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The Effects of Using Digital Mind Mapping on Rational Number Achievement and Creative Thinking among 7th Grade Jordanian Students

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Abstract This study aimed to investigate the effect of digital mind maps on rational numbers and creative thinking among Jordanian seventh-grade students. The quasi-experimental approach was used to achieve the objectives of the study. The study applied a sample of 120 male and female students of the seventh grade. The results of the study showed that there were differences in the students' responses in the rational number achievement test, and there was an apparent difference between the responses of the experimental group's students compared to the results of the control group's students, and that these differences were in favor of the females compared to males. It was also found that there was an interaction between the teaching method and gender in the achievement of seventh-grade students in the post test. The results of the study also showed that there were differences in students' responses to the creative thinking test, and there was no clear difference between the results of the experimental group's responses and the results of the control group's students' creative thinking test. The results also showed the existence of an interaction between the teaching method and the gender in the creative thinking of the seventh graders in the post test. The study recommended the necessity of conducting a study similar to the current study on subjects other than mathematics in different educational stages (primary, intermediate, secondary, and university).

Keywords Mind Maps, Achievement, Creative Thinking, Mathematics, Rational Numbers

1. Introduction

Mind maps are used for annual planning, which can be used to give the teacher a comprehensive view of the educational program for the whole school year, identify the sections for each stage of study and the types of lessons that must be taught, and plan for the mid-school year and usually they take the form of a smaller mind map that extends from branch or branches on the annual program. The mid-year plan can be used to determine the topics that will be covered within the curriculum that the teacher intends to cover, in addition to determining the pattern or arrangement that will be followed roughly. As for the daily planning, his mind maps will include precise details such as determining the time for the beginning and the end, the school day, the topics to be covered and the classroom situation [1].

Students can observe, discuss, conclude, deduct, and establish relations between concepts. Additionally, the student can make decisions based on his/her experience through the use of mind maps, which is called active learning or meaningful learning. It employs knowledge in problem-solving, in the support of creativity, and the development of inventiveness. Furthermore, the extended

time consumed by intervention influences the results of the creativity and better performance of students. Students can be creative and think creatively in their courses. Mind map applies this and transforms the environment of learning to enforce creativity in classrooms for more flexibility in presenting content rather than repeated tasks and procedures that affect the ability of students to generate ideas and then the outcomes of education [2].

Digital mind maps offered a dynamic, distributed learning environment which expanded the physical learning space and afforded students a means of developing, organizing and structuring their ideas using higher-order thinking skills and thereby enhanced their understanding [3].

The importance of mind maps appears through the mind arrangements for the information and knowledge that the student receives, which contributes to facilitating the process of retrieval of information and learning skills easily and easily and is clearly reflected in students' achievement within educational institutions, considering the academic achievement in its general sense indicates the amount of information obtained. Students, during their studies, do not bear fruit unless it results from a study of the abilities and preparations of students by those responsible for the process of student orientation. Academic achievement is the main entrance through which students' failure problems can be identified in schools [4].

Mind maps not only improve students' academic achievement and provide them with information and educational concepts in a way that is related to reality, but rather work to develop students' thinking and improve their creative skills. They contribute to developing thinking and creativity among learners as an important method in improving the cognitive and mind abilities of learners. Creative thinking is seen as a complex and purposeful mind activity guided by a strong desire to search for solutions or arrive at original products that were previously unknown, and thinking is distinctive, creative, comprehensive and complex, because it contains overlapping cognitive, emotional and ethical elements that make up a unique state of mind. Researchers use various expressions that are consistent with the concept of creative thinking [5].

Thinking as a cognitive process is an essential element in the mind-cognitive structure that a person possesses and is distinguished by its social character and systemic action that make it possible to exchange influence with the elements of the structure of which it is composed, i.e. influences and is affected by the rest of the other cognitive processes such as perception, perception, memory, and influences and is affected by the emotional, emotional and social aspects of personality. Thinking is distinguished from all cognitive processes because it is the most sophisticated and most complex of them, and its ability to penetrate into the depth of things, phenomena and attitudes and to surround them enables it to process information and produce and reproduce new knowledge and information, accurate comprehensive, brief [6].

The researcher believes that Mind maps are consistent with learning, where the learner builds his own version of knowledge, constructivism theory, as the conceptual map in theory is an expression of the individual's cognitive framework in content and organization, that is, it represents or expresses the cognitive structure of the individual in terms of its components and the relationships between these components. Some studies on memory have indicated that developing mind images of verbal information leads to better levels of remembering, especially since 40% of the people are classified as visual learners. Therefore, people learn best when you present them with information and concepts visually or visually.

2. Statement of the Problem

Mathematics is closely related to the details of a person's daily life and its activities. Man uses mathematics in its various applications and forms a lot without being aware of it directly, whether it is in the kitchen, office, study place, or places of entertainment, where mathematics organizes the human life and saves him from chaos and randomness, and it develops the human ability of rational reasoning, critical thinking, and spatial and spatial thinking, and it instills in him the necessary and effective communication skills in his life.

