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EFFECTIVENESS OF USING THINKING MAPS THROUGH THE EDMODO NETWORK TO DEVELOP ACHIEVEMENT AND MATHEMATICAL CONNECTIONS SKILLS AMONG MIDDLE SCHOOL STUDENTS

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ABSTRACT

Aim/Purpose	This research aimed to measure the effectiveness of using thinking maps through the Edmodo network to develop achievement and mathematical connections skills among middle school students.
Background	One of the most important and major problems in education is reduced levels of academic achievement among students generally and in mathematics specifically. This is having a negative impact on academic outcomes. As mentioned in statement of the problem, several studies have identified weaknesses in academic achievement in mathematics. The results and recommendations of previous studies have referred to the effectiveness of thinking maps in developing numerous variables. Previous studies have identified weaknesses in mathematical connections skills. No Arabic studies have addressed the effectiveness of thinking maps through the Edmodo network in developing achievement and mathematical connections skills among middle school students.
Methodology	The participants were a purposive sample of 102 second-year middle school students. These were divided into two groups: experimental (n = 49) and control (n = 53). To achieve the research objectives, the experimental approach in its quasi-experimental design was adopted with (pre-post) measurement for both groups. Data were analyzed using the Statistical Package for Social Sciences (SPSS).

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Contribution	This study added information to the literature on the effectiveness of the thinking maps strategy through the Edmodo network in developing achievement and mathematical connections skills. Devising a modern teaching strategy to help students solve mathematical problems and thus can be generalized to various fields of life. This also the first study on this subject in Saudi Arabia.
Findings	The results showed there was a significant difference between the mean post-test scores of the experimental and control groups on the achievement test in favor of the experimental group. Additionally, there was a significant difference between the mean post-test scores of the experimental and control groups on the mathematical connections skills test in favor of the experimental group. There was also a positive correlation between the development of achievement and mathematical connections skills among middle school students who used thinking maps through the Edmodo network.
Recommendations for Practitioners	At a practice level, holding courses and training workshops for middle school mathematics teachers that include training on how to use modern learning models enhanced with technology, including the thinking Maps strategy, in the mathematics curriculum. Preparing guidelines for middle school mathematics teachers on how to use Thinking Maps via the Edmodo Network and how to train students in its use.
Recommendation for Researchers	Further research is needed to study the Effectiveness of the Thinking Maps strategy via the Edmodo network on developing achievement and mathematical connections skills in other subjects and at different educational stages.
Impact on Society	Our findings encourage teachers and educational supervisors to adopt the use of thinking maps on learning platforms for mathematics teaching as an effective method for developing achievement and mathematical connections skills. Benefiting from the applications and experiences of developed countries who have used e-learning in teaching curricula in order to keep pace with contemporary developments.
Future Research	Future studies could be extended to identify the effectiveness of maps of strategic thinking across Edmodo network variables within other subsidiaries, such as mathematical communication, creative thinking, mathematical proof, mind habits, and so on. Assess the effectiveness of play-based learning strategies via the Edmodo network in developing achievement and mathematical connection skills. Conduct a study that measures teachers' and students' attitudes toward using the Thinking Maps strategy via the Edmodo network. Assessing the effectiveness of using the Thinking Maps strategy via an Edmodo network in achieving and developing creative skills among secondary school students.

Keywords	thinking maps, Edmodo network, academic achievement, mathematical connections skills

INTRODUCTION

Scientific and technological revolution has been one of the most important manifestations of the modern era. It has proved effective in facilitating the exchange of ideas and information between nations and individuals and has contributed to the comprehensive development of society economically, politically, culturally, socially, and educationally. Accordingly, there has been a need to implement constrictive amendments to education systems worldwide to keep pace with the technological evolution taking place in this era.

In response to contemporary developments, the teaching process in all its different stages has witnessed an increasing amount of interest paid by several developing and developed countries in discovering and testing modern methods. Their aim has been to move away from regular teaching methods to those that are more suitable for the human mind and its way of thinking. This will help students reach the highest level of efficiency and competence (Hassan, 2009).

In recent years, researchers have focused on searching for methods, strategies, and educational tools derived from learning theories. These theories concentrate on the cognitive processes that take place in learners' cognitive structures in relation to knowledge acquisition, storing information in memory, and using such knowledge for further learning and thinking. Odmo and Kelly (2001) also state that the educational strategies most likely to achieve this goal are constructivist strategies, one of the most important of which is thinking maps (Talafha, 2012).

Thinking maps are used as a visual thinking tool that constitutes a visual language for teachers and learners. It is a strategy linked to specific cognitive processes based on a cognitive skills base and reflects the way in which we build our knowledge. It is the most effective way to record thinking as it regulates teacher's learning experiences, develops relationships between knowledge and thinking, and accelerates the learning process, saving it in memory for a longer period (Asfour, 2008). Al-Jannabi (2014) referred to thinking maps as line graphs that regulate educational content by clarifying the interrelationship between thoughts, thus reflecting several basic thinking skills.

As the preceding discussion suggests, it is clear that the main factor that helps students prepare properly and competently is to provide interesting teaching methods utilizing the latest devices and educational resources offered by modern technologies. These can entirely transform preparation methods, develop creative thinking, and help students face the different situations during their scientific and practical life that are imposed upon them by the development of modern technologies. Subsequently, many universities and establishments, especially in advanced countries, have devised various plans and strategies for using modern technologies such as computerization and internalization to enhance their education systems (Al-Hasnawi, 2007).

Edmodo is a modern system that offers services for free to support learning systems and administrations. It combines a social communication interface with learning management tools, enabling teachers, students, parents, and officers to connect and cooperate in the teaching and learning of educational subjects. It also provides common educational jobs that exist in the most popular learning systems, such as Blackboard, which functions in a similar way to Facebook. Because many students are already familiar with social networks, it does not take long time for them to acclimatize to Edmodo. It has been argued that Edmodo has had a positive impact in stimulating students to make an effective contribution using the internet (Holland & Muilenburg, 2011).

Scholars believe that mathematics has been one of the main sciences over the ages due to its prominent role in various aspects of life. For Saudi Arabia to keep up with technological developments, the education ministry has exerted efforts to prepare a project concerned with developing and improving the mathematical curriculum with the participation of specialized international agencies. One of the key objectives of Vision 2030 is to integrate technology into the education due to its prominent role in advancing and developing mathematical learning.

Al-Saidi (2012) asserted that mathematical connection is one of the best methods for developing learners' ability to think and solve problems. It also helps students engage in the meaningful learning of mathematics by utilizing existing mathematical concepts, generalizations, and skills and then combining them to form representations that represent new knowledge. Thus, learners consider mathematics to be a form of correlated cognitive building. Al-Barakati (2008) contends that mathematical connection skills involve understanding how to relate and combine mathematical ideas to form an integrated interdependent whole. They also help in identifying appropriate mathematical concepts and using them in external contexts.

Given the importance of mathematical connection skills and the role of mathematics in general, Principles and Standards for School Mathematics has designated mathematical connection as a fourth standard of the Standards for School Mathematics. This standard states that students should be able to relate their understanding of mathematical concepts to knowledge, understand how such concepts are linked to processes, and apply mathematics in other sciences and in daily life through practical questions (Al-Mawla, 2009).

Indeed, mathematical connections are useful in helping students understand mathematical concepts and knowledge. This enables them to make significant progress in various fields of life and apply mathematical connections in mathematics and other sciences.

The perceived importance of thinking maps in the teaching and learning process has led researchers to apply the thinking maps strategy through Edmodo, the educational social network. They have also sought to verify the impact of raising the level of academic achievement among second-year middle school students and to address weaknesses in mathematical connections skills through a new strategy that develops students' thinking. Accordingly, Edmodo supports the learning of mathematics by integrating technology into the curriculum.

Statement of the Problem

Reduced levels of academic achievement among students generally and in mathematics specifically is one of the most important and major problems in education. This is having a negative impact on academic outcomes. Several studies (e.g., Al-Rashoud, 2014; Ibrahim, 2016) have identified weaknesses in academic achievement in mathematics. The results and recommendations of previous studies (Al-Otaibi, 2013; Abu Sakran, 2012; Ali, 2012; Beni Mosa, 2011) have referred to the effectiveness of thinking maps in developing numerous variables. Previous studies (Al-Khalili, 2018; Al-Nuaimi, 2016) have identified weaknesses in mathematical connections skills. No Arabic studies have addressed the effectiveness of thinking maps through the Edmodo network in developing achievement and mathematical connections skills among middle school students.

