning mathematics. When pupils played the game, they wanted to learn more and pay more attention because they liked to pass the game missions. This leads to retaining information in their memories.

Recommendations:

According to the research findings, the following recommendations can be presented to:

- **faculty of education:**
  - Include programs for the preparation of mathematics teachers in the faculties of education with appropriate training programs for how to design educational electronic games and use them in teaching.
- **Ministry of education:**
  - Supporting schools by providing an infrastructure that supports the use of electronic games in the educational process.
- **Schools:**
  - Holding training courses for teachers to train them on designing electronic games and how to employ them in the classroom.
- **Teachers:**
  - Include the use of electronic games in the educational process.
  - Choose electronic games that suit the ages of children.

Suggestions:

Using electronic games to enhance transfer and retention of learning in mathematics for preparatory stage.

Studying the effectiveness of electronic games in teaching mathematics to students of different levels (gifted, with learning difficulties or with special needs).

Using electronic games to develop creative thinking in mathematics for (STEM) pupils.

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