Despite the importance of mathematics in life for the individual and society, many students suffer from difficulties in acquiring and learning mathematical concepts and they are reluctant to take this subject. It has been confirmed by educational research, that it is from 3% to 6% of the total population suffers from difficulties in learning mathematical subjects, and this can be discovered in the child by observing the extent of the child's awareness of mathematical concepts and mathematical operations [7].

Through her work as a teacher in the Jordanian schools, the researcher noticed that the students usually have low mathematical achievement especially in the units of the rational numbers in different grades of schools. In addition to the previous studies that assured the unsuitability of the used teaching strategies, the researcher also noticed the opposite situation when she tried some other teaching techniques in teaching mathematics as she noticed increasing in the mathematical achievement and more understanding of the mathematical concepts. This led to the conclusion that there is a deep need for a new method that can be used to increase mathematical achievement and help gain the desired outcomes from the learning process.

It can be said that not only students but also teachers themselves have difficulties in teaching percentages, as they are the guides and providers of knowledge to these students, as the nature of the teaching material and its contents of integer numbers, fractional numbers, and decimal numbers, and the clear skills required for

arithmetic operations contributed. Considering that the educational content of the relative numbers requires a great effort from the parties to the teaching process, the teacher and the student, researchers had to find out the best ways to overcome the obstacles facing students in order to improve their educational achievement in this subject, as a primary starting point for future concepts related to teaching and learning mathematics.

The researcher studied the different teaching strategies which proved its validity in increasing the mathematical achievement. In addition, the researcher studied the strategies that increase the creative thinking skill which is the desired outcome from a successful learning process. The researcher was concerned with a special method which is mind maps. She chose it as the method of this thesis has proven its effectiveness as a successful teaching method for increasing the mathematical achievement and the creative thinking.

Based on the above, the study problem is determined by answering the main question of the study, which is: What is the effect of using digital mind maps on the achievement of the seventh-grade students on the achievement test in rational numbers and creative thinking in Jordan?

3. Significance of the Study

The present study offers multiple benefits to the practical side of the teaching-learning process. The result of this research can reveal the true scenario of teaching and learning mathematics. Readers of this research thesis will benefit through an awareness and understanding of the importance of digital mind mapping in learning mathematics.

Schools and teachers can use the results of this study to modify teaching methods to enhance the learning of students. For policymakers, the study will be helpful in policy formulation towards better teaching and learning practice. And the most important element of these processes are the students.

Mind mapping allows teachers to demonstrate the relationship between concepts that are particularly relevant to middle-class students. The results of this study will be beneficial to mathematics teachers, as it helps them develop innovative new ways of mapping their mind minds to reveal their creativity. Therefore, this study explores the effect of digital mind maps on students' creativity in teaching mathematics. In addition, the results obtained from this study could open the way for further research to improve research contributions in this field.

4. Objectives of the Study

The objectives of the current study are:

- To determine the effect of teaching using digital mind maps, paper mind maps, and the conventional method on students' achievement in rational numbers unit.
- To determine the effect of teaching using digital Mind maps, paper mind maps, and the conventional method on students' achievement in rational numbers unit based on the students' gender difference.
- To determine the effect of the interaction between the teaching method and the gender that contribute to the achievement of students in rational numbers unit.
- To determine the effect of teaching using digital mind maps, paper mind maps, and the conventional method on the creative thinking of students.
- To determine the effect of teaching using digital Mind maps, paper mind maps, and the conventional method on students' gender in creative thinking.
- To determine the interaction effect of the teaching method and the gender that contributes to the creative thinking of students.

5. Research Questions

The current study aims to answer the following research questions:

- Are there significant differences in students' achievements in rational number between groups of students who are taught using the digital mind maps and that of paper mind maps and conventional method?
- Is there a significant difference in students' achievements in rational number among male students who are taught using the digital mind maps, paper mind maps and conventional method?
- Is there a significant difference in students' achievements in rational number among female students who are taught using the digital mind maps and that of paper mind maps and conventional method?
- Are there interaction effects between teaching method and students' gender that contribute to student achievement in student's achievements in rational number?
- Are there significant differences in students' creative thinking between groups of students who are taught using the digital mind maps and that of paper mind maps and conventional method?
- Are there significant differences in students' creative thinking among male students who are taught using the digital mind maps and that of paper mind maps and conventional method?
- Are there significant differences in students' creative thinking among female students who are taught using the digital mind maps and that of paper mind maps and conventional method?

- Are there interaction effects between teaching methods and students' gender that contribute to creative thinking?

6. Definitions of Terms

Mind Map: A way to express a personal view of the world of ideas and graphs rather than just words, as branches, images and colors are used to express the idea. It is used as a method of using memory and relies on visual memory in an easy-to-review illustration and easy recollection of rules and instructions [8].