Therefore, the problem this research has identified is the reduced level of academic achievement among second-year middle school students. This may be due to teaching strategies used by certified teachers that are based on the principle of conservation and memorization. In addition to the difficulty of resolving mathematical tasks, students perceive the burden placed upon them by material that they have to pass without sufficient understanding. To address this problem, the researchers propose to strengthen and enhance the learning of mathematics by integrating technology into the curriculum. This will be achieved by exploiting the effectiveness of thinking maps through an electronic platform (Edmodo), which will enhance their education and develop mathematical connections skills.

Research Questions

The main research question is as follows:

> How effective are thinking maps through the Edmodo network in developing achievement and mathematical connections skills among second-year middle school students?

To achieve this, the main question is divided into the following sub-questions:

1- How effective are thinking maps through the Edmodo network in developing the achievement of middle school students?

2- How effective are thinking maps through the Edmodo network in developing mathematical connections skills among middle school students?

3- What is the connection between achievement and mathematical connections skills among middle school students?

RESEARCH HYPOTHESES

- There will be no significant differences ($\alpha \leq 0.05$) between the post-test mean scores of the experimental and control groups in the achievement test.
- There will be no significant differences ($\alpha \leq 0.05$) between the post-test mean scores of the experimental and control groups in the mathematical connections skills test.
- There will be no significant correlation ($\alpha \leq 0.05$) between achievement and mathematical connections skills among middle school students.

RESEARCH OBJECTIVES

The current research aims to:

1- Identify the effectiveness of the Edmodo thinking maps strategy in developing the achievement of middle school students.

2- Identify the effectiveness of the Edmodo thinking maps strategy in developing mathematical connection skills among middle school students.

3- Determine the connection between achievement and mathematical connections skills among middle school students.

RESEARCH IMPORTANCE

Depending on the aims of the current research, research importance can be divided into two aspects, theoretical importance and practical importance, more details are given below.

Theoretical Importance:

1- Devising a modern teaching strategy to help students solve mathematical problems and thus can be generalized to various fields of life.

2- Enriching educational libraries with a modern topic on the effectiveness of the Thinking Maps strategy via the Edmodo network.

3- Highlighting the role of educational platforms in developing achievement and mathematical connections skills.

4- Developing an educational vision on the effectiveness of the thinking maps strategy through the Edmodo network in developing achievement and mathematical connections skills.

Practical Importance:

1. Students: Providing an opportunity to develop achievement and mathematical connection skills among middle school students using thinking maps through the Edmodo network.

2. Teachers: Instructing teachers to implement the thinking maps strategy across the Edmodo network to develop achievement and mathematical connection skills among middle school students in a variety of lessons.

3. Curriculum developers: Providing useful insights regarding the use or application of thinking maps to those developing curricula in the Ministry of Education.

4. Researchers: Contributing to opening up new prospects for further research in order to keep pace with technology and exploit its positive role in education.

RESEARCH LIMITS

1- Objective limits: The first chapter (Algebra: Rational Numbers) from the second-year middle school students mathematics book in the first semester.

2- Time limits: The research was conducted in the first semester of the academic year 2019-2020.
3- Place limits: The research was conducted in Dammam, Kingdom of Saudi Arabia.
4- Human limits: The current research was limited to a targeted group of second-year middle school students in a government school in Dammam.

RESEARCH TERMINOLOGY

1-Thinking maps:

Khalil (2008, p. 72) defined thinking maps as "linear graphic organizations that contain content knowledge, reflect levels of thinking, and enhance visual learning, and consist of eight forms of visual planning maps that represent a common visual language used by both the teacher and the student in teaching and learning."

2-Edmodo network:

Mahmood (2016) defined the Edmodo network as a social networking platform dedicated to education that combines Facebook and Blackboard. It uses Web 2.0 technology and is controlled by the teacher who communicates with students through an open space by sending and receiving text and voice messages and discussing their grades, tests, duties, and so on.

Researchers have defined thinking maps through the Edmodo network as visual sets of linear graphics consisting of eight types of thinking maps. These provide the opportunity to stimulate and enhance the learning process between the teacher and the student through research and exploration via the social platform based on web 2.0. It is an integrated learning environment designed to meet all students' educational needs; it helps to develop creativity and innovation and increases students' motivation to learn.

3-Mathematical connections:

Obaid (2004) defined mathematical connections as a skill through which learners at all educational levels come to understand that mathematics is a useful tool through its rules, its logical and organizational methods, and its application in the service of other mathematical concepts, other sciences, and various life activities.

In this research, mathematical connections are defined procedurally as students' ability to relate existing rules, concepts, and mathematical ideas to those that are new in mathematics and other sciences.

THEORETICAL FRAMEWORK

This section presents the theoretical framework for the research. It is divided into three main aspects: Thinking maps, the Edmodo network, and the development of achievement and mathematical connections skills.

THE FIRST ASPECT: THINKING MAPS

The era in which we live is characterized by successive scientific and technological developments. These have encouraged many educators and curriculum planners to develop modern programs and strategies aimed at helping the learner to use scientific methods of thinking, thus creating a generation able to follow the required path of progress and creativity.

The thinking maps concept

Educators and those interested in the educational process have offered various definitions of thinking maps across a variety of practical and educational fields. For instance, Al-Otaibi (2013) defined it as a visual language consisting of eight types of maps explaining various relationships between the content. Their purpose is to develop thinking skills and mental perceptions and to encourage learning

and development, as a result of which thinking becomes a language familiar to the learner. Conversely, Al-Jannabi (2014) defined thinking maps as linear drawings used to organize educational content that explains and clarifies the interrelationships between ideas as well as reflecting basic thinking skills.

Despite the many definitions of thinking maps, it is generally agreed that they are a visual language consisting of eight types of maps that help students develop basic thinking skills and are used in teaching as a modern strategy.

Thus, thinking maps in the current study are defined as: a set of visual tools that are flexible and used to organize ideas, simplify mathematical information, and help learners to remember and organize mathematical material more effectively.

The importance of thinking maps

Holzman (2004, pp. 2-4) argues that thinking maps have an important role to play in education – whether in the classroom or at school level. This includes:

- The development of learners' attitudes towards scientific content.
- Promoting flexibility in thinking through the use of more than one map depending on the situation.
- Helping to focus and enrich the thinking of normal students and special needs students.
- Allowing the learner to see what they think, and thus reflect what has been learned in their minds.
- Assisting in the presentation of scientific content in an orderly and organized manner.

Characteristics of thinking maps

Thinking maps are distinguished by the following features of planning organizations: consistency, flexibility, development, integration, and reflection. These are explained as follows by Al-Shehri (2014) and shown in Figure 1.

1- Consistency: This implies that the thinking maps are homogeneous and coherent. For example, generating ideas when describing the characteristics of a concept that are coherent and homogeneous with the main concept (located in the main circle in the middle). This is what happens in the bubble map.

2- Flexibility: It is possible to expand maps and grow flexibly, whether in the circular map of the concept or in clarifying the multi and related flows, in the sense that the student can develop and modify any map presented to them in the classroom in an easy and flexible manner.

3- Development: It can be used at any grade level and can range from simpler to complex applications.

4- Integration: Concepts are integrated with each other and the topics within which they are used, whether these are systems or problems that require solutions.

5- Reflection: Learners can use thinking maps to assess how they think and their visual participation with each other or with the teacher.

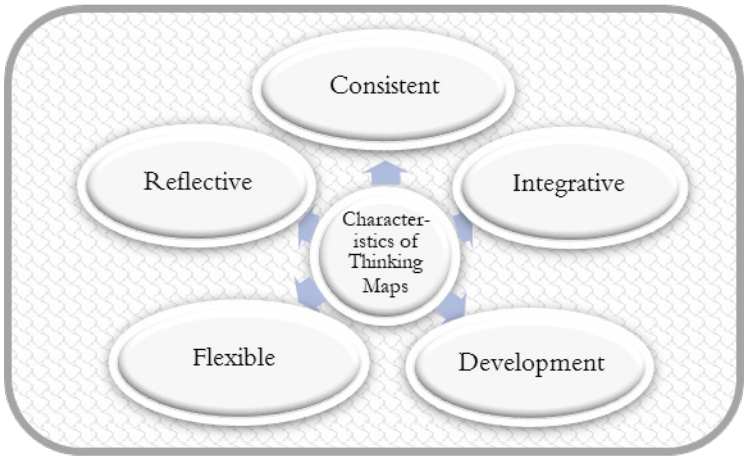


Figure 1. Specification of thinking maps (from Al-Shehri, 2014)

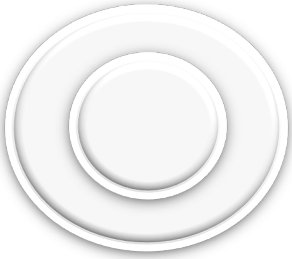
Based on these characteristics of thinking maps, researchers have argued that they help students to develop basic thinking skills, organize and arrange information, evaluate, produce, and generate new ideas, and overcome the problems they encounter.

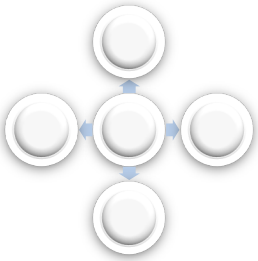
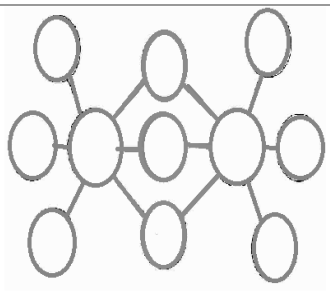
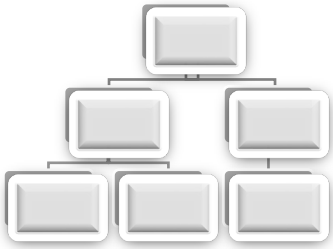
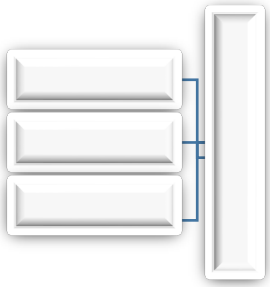
Types of thinking maps

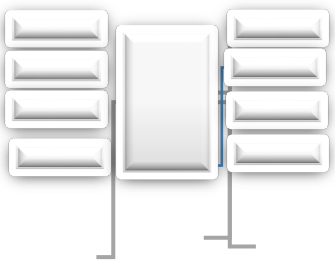
There are eight types of Thinking Maps: Circle Map, Bubble Map, Double Bubble Map, Tree Map, Flow Map, Multi Flow Map, Brace Map, and Bridge Map. A justifiable question to ask at this point is: Why only eight maps? David Hyerle found that there are 400 schematic organizers in the world and that these represented only eight basic thought processes. He therefore developed maps to visualize them schematically. Hyerle realized that the underlying components of thinking skills are easier to understand if they are presented in visual form. As such they become powerful models of thinking in the brain and can be delivered by writing or speaking. Each map is based on one of the basic cognitive processes (Hyerle & Curtis, 2004).

Researchers have concluded that different types of thinking maps help to attract students' attention and engage them in the educational process. It also helps them deal with complex and abstract information and interact with content through the use of shapes and colors, which makes studying more exciting. Now we will show in Table 1 the shapes of thinking maps and the function of each form.

Table 1. Types of thinking maps

The name of map	It is used to	How to build it	The shape
Circle Map	define some-thing or an idea.	Draw two circles with the same center and different in the diameter; in the central circle put a word, symbol or picture representing the topic, and in the outer circle write everything that the stu-dent knows about the topic.	

The name of map	It is used to	How to build it	The shape
Bubble Map	describe the properties and characteristics of something.	Draw a central circle surrounded by a group of circles. In these you can write down adjectives, characteristics.	
Double Bubble Map	highlight the similarities and differences between two topics or concepts.	Draw two adjacent central bubbles in which the two ideas are written. Bubbles are then added between the two ideas to capture the common elements between them.	
Tree Map	categorize, organize information, and clarify the relationships between headings and subheadings.	Draw a rectangle that expresses the subject as a whole, then branching into a group of geometric shapes expressing the main ideas.	
Brace Map	clarify the relationship between the whole and the part in the topics.	Draw a rectangle that expresses the topic, concept or basic idea, and then subdivide the components as necessary.	
Flow Map	organize information in a logical order, and sequence steps of a process or event.	Draw a group of consecutive rectangles in which the event or topic is written in the first rectangle; add substages as necessary to illustrate the relationships in an organized shape.	

The name of map	It is used to	How to build it	The shape
Multi-Flow Map	clarify the relationship between the cause and the result.	Draw a main rectangle; inside it put the name of the event or process. On the right and left sides of it draw rectangles. On the right-hand side write the causes, and on the left-hand side write the results.	
Bridge Map	clarify the similarities and the relationship between two things.	Draw a pyramid, and place the two information pairs on each side of the pyramid.	

THE SECOND ASPECT: EDMODO NETWORK

Recent developments and the information revolution we live in today, especially in the field of education, are among the most important areas concerned with integrating technology into their educational environment. It is the basis on which other areas focus.

Definition of Edmodo

Edmodo is a closed social network that permits entry only through a code number and provides services to its beneficiaries (students, teachers, and parents) that are aimed at providing an interactive educational environment and strengthening the positive relationship between its users (Al-Masry & Al-Ashqar, 2018; Al-Obaid & Al- Shaya, 2017; Kongchan, 2013).

An overview of the Edmodo network (its establishment and development)

Edmodo was first launched in Chicago, Illinois, in the year, 2008. The initial idea came from Jeff O'Hara and Nic Borg, who were working in technical support departments at schools in Chicago. They saw how often students use social media sites such as Facebook, Twitter, and so on.

In particular, they noticed that communication between the students tended to reduce once they enter the classroom. Therefore, they launched a cooperation experience between two adjacent educational institutions in the form of a platform for cooperation and social learning. Thus, the first social network was established for educational purposes to achieve a fit between the school community and the student community outside the school. The Edmodo network aims to connect the educational environment with the twenty-first century (Mahmood, 2016).

In the year 2008, the first tweet was sent on Twitter to announce the launch of the Edmodo program as a social media platform that allows teachers to communicate with their students. In 2010, 1500 mobile devices were equipped with Edmodo in the region of Silicon Valley in America so that it could be tested and used by students. After several months, there were one million users of the program in cities across the United States of America and abroad, facilitating communication between students of one classroom or from one classroom to another. At the start of 2011, teachers asked the

founders of Edmodo to provide different ways to contact and then asked content creators to produce different content for use in the classroom. This resulted in the launch of the community version of the Edmodo program. A primary account has since been created for teachers to communicate with other teachers in America and more than 50 other countries (Al-Nasser, 2013). This enables them to benefit from each other's experiences.

According to the Edmodo.com website, in 2019 the number of people using the Edmodo program exceeded 100 million.

Edmodo network benefits

Al-enezi (2017) stated that the Edmodo network provides many benefits for teachers and learners in the educational process.

For instance, the Edmodo Network benefits the students in the following ways:

- Facilitates communication between the student and their teacher in complete confidentiality.
- Facilitates interaction and communication between students to solve problems.
- It helps students complete their tasks, especially students who are absent as the homework is on the platform. The calendar also helps students organize important ideas and dates.
- Provides opportunists for shy students to participate and post their ideas and opinions.
- Widens students' understanding by expanding their awareness of the latest developments in their field of specialization.

Edmodo Network also has the following benefits for the teacher:

- Contributes to the evaluation of students' work and the viewing of homework and grades.
- Facilitates regular interaction with the parents so that they can monitor the progress of their children.
- Eases the exchange of materials and ideas between the teacher and their pupils inside the school or with other local, Arab, or international schools.
- Enhances the use of time by placing specific topics on the platform to discuss with students.

The researchers also cite the following benefits of the Edmodo network in teaching and learning mathematics:

- It helps in strengthening positive relationships between mathematics teachers by enabling them to exchange mathematical experiences and ideas within and outside the school environment.
- It encourages students to communicate with each other to solve mathematical problems they find challenging. This in turn facilitates an understanding of mathematical concepts that are difficult for the student to understand.
- E-tests, assessment of student performance, and supervision via the Edmodo Network improve mathematical learning.