Digital Mind Mapping: [9]. defined the digital mind map as a creative graphic drawing based on specialized computer programs consisting of branches that cross the center using lines, words, symbols, and colors and is used to represent the relations between ideas and information. And in another definition, it is a method using computer software to help students think, produce and organize their ideas. Also, digital mind maps can be defined as creative free sketches for mind maps generated by specific computer programs. It is designed like the ordinary mind map starts from the center and branches come out from it using lines, arrows, words, symbols, and colors. Digital mind maps are used to represent relationships between thoughts, and information and are designed by spontaneous and creative thinking.

Rational Number Achievement: Achievement is defined as the knowledge and skills acquired by the student as a result of studying a specific subject or unit of education [10]. Achievement is defined as the progress that the student possesses in a definite subject which is measured as a difference between the knowledge before and after learning a specific part of a subject.

Creative Thinking: It is thinking that is characterized by non-imitation, and its outputs are novel and valuable to both the thinking person and the culture to which he belongs, and the thinker is driven by strong motivation and high perseverance, and it is a complex and purposeful mind activity directed by a strong desire to search for solutions or arrive at original outcomes that were not previously known [10].

Research design: The research design is defined as the structure of the methodology that the researcher used to conduct a study to collect the various research components in a rational manner so that the study problem can be properly addressed.

The quasi-experimental approach is a type of experimental approach that aims mainly to study the causes of phenomena by treating the level of some independent variables, measure the result, and evaluate the relationships between cause and effect, but about the application of the experiment if all the important factors that may affect phenomena are fully controlled. It is considered to be a real experiment, but it is often not possible or practical to control all the key factors, so it becomes necessary to apply a quasi-experimental research design [11].

Sampling: The study population consisted of all seventh-grade students in government schools in Irbid Governorate. There are 2,690 students enrolled in government schools for the 2019/2020 academic year, according to the statistics of the Directorate of Education in Irbid Governorate.

Sampling is the process of selecting a portion of the population to be introduced to the independent variable and studying its effect on that sample. The sample of this study consisted of an intended sample of seventh-grade students in two secondary schools in Jordan, one for girls and the other for boys. The total number of students in each school is 60, which are divided into 3 groups, each group including 20 students.

Students in each school were divided into 3 groups, each containing 20 students, a control group, and two experimental groups. The control group learns by traditional methods while the two experimental groups learn using mind maps. The first experimental group learns using a paper mental map, while the other experimental group learns using digital mental maps.

Study Instrument: In order to achieve the objectives of the study and reach real results, the researcher adopted the following tools: An educational guide according to the method of Mind Maps, Rational Numbers Achievement Test, Creative Thinking Test, Student Questions, and Teacher Interview.

Rational Numbers Achievement Test: The consistency of the achievement test in the rational numbers was extracted in two ways: the test was applied in its initial form, and the test was repeated by applying the test, and it was re-applied after two weeks on a group from outside the study sample consisting of (25) students from both groups. The stability modulus of the questions was measured using Coder Richardson's equation (KR) as follows. $X = K/(K-1) * (1 – U)*(K-U) / (K*V)$, where K is the number of items, U is the mean of X, and V is the variance of X. The KR equation was calculated for the groups of the pilot study and proved the reliability of the study procedures and tools.

By analyzing the grades of the control group for the girls ’school, it is shown that the average scores of this group in the post test were 13.8, while the average scores of the pre-test for the control group in the boys’ school ratio was 12.95, which indicates that there are no statistically significant differences between the two groups in the two schools, based on the post test, which included 20 items**.**

The standard deviation of the control group in the girls’ school is 3.205, while the standard deviation of the control group in the boys’ school was 2.910, which indicates that there are no statistically significant differences at the level of statistical significance (0.05) between the standard deviation of the students' scores in the post test of the two schools' control groups.

Creative Thinking Test: The stability of the Torrance

Test for Creative Thinking was extracted in two ways: the test was applied in its initial form and retested by applying the test, and it was re-applied after two weeks on a group from outside the study sample consisting of (25) male and female students who were not members of the two experimental groups. And then the Pearson correlation coefficient was calculated between their estimates both times, reaching (0.90). The reliability coefficient was also calculated using the internal consistency method according to the Cronbach Alpha equation, reaching (0.88). These values were considered appropriate for the purposes of this study.

Student Questions: The stability of the decision was extracted in two ways: The test was applied, in its initial form, and re-tested, by applying the test, and re-applied after two weeks on a group from outside the study sample consisting of (25) students who were not members of the experimental and control groups, and then computing Consistency using the smart Pls program, where the output A showed the stability value (0.82), and that the value of (R) for students 'attitudes was (0.79). This means that this percentage explains (79%) of the students' attitudes towards the teaching method followed.