Based on this wide range of benefits, it is safe to conclude that the use of educational platforms helps increase the motivation of learners. It also contributes to developing a deep understanding of how to solve more complex mathematical problems and equations. This increases the quality of educational outcomes.

What distinguishes Edmodo from other social media?

Edmodo is distinct from other forms of social media because it is designed for teachers, students, and parents to exchange information, ideas, opinions, files, and scientific developments. In particular, teachers can send data, define and give grades, and receive assignments through the network. It also

provides a number of additional characteristics, including transferring files, e-mail, distance-learning, and information for parents and those interested in the success of learners (Al-Rashoud, 2014).

Similarly, Al-Qaid (2015) stated that it is a safe and closed environment between students and teachers, and there is no place for any disturbing or distracting exchanges not related to education. The teacher has control over the interactive classes they create for their students and manages them by inviting students to attend each class. It is easy to use as Edmodo is similar to the Facebook interface, which means that it is familiar to students. It only takes seconds to create a new virtual classroom. No special information is required for students during registration other than their name, username, and password. They are not required to have emails in advance.

Perhaps the most prominent feature that distinguishes this platform is that it is not limited to a website that can be browsed online. It also has an application that can be downloaded on mobile devices, be these smart phones or tablets, using the Apple ISO system and the Android system (Android) (Yagci, 2015).

Several researchers believe that the most important characteristic that distinguishes Edmodo from other forms of social media is that it keeps pace with technological developments in the field of education. Due to the widespread popularity of smart phones and tablets among different groups in society, its low costs and the ease of downloading and use facilitates the performance of tasks such as solving homework, quizzes, managing debates, and offering opinions, thus widening students' scientific horizons.

The Third Aspect: Mathematical Connections Skills

Mathematical connections are important for the progress of mathematics, the significance of which lies in its applications in scientific fields and its contributions to improving the physical world through its inherent aesthetic appearance. To achieve advanced, meaningful learning, the connections between topics must be clear, understandable, and systematic (Al-Siadawi, 2012).

The definition of mathematical connections skills

There are several ways in which mathematical connections skills have been defined.

For instance, Al-Ruwais (2011, p. 382) defines them as "linking new ideas to the previous ones, linking students' subsequent experiences to their previous experiences, as well as linking mathematical topics together in a specific class and between different classes, and linking mathematics to other sciences."

Alternatively, Obaidah (2007) defines the use of such skills as a mathematical process that enhances student's awareness of the relationships between the elements of a subject, whether at the level of topics or fields, as well as their application in daily life.

Finally, Dhuhair (2017) defines mathematical connections skills as the fields through which students can understand the coherence of mathematics as an integrated science with various branches. They come to appreciate the way in which the mathematical ideas are connected to each other to become whole and coherent and are applied in other fields outside the context of mathematics to benefit all aspects of life.

Accordingly, in this paper mathematical connections skills are defined as a skill in which the learner realizes their ability to link harmonious and integrated laws, concepts, and mathematical relationships to achieve an understanding of connections between mathematics and a variety of subjects through its application in different aspects of daily life.

Mathematical connections skills

Mathematical connections encompass a number of skills. The necessary requirements for achieving these are shown in Figure 2. These are based on those cited in the National Council of Teachers of Mathematics document issued in 2000, as well as in related literature and research (Al-Barakati, 2008; Abbas & Al-Absi, 2007; Abu Zaina, 2010; Badawi, 2007).

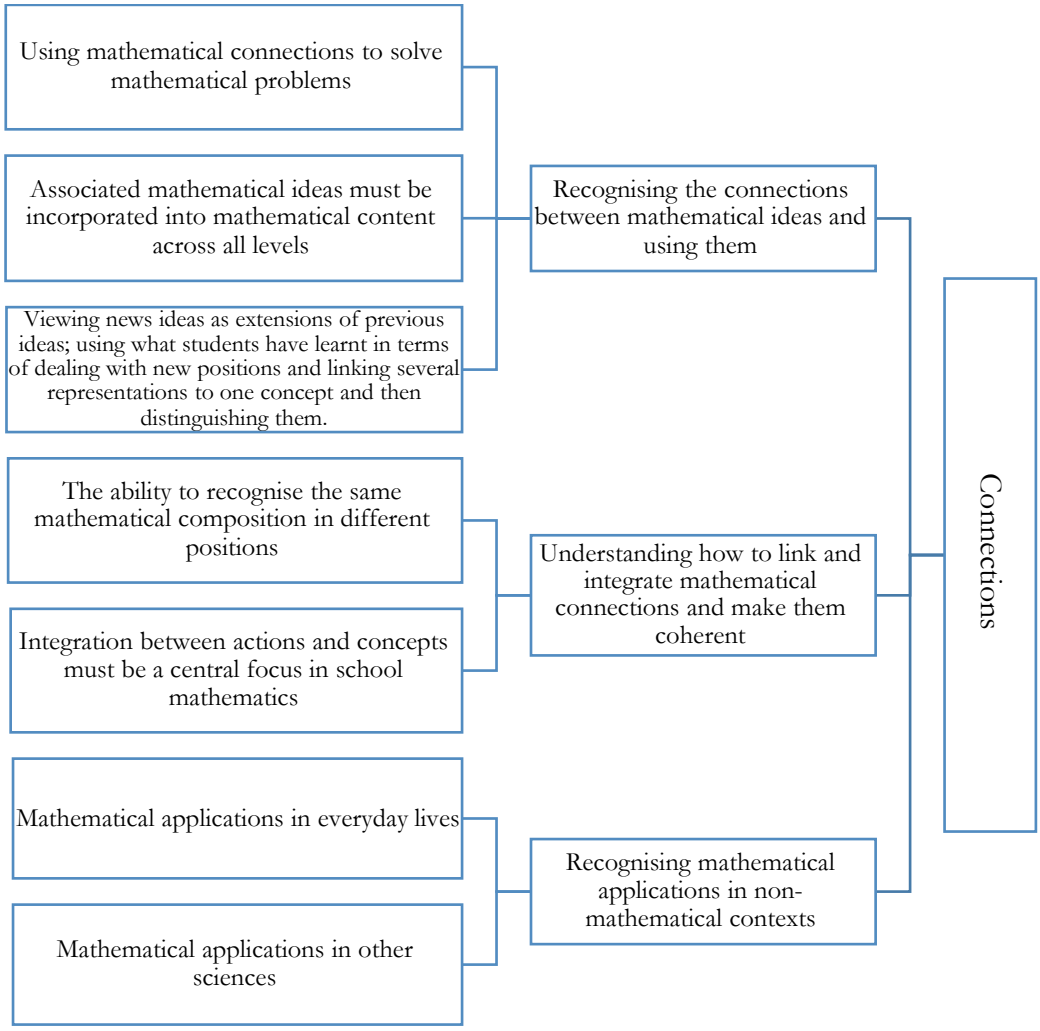


Figure 2. Mathematical Connection coefficient
(from Badr, 2010, p. 81, quoted from the Division of Curriculum and Instruction in Pinellas County Schools, 2006)

The National Council of Teachers of Mathematics document (NCTM, 2000, p. 274) listed the following three main skills:

1- Identifying and then using the relationships and connections among mathematical ideas.
2- Understanding ways of connecting mathematical ideas to form an integrated interdependent essence.
3- Identifying mathematics, its applications, and then using these in external contexts.

Importance of mathematical connections skills

Al-Ruwais (2011) noted the importance and necessity of teaching that asserts the connection of mathematical ideas, facts, and actions and linking these to other mathematical ideas and specializations. In so doing students not only learn mathematics, they learn about its uses.

Asr (2006) explained mathematical connections as one of the components of mathematical power. It thus represents the evaluation side in that it shows the mathematical power inherent in realizing connections within and between levels of knowledge. In addition, connections between fields of mathematics, and between mathematics and other sciences, enable the learner to build or enhance a perception that is already based on the usefulness of mathematics.

Al-Tannah (2008) explained that one of the objectives of modern mathematics is to enhance connections between concepts and curriculum elements, as well as the connections among different fields of mathematics and between mathematics and other sciences. This enhances learners' perceptions of the usefulness and importance of mathematics. It also uses ideas, concepts, and general principles that explain the field of mathematics and connects its branches in an integral fashion.

The preceding discussion thus demonstrates the importance of mathematical connections skills in helping learners to know facts, laws, and theories in order to solve problems in real-life situations. Its importance is not limited to learning and teaching mathematics and its applications also includes those in all other school curricula.

Role of the teacher in developing mathematical connections skills

One of the main methods used to help students connect mathematical topics and ideas is to develop a favorable climate in the classroom that will encourage students to resolve questions and take advantage of solutions to recognize connections. The advanced nature of problems and a climate that encourages the use of mathematical ideas and the provision of mathematical tools all enhance students' ability to recognize the close connection between mathematics topics, and to recognize mathematics as a single unit (NCTM, 2000).

Mohammed (2015) stated that, according to the Standards of National Council for Mathematics Teachers (NCTM, 2000), it is possible for the teacher to build mathematical connections when teaching mathematics as follows:

1- Selecting mathematical problems, including mathematical ideas within school subjects.
2- Encouraging students to discover new mathematical ideas.
3- Helping students make connections between what is learned from mathematical concepts, generalizations, actions, ideas, and their use in solving mathematical problems.
4- Preparing and specifying mathematical examples that demonstrate to students the connections among mathematical subjects and other school subjects and daily life.
5- Creating multiple connections between mathematical branches.

Thus, the teacher has a significant role to play in developing mathematical connections skills and academic achievement by encouraging students to think about and solve problems they face in their everyday life. They can enable mathematics students to view themselves as an integrated cognitive unit in all aspects of their scientific and practical life.

REVIEW OF LITERATURE

THE FIRST ASPECT: STUDIES THAT DISCUSS THINKING MAPS

Khalil (2008) explored the impact of using thinking maps on developing achievement and the deep, motivational understanding of students in a science subject in Egypt. The researcher used the experi-

mental approach based on the design of pre and post the experimental processors. The sample comprised 80 students from fifth-grade primary school, who were then divided into two groups: control group and experimental group. Each group contained 40 students. The results revealed significant differences between the average scores of the experimental group and the control group in post-achievement test, its different levels, the deep- level comprehension test, and the scale of achievement motivation, all in favor of the experimental group.

Fatah Allah (2011) aimed to reveal the impact of thinking maps based on integration in developing achievement in a science subject, critical thinking, and a move towards cooperative work among middle school students in the Kingdom of Saudi Arabia. The sample comprised 73 students divided into two groups: 37 students in the experimental group and 36 students in the control group. To achieve the study objectives, the researchers used the following tools: Critical thinking Test, Academic Achievement Test, The scale of cooperative work tendency. The results showed there were significant differences between the mean scores of both groups and in the post-application of the critical thinking test for the experimental group.

Beni Mosa (2011) conducted a study aimed at identifying the effectiveness of using thinking maps in developing the skills of mathematical proof, creative thinking, and achievement in engineering among first-year secondary school students in Egypt. The sample comprised 70 students divided into two experimental and control groups. To achieve the study objectives, the researcher prepared and applied the following tools (achievement test, mathematical proof skills test, creative thinking test). The results showed there were significant differences between the average grades of students in the experimental group and the control group in the remote application of all three tests in favor of the experimental group.

A study by Lopez (2011) aimed to identify the effect of the cognitive model and thinking maps on developing the academic language of English language students. The researcher used the experimental approach, the sample comprised two groups, one of which was "experimental" and was subjected to training in the use of the cognitive model and thinking maps, and the other was a "control". The sample was chosen from seven schools (three primary schools, two middle schools, and two secondary schools) in New York City. The results revealed that in schools where teachers used the cognitive model and thinking maps, students exhibited substantial improvements in their English language ability and outperformed peers whose teachers did not use the cognitive model and thinking maps.

Ali (2012) aimed to build a strategy based on thinking maps to develop reflective thinking skills and high-level thinking skills among secondary school students learning chemistry in the Kingdom of Saudi Arabia. The sample comprised second-year secondary school students in Riyadh (experimental group) and in Ha'il (control group). Three classes from three schools in each city were randomly selected. To achieve the objectives of the study, the researcher designed the student and teacher guide based on the thinking maps strategy. They also developed a test to measure reflective thinking skills and a test to measure high-level thinking skills. The results showed that the Thinking Maps strategy was effective in developing reflective thinking skills and high-level thinking skills among second-year secondary school students.

Babtain (2012) determined the effectiveness of using thinking maps to teach science on developing achievement and creative thinking among first-year middle school students in the city of Makkah Al-Mukarramah. To achieve the goal of the study, the researcher used the experimental approach, and the sample of 118 students was divided into two groups: 60 control female students and 58 female experimental students. The results showed there were significant differences between the average scores of both groups in post-application of the achievement test and creative thinking in favor of the experimental group.

Alrifai (2014) investigated the effect of a thinking maps strategy on chemistry achievement and developing mental skills for third-year middle school students. The researcher used the experimental approach. The sample comprised 36 students in the third-year middle school who learnt using thinking maps and a control group who learnt using the traditional method. The results showed that using a thinking maps strategy to teach chemistry increased educational achievement and the development of mental skills among students.

Finally, Sharaf (2016) aimed to identify the effectiveness of thinking maps in teaching engineering for developing some habits of mind and visual thinking skills among middle school students. The researcher employed an experimental approach with two equivalent groups. The sample comprised 74 female students divided into two equal groups (experimental and control) of 37 female students. The results showed there was a significant difference (0.01) between the average grades of students in both groups in the post-application of each scale in favor of the experimental group. The results also showed a statistically significant difference (0.01) between the average grades of the experimental group students in the pre and post applications of the scale in favor of the experimental group.

General comments on these studies

General commentary on studies dealing with the first aspect "Studies That Discuss Thinking Maps"

Table 2 shows general comments on the first aspect "studies that discuss thinking maps" in terms of the variables, study goals, the method used, the research sample, the research tools, and the results.

Table 2. General comments on the first aspect

In terms of	General comments on these studies
The Variables	The current research is similar to previous studies in considering achievement as a dependent variable
Study Goals	Several studies (Ali, 2012; Babtain, 2012; Beni Mosa, 2011; Fatah Allah, 2011; Sharaf, 2016) explored the effect of thinking maps (creative, visual, cogitative, and innovative thinking) on developing achievement. Lopez's (2011) study explored the impact of the cognitive model and thinking maps on the development of academic language among English language students, while Sharaf (2016) aimed to identify the effectiveness of thinking maps in developing habits of mind and visual thinking skills when teaching engineering. Other studies (Alrifai, 2014; Khalil, 2008) aimed to determine the effectiveness of thinking maps in developing achievement, mental skills, and deep understanding.
The Method Used	Most of the previous studies agreed on the use of an experimental approach.
The Research Sample	The current research is similar to several other researchers (Alrifai, 2014; Babtain, 2012; Fatah Allah, 2009; Sharaf, 2016) in choosing a sample of middle school students. It, therefore, is not similar to those researchers (Ali, 2012; Beni Mosa, 2011) who chose a sample from secondary school students; Khalil (2008), who chose a sample from primary school students; and Lopez (2011), who chose a sample from various grades (primary, middle, and secondary).
The Research Tools	The tools used in previous studies varied according to their objectives; however, all used achievement tests (pre and post).

In terms of	General comments on these studies
The Results	All previous studies have shown the effectiveness of using the Thinking Maps strategy to raise the level of educational attainment among students.

THE SECOND ASPECT: STUDIES COVERED IN THE EDMODO NETWORK

Mei (2012) conducted a study in Japan to unveil the role of electronic educational platforms based on the internet in collaborative learning, mapping, and collaborative learning based on computer. To achieve the goals of the study, the electronic educational platforms was used through the collaborative learning. The sample comprised 68 male and female students divided into two groups, (experimental and control). The results showed that the electronic educational platforms played a positive role in supporting and enhancing interaction and cooperation between students and improving their cognitive capabilities and organizational strategies. The results also indicated that the electronic educational platform contributes to developing students' abilities through class interaction and the exchange of information through collaborative and constructive learning.