Teacher Interview: The stability of the interview was extracted in two ways: the interview was applied in its initial form and retested by applying the test, and reapplied after two weeks to a group from outside the study sample consisting of (4) teachers and teachers of the seventh-grade students who were not members of the two groups. Experimental and control, and then the Pearson correlation coefficient was calculated between their estimates both times, reaching (0.90). The stability coefficient was also calculated using the internal consistency method according to the Cronbach Alpha equation, reaching (0.91). These values were considered appropriate for the purposes of this study.

Statistical Treatment: In many of the studies, the analysis takes place during the collecting of the data, the matter that facilitates the shaping of the process of collecting the data. This analysis which is called temporary or chain analysis enables the researcher to step forward to improve the questions, add more hypotheses, and continue his research effectively. It also enables the researcher to exclude the negative cases that contradict with the hypothesis of the research and work on refining it. That kind of analysis is something vital as no way for the researcher not to think of the seen or heard collected data.

The analysis of the data starts with identifying the relevant data and examining it by constant comparison, in which each item is checked or compared with the rest of the data to establish analytical categories. This process needs a solid and systemic methodology. This process must be inclusive, as each category should reflect the minor differences in the data and turn it into few codes. A number of computer software packages have been developed to assist with this process.

Quantitative data of this research were collected through evaluation tests that will be conducted before and after the experiment and will be analyzed using the SPSS program.

Several software packages designed for qualitative data analysis allow complex organization and data retrieval.

The researcher used the statistical analysis program to come up with the results of the study, and also used the Smart PLS program to detect the consistency of the identification of trends towards learning.

The results of the first question, which states: are there significant differences in students' achievements in rational number between groups of students who are taught using the digital mind mapping and that of paper mind mapping and conventional method?

From this question, the following null hypothesis was derived: There are no statistically significant differences at the level of significance (a= 0.05) in the averages of students' achievement per unit of relative numbers due to the teaching method (digital mind maps, compared to drawing Mind maps and the traditional method).

To answer this question, the arithmetic means and standard deviations were extracted for the answers of the study sample individuals on the rational number achievement test. Table No. 1 illustrates the results.

Table 1. The arithmetic means and standard deviations of the responses of the study sample individuals

Group	Number	Average	standard deviation
Control	40	5.93	2.00
Experimental (1)	40	5.47	2.09
Experimental (2)	40	5.93	2.00

It is evident from the table above that there is a variation in the arithmetic mean and standard deviations for each of the study sample members in the three groups, the control group, the first experimental group that was studied using digital mind maps, and the second experimental group that was studied using paper mind maps, and the tracer of the study results and compared them between the three groups. An increase in the averages and deviations in favor of the experimental groups compared to the control was observed. And by comparing the two experimental groups, an increase in favor of the group studied using digital mind mapping was observed.

Investigate the effect of Gender on the mathematical achievement of the control group by TWO WAY ANOVA

From the following table, it is clear that: p value for the Gender variable is 0.074 which means there is no statistical significance between the scores of girls and boys and indicates the absence of gender variable on the mathematical achievement in the control group.

There is no significant effect on the mathematical

achievement for the control group in pre and post-test as the level of significance p. Value is 0.280, which is greater than 0.05, indicating the failure of conventional methods of teaching in raising the mathematical achievement of the students.

Table 2. Shows the statistical studies of the control groups by TWO WAY ANOVA

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	34.425[a]	2	17.213	2.231	.114
Intercept	15042.613	1	15042.613	1950.091	.000
x1	25.313	1	25.313	3.281	.074
x2	9.113	1	9.113	1.181	.280
Error	593.963	77	7.714		
Total	15671.000	80			
Corrected Total	628.387	79			

X1: Gender variable

X2: Rational numbers achievement

Calculating the mean and standard deviation of the students score in the pre-test for the 1st experimental group which learned using paper mind maps.

By analyzing the students' scores of the 1st experimental group of the girls' school, the results revealed that the mean of the scores of this group in the pre-test is 13.65 while the mean of the scores of the pre-test of 1st experimental group in boys' school is 12.5 which indicates the absence of statistically significant difference between the two groups in the two schools.

The standard deviation of the 1st experimental group of girls' school is 3.1334 while the standard deviation of the 1st experimental group in boys' school was 3.32, indicating that there is no statistically significant difference at the statistically significant level (0.05) between the standard deviation of students' scores in the pre-test for the 1st experimental groups in girls' school and boys' school.

Calculating the mean and standard deviation of the students score in the post-test for the 1st experimental group which learned using paper mind mapping

Calculating the mean of students' scores in the pot-test revealed that the mean of the 1st experimental group in the girls' school is 18.35 while the mean of students' scores in the 1st experimental group of the boys' school is 18.0 which indicates the absence of the significant statistical difference between the means of scores for the two experimental groups of the two schools.

Calculating the mean of scores is followed by calculating the standard deviation of the scores which indicates the statistical significance between the pre and the post test. The standard deviation of girls' 1st experimental group was 1.3869 while the standard deviation of boys' control group was 1.565.