Thongmak (2013) studied the effect of learners' characteristics in adopting the Edmodo tool. The aim was to enhance co-operation between classrooms based on the model of technology acceptance. Employing a descriptive method, the sample comprised 182 female and male students at a Thailand university. A questionnaire was administered by the researchers that contained eight factors, including perceived benefit, perceived use easiness, and behavioral intention to use technology. Among the most important results were that "perceived use easiness", "perceived benefit", and teacher attributes were all determinants that affected learners' intention to use Edmodo.

A study by Al-Mutairi (2015) aimed to identify the effectiveness of the flipped classroom strategy by using the Edmodo educational platform to develop self-learning skills and academic achievement in first year biology students at secondary schools. To achieve the objectives of the study, the researcher employed the experimental approach in its quasi-experimental design, based on a pre and post design for two (experimental and control) groups. The sample comprised 62 students who were randomly selected (32 in the experimental group and 30 students in the control group) from first-year secondary school students in the joint program for the curriculum system in the governorate of Unaizah in the Kingdom of Saudi Arabia for the academic year 2015. The results showed there was a significant difference (0.01) between the mean grades of both groups in all dimensions, and the total score, all in favor of the experimental group.

Al-Muqrin (2016) aimed to identify the effect of e-learning using the learning management system (Edmodo) on achievement in biology at knowledge-related levels (remembering and understanding) among second-year secondary school female students in Riyadh. A quasi-experimental approach was applied. The sample comprised 54 female students from the second semester 2015/2016, who were divided into two groups: experimental and control, with 27 students in each group. The results showed there were significant differences between the averages of both groups in post achievement at the level of remembering in favor of the control group, and no statistically significant differences between the average between both groups in post achievement at the level of understanding. The results also showed there were no significant differences between the averages of both groups in post-achievement, nor between the mean of the pre and post direction for the experimental group.

Al-Johani (2016) explored the opinions of postgraduate behavioral education students towards future use of the Edmodo educational platform. The study was conducted in the first semester of the academic year 2015/2016 with a sample of 24 female postgraduate students at the Faculty of Education at Taibah University. The Technology acceptance model was used to construct the study tool. The results showed there was a significant relationship between the trend of postgraduate female students towards the use of the Edmodo platform and their behavioral intentions regarding future use, as well

as between the perceived benefit and perceived self-efficacy and trend towards using the Edmodo educational platform.

Dashti (2017) aimed to measure the attitudes of a female teacher towards the learning management system through the use of the Edmodo application management system among students at the college of education, Kuwait University. A quasi-experimental design was employed in which the researcher used the Edmodo application with 107 female students. First, the researcher trained students in its use from the beginning of the academic year 2016/2017. The researcher then designed a questionnaire to assess the outcomes. The results showed Edmodo helped the female student teacher to communicate with the course professor and her female student colleagues and also enabled students to submit assignments at any time and from anywhere. The results also showed that the degree to which the female student teacher used Edmodo, and the specialization and the study units passed, have an impact on students' use of a learning management system in the future.

Finally, Al-Jasser (2018) aimed to identify the impact of using Edmodo on academic achievement in an English language course for fourth-grade primary school female students and to identify these student's attitudes towards e-learning and its effect on reducing their level of shyness. A quasi-experimental design was used, comprising pre- and post-measurement scores on tests taken by two groups, one of which was the control and the other was the experimental group. The results showed no significant and educational effect of using Edmodo in teaching the English language on the development of achievement among fourth-grade students, and no significant differences between the groups and the control group in the direction towards learning English language. However, the results confirmed that the students of the experimental group were less shy than the control group after using Edmodo.

General commentary on studies dealing with the second aspect "Studies Covered in the Edmodo Network"

Table 3 shows general comments on the second aspect "Studies Covered in the Edmodo Network" in terms of the variables, study goals, the method used, the research sample, the research tools, and the results.

Table 3. General comments on the second aspect

In terms of	General comments on these studies
The Variables	The current research is similar to that of previous studies in considering achievement as a dependent variable.
Study Goals	Several studies aimed to identify the impact of using the Edmodo network on academic achievement among students (Al-Jasser, 2018; Al-Muqrin, 2016; Al-Mutairi, 2015). Others aimed to identify the impact of using the Edmodo network on collaborative learning, (Mei, 2012; Thongmak, 2013). In addition, Dashti (2017) aimed to identify the impact of using the Edmodo network on faculty staff members. Finally, Al-Johani (2016) investigated the views of postgraduate students towards the use of the Edmodo educational network in the future.
The Method Used	The current research is similar to Al-Mutairi (2015) in its use of an experimental approach in its quasi-experimental design. It not similar to other researchers (Al-Muqrin, 2016; Dashti, 2017; Al-Jasser, 2018) who used a quasi-experimental design and Thongmak (2013) who used a descriptive method.

In terms of	General comments on these studies
The Research Sample	The current research differs from Thongmak (2013), Al-Johani, (2016), and Dashti, (2017) in not choosing undergraduate students; Al-Jasser (2018), in not choosing a sample primary school students; Mei (2012) in not recruiting students from different levels of education (primary, intermediate, and secondary); and Al-Mutairi (2015 and Al-Muqrin (2016) in not selecting a sample of secondary school students.
The Research Tools	The tools used in previous studies varied due to differences in their objectives; nevertheless, all agreed to use the Edmodo network. The current study is consistent with previous studies in developing the academic achievement of students. The current study differed from previous studies in its reliance on using the Thinking Maps strategy via the Edmodo Network to develop mathematical connections skills.
The Results	Some of the results of previous studies showed that the Edmodo network plays an effective role in developing the achievement of students at all academic levels, as shown by the superiority of experimental groups over the control groups in the post-tests that were conducted.

The Third Aspect: Studies on the Development of Achievement and Mathematical Connections Skills

Al-Kharusi (2008) aimed to investigate the effect of using a teaching strategy based on mathematical representations and connections on mathematical achievement and reasoning among third-year middle school students in Muscat. An experimental approach was employed. The sample comprised 122 tenth grade students, 61 for the experimental group and 61 for the control group. The most notable results were significant differences between the average grades of female students in both groups in both the achievement test and the mathematical thinking test in favor of the experimental group.

Al-Barakati (2008) aimed to determine the effect of teaching using Multiple-Intelligences and Six Hats Strategies on achievement, communication, and mathematical connections among third-year middle school students in Makkah Al-Mukarramah. The sample comprised 95 students divided into four groups: three of which were experimental and the fourth a control. The results showed there were significant differences between the two groups in terms of academic achievement, levels of remembering, application, imagination and composition, and mathematical connectivity, all in favor of the experimental group.

Al-Agha (2012) investigated the effect of teaching a proposed unit based on mathematical links in the development of critical thinking skills and on assessing the scientific value of mathematics. An experimental approach was employed. The sample comprised 65 second-year secondary school students. Following the teaching of the proposed unit and the application of its tools, significant differences were found between the average grades of female students in both groups in post-application of the scale for assessing the scientific value of mathematics. These were in favor of the experimental group.

Al-Saidi (2012) aimed to determine the effectiveness of a program based on several metacognitive strategies used in teaching mathematics on the development of mathematical connections skills and the ability to solve life problems among middle school students. The researcher employed an experimental approach and the sample was randomly selected. The sample comprised 130 first-grade primary students in Qalyubiyya Governorate, who were divided into two groups; one of which was experimental (65 students) and the other was a control (65 students). The results showed there were significant differences between the average grades of students in both groups in the post-application

of the mathematical connections test as a whole and its sub-skills, and in the test of solving life problems. These were all in favor of the experimental group.

Mohammed (2015) conducted a study aimed at identifying the effectiveness of teaching a statistics unit based on mathematical representations and connections on the development of statistical thinking skills, achievement, and retaining results among second-year middle school students in Fayoum Governorate. The researcher used an experimental approach and the sample comprised 70 students divided into two groups: an experimental group of 36 female students and a control group of 34 female students. The results showed there were statistically significant differences in favor of the experimental group in the post-application of both tests, and statistically significant differences in favor of the experimental group in the results of the deferred achievement test.