The previous values indicated the absence of the statistical significance difference between the 1st experimental group in girls' school and the 1st experimental group of the boys' school as the *p* value is 0.186 which is more than the statistical significance value. In addition, there is also a statistical significance difference between scores of pre and post-test as the *p* value is 0.00 which is less than the statistically significant level (0.05).

Second: The results of the second question, which stated: Is there a significant difference in students' achievements in rational number among male students who are taught using the digital mind mapping and that of paper mind mapping and conventional method?

From this question, the following null hypothesis was derived: There are no statistically significant differences at the level of significance (a= 0.05) in the averages of student achievement in terms of relative numbers due to gender (males and females). Based on the teaching method (digital mind maps, compared to paper mind mapping and the traditional method).

To answer this question, the arithmetic means and standard deviations were extracted for the answers of the study sample individuals on the rational number achievement test. Table No. 3 illustrates the results.

Table 3. The arithmetic means and standard deviations of the responses of the study sample individuals

group	Gender	Number	Average	standard deviation
c.g	Male	20	7.01	0.26
	Female	20	4.82	0.14
e.g1	Male	20	8.19	0.26
	Female	20	4.76	0.14
e. g2	Male	20	7.01	0.26
	Female	20	4.82	0.14

Table 4. **T**he statistical studies of the 1st experimental groups by TWO WAY ANOVA

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	531.450[a]	2	265.725	41.988	.000
Intercept	19531.250	1	19531.250	3086.202	.000
x1	11.250	1	11.250	1.778	.186
x2	520.200	1	520.200	82.199	.000
Error	487.300	77	6.329		
Total	20550.000	80			
Corrected Total	1018.750	79			

a. R Squared = .522 (Adjusted R Squared = .509)

X1: Gender Variable

X2: Rational numbers achievement

In order to know the statistical significance of the apparent differences according to the teaching method, two-way ANOVA analysis was used as shown above.

Investigate the effect of Gender on the mathematical achievement of the 1st experimental group (using TWO WAY ANOVA).

From the table 4, we conclude that: There is no significant effect of the gender on the mathematical achievement for the two 1st experimental groups, as the level of significance p. Value is 0.186 which is greater than level of significance (0.05).

There is a significant statistical effect between the pre-test and post-test in terms of mathematical achievement for the first experimental group which studied using paper mind maps, as the level of significance p. Value is 0.00 which is less than the level of significance (0.05). This significant difference indicates the effectiveness of paper mind maps in increasing the mathematical achievement of the students.

Calculating the mean and standard deviation of the students score in the pre-test for the 2nd experimental group which learned using Digital mind maps.

By analyzing the students' scores of the 2nd experimental group of the girls' school, the results revealed that the mean of the scores of this group in the pre-test is 13.25 while the mean of the scores of the pre-test of 2nd experimental group in boys' school is 13.3 which indicates the absence of statistically significant difference between the two groups in the two schools.

The standard deviation of the 2nd experimental group of the girls' school in the pre-test is 2.7314 while the standard deviation of the 2nd experimental group in the boys' school in pre-test was 3.045, the matter that indicates that there is no statistically significant difference at the statistical significant level (0.05) between the standard deviation of students' scores in the pre-test for the 2nd experimental groups in girls' school and boys' school.

Calculating the mean and standard deviation of the students score in the post-test for the 2nd experimental group which learned using paper mind mapping.

Calculating the mean of students' scores in the pot-test revealed that the mean of the 2nd experimental group in the girls' school for the post test is 18.35 while the mean of students 'scores in the 2nd experimental group of the boys' school is 18.65 which indicates the absence of the significant statistical difference between the means of scores for the two experimental groups of the two schools.

Calculating the mean of scores is followed by calculating the standard deviation of the scores which indicates the statistical significance between the pre and the post test. The standard deviation of girls' 2nd experimental group was 1.1367 while the standard deviation of boys' control group was 1.226.

The previous values indicated the absence of the statistical significance difference between the 2nd experimental group in girls' school and the 2nd experimental group of the boys' school as the *p* value is 0.723 which is more than the statistical significance value. In addition, there is also a statistical significance difference between scores of pre and post-test as the *p* value is 0.00 which is less than the statistically significant level (0.05).

The results of the Third question that was stated: are there significant differences in students' critical thinking between groups of students who are taught using the digital mind mapping and that of paper mind mapping and conventional method?

To answer this question, the arithmetic means and standard deviations were extracted for the answers of the study sample individuals on the rational number achievement test. Table No. 5 illustrates the results.

Table 5. The arithmetic means and standard deviations of the responses of the study sample individuals

Group	Number	Average	standard deviation
Control	40	2.77	1.75
Experimental (1)	40	3.22	0.56
Experimental (2)	40	5.20	1.22

It is clear from the table above that there is a discrepancy in the arithmetic means and standard deviations. In order to show the differences in favor of any of the groups, the researcher used the (Independent t_ test) test. Table 6 shows the results.