Youssef (2015) investigated the effect of a self-organized problem-based learning strategy on the development of mathematical connections skills and mind habits among first-year middle school students. An experimental design was employed and the sample comprised 65 first-year middle school students: 32 in a control group and 33 in an experimental group. The results demonstrated the effectiveness of a self-organized learning strategy based on the development of mathematical connections skills and several mind habits. A significant positive relationship was also found between students' habits of mind and mathematical connections skills.

A study by Al-Nuaimi (2016) aimed to determine the effect of using the GeoGebra program on the development of mathematical connections skills among first-year secondary school students in Riyadh. To achieve the objective of the study, the researcher employed the experimental approach in its quasi-experimental design consisting of a pre and post-test completed by both experimental and control groups. The sample comprised 70 female first-year secondary school students in Riyadh for the year 2015/2016. The results showed there were significant differences (0.01) between the mean scores of students in both groups in the post-application of the test of mathematical connections skills (to identify the relationships and links between mathematical ideas and their use, how mathematical ideas relate to each other in order to produce an integrated and interconnected whole, to identify mathematics and its applications in a context outside of mathematics) in favor of the experimental group.

Al-Sidawi and Khazal (2017) conducted a study to investigate the effect of using the similarities strategy on the development of mathematical connections skills among primary school students. To achieve the objective of the study, the two researchers employed a quasi -experimental approach. The two researchers prepared a unit of study based on the similarities strategy, the content of which was selected from a mathematics book for fourth-year primary school students in Iraq entitled: "Plural". This was taught to a sample of 40 students. The results showed there was a significant difference in students' grades on the mathematical connections test between the pre and immediate post-test for the sake of the immediate post-test. There is no statistically significant difference in the grades of students on the mathematical connections test between immediate post-test and the postponed post-test.

General commentary on studies dealing with the third aspect "Studies on the Development of Achievement and Mathematical Connections Skills"

Table 4 shows general comments on the third aspect "Studies on the Development of Achievement and Mathematical Connections Skills" in terms of the variables, study goals, the method used, the research sample, the research tools, and the results.

Table 4. General comments on the third aspect

In terms of	General comments on these studies
The Variables	The current research is similar to that of previous studies in that mathematical connections skills is a dependent variable.
Study Goals	Several studies have identified an effect on developing achievement and mathematical connections skills (Al-Barakati, 2008; Al-Kharusi, 2008; Mohammed, 2015).
The Method Used	The current research is similar to Al-Nuaimi (2016) in using an experimental approach in its quasi-experimental design. It is not similar to other researchers (Al-Kharusi, 2007; Al-Barakati, 2008; Al-Agha, 2012; Al-Saidi, 2012; Mohammed, 2015; Youssef, 2015) who used an experimental approach and Al-Sidawi and Khazal (2017) who used a quasi-experimental design.
The Research Sample	The current research agrees with Al-Barakati (2008), Al-Saidi (2012), Mohammed (2015) and Youssef (2015) in recruiting a sample of middle school students. It disagreed with Al-Sidawi and Khazal (2017) who recruited a sample of primary school students and several other researchers (Al-Kharusi, 2007; Al-Agha, 2012; Al-Nuaimi, 2016) who recruited a sample of secondary school students.
The Research Tools	The current study follows Al-Kharusi (2008), Al-Barakati (2008), and Mohammed (2015) in using test of mathematical connections skills and an achievement test. All studies have confirmed the effectiveness of mathematical connections in raising the level of academic achievement among students.
The Results	Some of the previous studies have demonstrated the development of mathematical interdependence skills among students taught mathematics. This has been shown in the superior scores of experimental groups in the post-tests compared with control groups taught by the traditional methods.

General Comment on Previous Studies

The current study is similar to some of the previous studies on the effectiveness of thinking maps in increasing the development of achievement and thinking skills among students. However, it differs in that it explores the effectiveness of thinking maps via the Edmodo network in increasing the development of achievement and mathematical interdependence skills of middle school students.

Although the tools employed varied in previous studies, most performed the pre- and post-test. This study therefore did likewise.

The samples varied among previous studies, some of them encompassing primary, or middle, or secondary or university stages, and some of them covering all stages (primary, middle, secondary). The sample for the current study consists only of second-year middle school students.

Most previous studies have identified the effect of thinking maps on developing achievement and thinking skills, whereas in this study the focus is on the effectiveness of thinking maps via the Edmodo network in developing the achievement and mathematical interdependence skills of middle school students.

The benefits derived from previous studies

1- The current study benefited from previous studies in developing the idea for the study, developing a general view in the topic, choosing an appropriate and suitable approach for this study (quasi-experimental), and in developing the theoretical framework.
2- The results of several previous studies have shown the positive effect of using a thinking maps strategy via the Edmodo platform on enhancing achievement among students.
3- The current study also differs from previous studies in that its general goal was to determine the effectiveness of using a thinking maps strategy via the Edmodo network to develop achievement and mathematical interdependence skills among middle school students.
4- This study benefited from previous studies in arranging and organizing the theoretical framework and supporting it with the most prominent results and various procedural definitions.
5- They gave us the chance to identify the appropriate research sample in a correct manner.
6- The current study benefited from previous studies in building, designing, and tuning research tools to achieve the research objectives.
7- They helped us to choose appropriate statistical methods to the nature of the research.
8- The researchers tried to analyze, interpret, and discuss the results of the previous studies and linking them with the results of the current research.

METHODOLOGY

RESEARCH PROCEDURES

This section describes the research methodology employed, the sample, and the experimental processing material and research tools used in terms of their construction, including assessment of their validity and reliability. This section also includes a description of the procedures undertaken by researchers in applying the research tools, and the statistical methods used to calculate the reliability of tools and analyze the results.

First: Research methodology

To achieve the research objectives, the experimental approach in its quasi-experimental design was employed which is based on applying pre and posttest to two equal groups: one experimental and the other control.

Second: Research community

The research community consisted of all second-year middle school students in Dammam for the first semester of the academic year 2019.

The Research Sample: The researchers utilized two types of samples:

A. Exploratory sample:
The exploratory research sample completed the achievement development test and the mathematical interdependence skills to ensure honesty and consistency among the respondents. The sample comprised 42 second-year middle school students in Dammam, all of whom were intentionally chosen. Achievement development was tested on Tuesday, 24\9\2019. On Wednesday, 25/9/2019 the mathematical connections test was administered. After 15 days, the same students undertook the tests again on Wednesday 9\10\2019 and Thursday 10\10\2019, respectively.

B. The primary sample:
The research sample consisted of a purposive sample of second-year middle school students of the East Dammam office in the General Administration in the Eastern Region. This school was chosen for two reasons:

- The second researcher works as a teacher in the school; therefore, it was easy to ensure the cooperation of the school administration in facilitating the research.
- A random choice was not possible as selection had to be based on the desire and readiness of students to participate through the Edmodo network. This was dependent on the availability of devices and the Internet.

The total research sample comprised 113 students divided into two groups:

A) Experimental group: 49 students studying Algebra: rational numbers according to the thinking maps strategy used via the Edmodo network

B) The control group: 53 students studying Algebra: rational numbers according to the traditional method

Table 5 shows the number of students in the experimental and control group.

Table 5. The number of students in the experimental and control group

The group	The number of students registered at the beginning of the experiment	The number of students excluded from the experiment	The number of students within the statistical treatment
The experimental	55	6	49
The control	58	5	53
Total	113	11	102

Set of the research variables. Out of concern for the validity of the results, the researchers applied the achievement test and mathematical connections skills among middle school students to verify the homogeneity and parity of the experimental and control groups in terms of the following:-

A- *Chronological age*: The researchers reviewed the students' data through the official records between the sample members, to make sure of the chronological age of the experimental and control groups, we found that the average age of the students ranged between (14.25-14.41) years.

B- *Economic and social level*: The research sample was chosen from one school, this is because students of the experimental and control groups are roughly from the same socio-economic level.

Third: Research tools and empirical probability subjects

The researchers developed tools to assess how effective a thinking map strategy is across an Edmodo network in developing achievement and mathematical connections skills. These tools were as follows:

1) Development of an Algebra achievement test (Rational Numbers) for a mathematics book aimed at second-year middle school students. This was prepared by the researchers as follows.

A. Preparing the achievement test for unit content (Algebra: Rational Numbers) at cognitive levels (Memorialization, Comprehension, Application, Analyzing). The questions prepared were in a multiple-choice format, and the test was submitted to a group of arbitrators to ensure its validity. It was then administered to a sample of 42 second-year middle school students.