Table 6. Test ((Independent t_ test)) depending on the variable of the teaching method

Teaching method	Group	N	Mean	St. deviation	Sig
Traditional	Control	40	2.19	.267**0**	0.00*
Digital mind maps	Experimental (2)	40	2.87	.261**0**	0.335
Paper mind maps	Experimental (1)	40	2.53	.429**0**	0.21

**Function at 0.05

It is clear from the table above that there is a difference in the results of the responses of the individuals of the study sample who were taught according to the digital mind maps method and that of the paper mind maps and the traditional method, and that there is a clear indication at the level of significance of (0.335)

By analyzing the students' scores of the 2nd experimental group of the girls' school, the results revealed that the mean of the scores of this group in the pre-test is 13.25 while the mean of the scores of the pre-test of 2nd experimental group in boys' school is 13.3 which indicates the absence of statistically significant difference between the two groups in the two schools.

The standard deviation of the 2nd experimental group of the girls' school in the pre-test is 2.7314 while the standard deviation of the 2nd experimental group in the boys' school in pre-test was 3.045, the matter that indicates that there is no statistically significant difference at the statistically significant level (0.05) between the standard deviation of students' scores in the pre-test for the 2nd experimental groups in girls' school and boys' school.

The previous values indicated the absence of the statistical significance difference between the 2nd experimental group in girls' school and the 2nd experimental group of the boys' school as the *p* value is 0.723 which is more than the statistical significance value. In addition, there is also a statistical significance difference between scores of pre and post-test as the *p* value is 0.00 which is less than the statistically significant level (0.05).

Table 7. Mean and standard deviation of pre and post tests for the 2nd experimental groups

v	Pre-test (girls)	Post-test (girls)	Pre-test (Boys)	Post-test (Boys)
Mean	13.25	18.35	13.3	18.65
Standard deviation	2.7314	1.1367	3.045	1.226

Investigate the effect of gender on the mathematical achievement of the 2nd experimental group using TWO WAY ANOVA.

From table (8) we conclude the following: There is no statistically significant difference between the scores of the 2nd experimental group in the girls' school and the 2nd experimental group in the boys' school as the *p* value is 0.723 which is more than the significant level (0.05) which indicates the absence of the effect of Gender on the mathematical achievement.

Table 8. shows the statistical studies of the 2nd experimental groups by TWO WAY ANOVA

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	546.625a	2	273.313	56.670	.000
Intercept	20193.012	1	20193.012	4186.912	.000
x1	.613	1	.613	.127	.723
x2	546.012	1	546.012	113.213	.000
Error	371.363	77	4.823		
Total	21111.000	80			
Corrected Total	917.988	79			

X1: Gender Variable

X2: Mathematical achievement

There is a statistically significant effect of the mathematical achievement in pre- test and post- test as the p value is 0.00 which is less than the level of significance (0.05). This difference indicates the effectiveness of digital mind maps in increasing the mathematical achievement of the students.

The results of the Fourthly question, which was stated: are there significant differences in students' critical thinking among male students who are taught using the digital mind mapping and that of paper mind mapping and conventional method?

From this question, the following null hypothesis was derived: There are no statistically significant differences at the significance level ($0.05 = a$) in the mean creative thinking of students according to the relative numbers due to gender (males and females). Based on the teaching method (digital mind maps, compared to paper mind mapping and the traditional method).

To answer this question, the arithmetic means and standard deviations were extracted for the answers of the study sample individuals on the rational number achievement test. Table No. 8 illustrates the results.

Table 9. The arithmetic means and standard deviations of the responses of the study sample individuals

group	Gender	Number	Average	standard deviation
c.g	Male	20	3.43	0.04
	Female	20	3.55	0.53
e.g1	Male	20	4.19	0.60
	Female	20	4.00	0.52
e. g2	Male	20	3.73	0.22
	Female	20	4.02	0.53

In order to know the statistical significance of the apparent differences according to the teaching method, the accompanying one-way MANCOVA analysis was used, as shown in Table (10).

Table 10. Results of the multiple single-variable analysis of variance associated with the arithmetic averages of the performance of the study members according to the gender level

Source	level	sum squares	Average	F	Sig	(η^2)
Teaching method	Gender	6.734	6.734	96.098	.000	**0.628**
	Error	3.994	0.070	----	----	----
	Total	10.878		----	----	----

**Function at 0.05

It can be seen from Table (10) that there were statistically significant differences at the level of significance ($\alpha = 0.05$) between the two arithmetic averages of the performance of the seventh-grade students due to gender. In favor of the students, with an arithmetic average (6.73) in the group that studied according to the digital mind maps method, compared to the male students with an arithmetic mean (3.99), in the group that studied according to the paper mind maps method and the traditional method.

The results of the Fifthly question, which stated: are there significant differences in students' critical thinking among male students who are taught using the digital mind mapping compared to paper mind mapping and conventional method?

To answer this question, the arithmetic means and standard deviations were extracted for the answers of the study sample individuals on the rational number achievement test. Table No. 11 illustrates the results.

Table 11. The arithmetic means and standard deviations of the responses of the study sample individuals

group	Gender	Number	Average	standard deviation
c.g	Male	20	3.43	0.04
	Female	20	3.55	0.53
e.g1	Male	20	4.19	0.60
	Female	20	4.00	0.52
e. g2	Male	20	3.73	0.22
	Female	20	4.02	0.53

In order to know the statistical significance of the apparent differences according to the teaching method, the accompanying one-way MANCOVA analysis was used, as shown in Table (12).

Table 12. Results of the multiple single-variable analysis of variance associated with the arithmetic averages of the performance of the study members according to the gender level

Source	level	sum squares	Average	F	Sig	(η^2)
Teaching method	Gender	6.734	6.734	96.098	.000	**0.628**
	Error	3.994	0.070	----	----	----
	Total	10.878		----	----	----

It can be seen from Table (12) that there are statistically significant differences at the level of significance ($\alpha = 0.05$) between the two arithmetic averages of the performance of seventh graders due to the gender variable. In favor of females with an arithmetic average (6.73) in the group that studied according to the digital mind maps method, compared to female students with an arithmetic mean (3.99) in the group that studied according to the paper mind maps.

The results of the sixthly question that was stated: are there interaction effects between teaching methods and students' gender that contribute to achievement?

From this question, the following null hypothesis was derived: There are no statistically significant differences at the significance level (= 0.05) in the average creative thinking of students in units of relative numbers due to the interaction between the teaching method and gender.

To answer this question, the arithmetic averages and standard deviations of the study sample individuals were extracted. Table No. (13) illustrates the results.

Table 13. The arithmetic means and standard deviations of the study sample according to the interaction between gender and the teaching method

Gender	Digital mind maps		Paper mind maps		Traditional	
	Average	standard deviation	Average	standard deviation	Average	standard deviation
Male	2.94	0.177	2.88	0.250	2.882	0.040
Female	2.91	0.255	2.55	0.399	2.550	0.029

Table 14. The results of the multiple one-way analysis of variance associated with the arithmetic averages of the performance of the study members according to the teaching method and interaction with the gender

Source	level	sum squares	Average	F	Sig	(η^2)
Teaching method	Teaching method	**6.67**	**6.67**	**3.54**	**0.07**	**0.1122**
	Teaching Method * Gender	**9.60**	**9.60**	***5.10**	**0.03**	**0.1540**
	Error	**52.73**	**1.88**	**-----**	**-----**	**----**
	Total	**69.00**	**2.30**	**-----**	**-----**	**----**

**Function at 0.05

It is noted from Table (13) that there are apparent differences between the arithmetic mean of the performance of the seventh-grade students resulting from the different type of teaching method. In order to know the statistical significance of the apparent differences according to the teaching method and the interaction between them and gender, the accompanying one-way MANCOVA analysis was used, as shown in Table (14).

It can be seen from Table (14) that there were no statistically significant differences at the level of significance ($\alpha = 0.05$) between the arithmetic means for the performance of seventh-grade students due to the difference in the teaching method, digital mind maps and paper mind maps.

It is also evident that there are no statistically significant differences at the level of significance ($\alpha = 0.05$) between the arithmetic means of the performance of seventh graders due to the interaction of (teaching method x gender).

Results of the question regarding the questionnaire of the study presented to students:

As for the third question "What are the students' attitudes towards the method of teaching used, table 15 shows the results.

Mean scores and standard deviations were calculated to explain students' attitudes toward teaching strategies. As can be seen from Table 15, the scores for descriptive statistics of students' attitudes toward teaching method as shown in average scores range from 3.667 to 4.000 on a five-point scale. The highest score was 4,000 and it is concerned with the idea that digital mind mapping strategies are useful and appropriate, while the lowest score of 3,667 is concerned with ideas that help them predict what will happen next in the text and help them make connections between the educational material, their achievement and their creative thinking.

Table 15. Means and standard deviations for each statement of the attitudinal scale

Item Number	Mean	Std. Deviation	Level of Agreement
1	3.889	.323	High
2	3.667	.485	High
3	3.833	.383	High
4	4.000	.000	High
5	3.667	.594	High
6	3.833	.383	High
7	3.833	.383	High
8	3.889	.323	High
9	3.889	.323	High
10	3.889	.323	High
Total	3.890	1.092	High

*The mean scores out of 5

Moreover, the conformance ranges with traits were determined in the survey using the following criterion: the 1-1.80 interval showed a very low level, the interval 1.81-2.60 showed a low level, the 2.61-3.40 interval showed a medium level, the interval showed 3.41 -4.20 is high, and the interval from 4.21-5.00 showed a very high level of compliance with the survey statement. With this in mind, students reported a high level of teaching method.

The mind map diverges in a way similar to brain cells to facilitate the access of information to the brain, and it is a good way to link the ideas and information in the mind of the learner with the new information, thus producing new ideas and creative solutions to specific problems, and the mind map enables the person to use the left and right parts of his brain, thus increasing the ability to learn and

comprehend, so it is modeled in a way similar to nerve cells in the brain.

The mind map gives students motivation to learn because it makes educational science interesting and untied. All information in the educational material is covered in a comprehensive and concise manner. The learner has a large number of ideas. Mind map helps the learner to link information together, making it easier for him to understand, preserve and remember it, increase concentration, develop memory, and make it easier for the student to study subjects where it is difficult. The student is able to review the previous information and link it to new concepts, and take into account the individual differences, each student draws the mind map that suits his abilities, and helps the teacher to reduce the number of words used to explain the subject in the educational process, thus increasing the opportunity of focus and attention among students, develop the creative skills of the learner and the teacher, and graduate the potential of each of them.

Results of the question related to the interview questions presented to teachers

Teachers who participated in the study were presented with a set of questions. The hypothetical validity was verified by presenting a set of questions to the experts to ensure the ease of the interview questions and the suitability of the question to the aim of the study. The experts agreed on the validity of the interview questions after giving some notes that were made on the interview questions.

The 10-question interview questions were presented to 4 teachers who taught the six groups that participated in the study, the recall rate was 100%, and the answers were as follows:

The first question was "In your opinion, what are the difficulties the students face in understanding the mathematical concepts?" 75 % of the teachers agreed the difficulty of remembering the concept and applying is the major difficulty which face the students when learning mathematics. However, 25% of the teachers said that the difficulty of the subject itself is the difficulty that confronts the students.

The 2nd question was "In your opinion, what are the difficulties that you as a teacher are facing in teaching Rational numbers?" 50 % of the teachers said that they are facing difficulties in demonstrating the concepts to the students who need several methods to understand those concepts. On the other hands, 25% of the teachers said that there are shortages in demonstrating tools, while the last 25 % of the teachers said there are other difficulties that they are facing during teaching rational numbers which are the unsuitability of conventional methods to deliver the mathematical concepts, lack of the enough time to explain the mathematical concepts and applying it.

The 3rd question was "Do you think mind map is an effective tool which helps deliver the mathematical concepts? Please explain why. 100 % of the teachers answered "Yes, very effective" commenting that the mind maps, either it is paper or digital, helped them deliver the mathematical concepts effectively due to the color attractiveness and its design help the students concentrates and enabled their brain to receive information easily. However, no one of the teachers disagreed on the un-effectiveness of the mind maps to deliver mathematical concepts.

The 4th question was "Do you think that using mind maps have raised the students' interaction level?" 75 % of the teachers agreed that mind maps have raised the students' interaction level while 25% agreed that it raised the interaction level somehow.

The 5th question was "How do you describe their interaction?" 100% of the teachers have described that the level of interaction of the students have been raised in terms of paying more attention to the lesson, participating in the class activities more than usual, participating in designing mind maps either it is digital or paper, and trying to work hard than usual.

The 6th question was "Did the students understand Rational Numbers easily with mind maps?" 50 % of the teachers agreed that the students understood Rational Numbers easily with mind maps while 25% of them saw that it is somehow participated in increasing their level of understanding. Only 25 % disagreed with the idea that mind maps raised the students' understanding of Rational number.

The 7th question was "Choose the best answer that describes the level of Students' creative thinking before using mind maps." 75% of the teachers answered "Only few students showed creative thinking" and the rest of them which represented 25 % of the teachers answered "None of the students showed creative thinking"

The 8th question was "Choose the best answer that describes the level of students' creative thinking after using mind maps." 100% of the teachers agreed that most of the students showed creative thinking.

The 9th question was "How do you find teaching with mind mapping in comparison with the ordinary teaching methods in terms of students' interaction, rational number achievement and creative thinking?" 100% of the teachers agreed that mind mapping has improved the interaction of the students in the class, and helped deliver the mathematical concepts of Rational numbers easily the matter that increased the mathematical achievement of the students in the test performed on the Rational numbers unit. In addition to the previous advantages, the mind mapping helped increase the level of students' creative thinking that was measured using Torrance test.

The 10th question was "Do you see that mind maps overcame the difficulties students face in understanding Rational number and increased their mathematical achievement?" 100 % of the teachers agreed that Mind maps have overcome the difficulties students have faced in

understanding Rational numbers and increased their mathematical achievement after learning with this method.

Recommendations

In light of the results of the current research, the researcher recommends the following:

- The necessity of adopting the two mind map strategies in teaching mathematics for the seventh-grade students.
- Urging male and female teachers to adopt a mind map in teaching as strategies that help students to increase academic achievement.
- Directing male and female teachers to not be limited to traditional methods, and the necessity to diversify the use of modern methods and methods, and to use the two mind map strategies as a modern method that many studies have proven their effectiveness in increasing students' academic achievement.

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