B. Reliability was calculated using Cronbach's Alpha and the coefficient reached 0.693, which is high for this test.

C. The calculated discrimination coefficients ranged from 0.09 - 0.57.

D. Internal consistency coefficients were calculated for the grades of all the students in the exploratory sample at each level individually with overall test scores. The values for memorialization, comprehension, application, analyzing, composition, and evaluation were 0.01 -

0.05 in most paragraphs of the achievement test; however, 4 paragraphs did not achieve statistically significant correlations.

E. The performance time on the test was calculated as 35 minutes, there were 15 vocabulary items in its final form, and the final score on the test was 15 (a student scores one mark for every correct answer).

2) Testing mathematical connections skills of Algebra: Rational Numbers for a mathematics book aimed at second-year middle school students. This was prepared by the researchers as follows.

A. Preparing a mathematical connections skills test of Algebra: Rational Numbers that encompassed three skills; the questions were in a multiple-choice format and the test was submitted to a group of arbitrators to ensure its validity.

B. It was tested on a sample of 42 second-year middle school students and the reliability coefficient was calculated using Cronbach's Alpha. This reached (0.701), which is high for this test.

C. The calculated discrimination coefficients ranged from 0.04 - 0.71 at an average of 0.375.

D. Internal consistency coefficients were calculated using the scores of the exploratory sample at each level individually with overall test scores. The value of coefficients for memorialization, comprehension, application, analyzing, composition, and evaluation were 0.01 - 0.05 for the total score on the test; however, 3 paragraphs did not achieve statistically significant correlations.

E. The performance time on the test was calculated as 35 minutes, there were 15 vocabulary items in its final form, and the final score on the test was 15.

3) Preparing the teacher's guide according to the thinking maps strategy via Edmodo network for the unit "Algebra: Rational Numbers." The guide includes an introduction, a summary of thinking maps and the Edmodo network, the general objectives of the unit, educational methods currently used, and lessons designed according to thinking maps via the Edmodo network. It also includes the time distribution for each subject as well as homework for each lesson and worksheets for students. The teacher's guide was submitted to a group of arbitrators and the necessary modifications made upon receipt of their feedback.

Fourth: Research steps

The research was conducted in the following stages.

Phase 1: Before conducting the research:

1- Obtaining a letter from the Imam Abdulrahman bin Faisal University on facilitating the mission of researchers that directed the concerned authorities to implement the research. The Ministry of Education (East Dammam Office) Eastern Province issued a speech to the school allowing the researchers to conduct the research with second-year middle school students.

2- The experimental group were taught how to register with and use the Edmodo network.

3- Preparing the Teacher's Guide for Unit Algebra: Rational numbers (and presented to the arbitrators).

4- Preparing working papers for the Algebra: Rational numbers unit and presenting this to the arbitrators.

5- Algebra Unit Content Analysis: Rational numbers (includes concepts, circulars, skills).

6- Preparing the achievement test and presenting it to competent arbitrators for feedback.

7- Preparing the test (mathematical connections skills) and presenting it to the competent arbitrators for feedback.

8- Equivalence of the two groups: The equivalence of the two groups (experimental and control) was verified by using the T-test for the two independent samples between the mean scores of the pre-application of the two groups in the achievement test and the mathematical connections skills test, and Table 6 illustrates that.

Table 6. Parity of the two research groups

The type of set	The group	The number	Arithmetic Mean	Standard deviation	The value of (T)	Degrees of freedom	The significance
The age	The experimental	49	14.41	0.734	-1.122	100	not significant
	The control	53	14.25	0.731			
Pre application for achievement test	The experimental	49	4.9	2.778	-1.722	100	not significant
	The control	53	4.0	2.488			
Pre application for test mathematical connections skills	The experimental	49	6.43	3.102	-1.767	100	not significant
	The control	53	5.40	2.797			

It is evident from Table 6 that there are no statistically significant differences between the experimental and control groups in the pre-application of the achievement test and the mathematical connections skills test, which indicates the parity of students of the two groups in the research variables before experimentation.

Phase 2: Conducting the research:

1- A pre-test was conducted for both experimental and control groups on 26/9/2019 to measure achievement and ensure it was equivalent for both.

2- A pre-test was conducted for both experimental and control groups on 29/9/2019 to measure mathematical connections skills and ensure it was equivalent for both.

3- The experimental group comprised 49 students using thinking maps (through the Edmodo network) and the control group comprised 53 students using the traditional method. Each group attended 20 lessons from 30/ 9/2019 to 27/10/2019.

4- Effective participation by the students in completing assignments and tests. Grades were awarded electronically.

Phase 3: After the research:

1- A post-test was conducted for both experimental and control groups on 28/10/2019 to measure achievement and ensure it was equivalent for both.

2- A post-test was conducted for both experimental and control groups on 29/10/2019 to measure mathematical connections skills and ensure it was equivalent for both.

3- Data collection, tabulation, organization, statistical analysis, and interpretation.

Fifth: Statistical methods

Researchers used the following statistical methods to process and analyze the data collected.

1- Using a Holst equation to verify the content analysis tool.

2- Using difficulty and discrimination coefficients to test the achievement and mathematical connections skills.

3- Calculating Pearson correlation coefficients to assess internal consistency between each of the test axes and the test as a whole (for both achievement and mathematical connections skills tests).

4- Cronbach's Alpha used to calculate the reliability.

5- Mathematical averages and standard deviations calculated for both achievement and mathematical connections skills tests.

6- Squared ETA to determine the effectiveness of the thinking maps strategy through Edmodo network.

7- T-test for two independent samples to identify differences between the experimental and control groups in developing achievement and mathematical connections skills.

DISCUSSION OF THE RESULT BY DIMENSIONS

This section presents the findings regarding the effectiveness of the thinking maps strategy through Edmodo network in developing achievement and mathematical connection skills among middle school students. It then interprets and discusses the research results in light of the theoretical framework used in previous studies.

RESULTS RELATED TO MAIN QUESTION

How effective are thinking maps through the Edmodo network in developing achievement and mathematical connections skills among middle school students?

To answer this question, the following hypotheses were tested.

FIRST QUESTION -ANSWER AND INTERPRETATION

The first question states: How effective is the use of thinking maps via the Edmodo network in developing achievement among middle school students?

The first hypothesis stated: "There will be no significant difference ($\alpha \leq 0.05$) between the mean scores of the experimental and control groups in the post-test for the achievement test."

To test this hypothesis, the researchers calculated the arithmetic average and standard deviation for both experimental and control groups using a T-test for Independent Samples. The results are presented in Table 7.

Table 7. (T) values comparing the mean scores of experimental and control groups of students in the post-test for the achievement test

Level of significance	ETA square *2*	(T) value	Degrees of freedom	Standard deviation	Arithmetic average	Number	Group
0.05	0.260	5.925	100	2.776	10.57	49	Experimental group
				3.41	6.91	53	Control group

Table 7 shows that the arithmetic average of the experimental group in the post-test is 10.57 and for the control group it is 6.91. The T value is 5.925 at 100 degrees of freedom at a significance level of 0.05, Thus, there is a statistically significant difference ($\propto = 0.05$) between the experimental and control groups in the post-test. There is a notable graphical variation between the scores in the experimental and control groups in the post-application of the achievement test. This is in favor of the experimental group, and thus the null hypothesis is rejected.

To show the size of the effect of the independent variable (the effectiveness of the Thinking Maps strategy via the Edmodo network) on the dependent variable (achievement development) Eta squared ($^{2}\mu$) was calculated. This reached 0.260 for the experimental and control groups, which is greater than 0.14. The effect size is very large, which indicates the Thinking Maps strategy via the Edmodo Network has had a significant and effective impact on the development of student achievement.

This is consistent with the results of studies that have demonstrated the positive impact of using different teaching methods to enhance achievement, including Khalil (2008) and Sharaf (2016) who studied the strategy thinking maps, and Mei (2012) and Dashti (2017) who conducted research on the Edmodo network.

The results indicate the effectiveness of using the Thinking Maps strategy via Edmodo network and its impact on developing academic achievement. The researchers attribute this to the following.

- The Thinking Maps strategy helped connect current learning with previous learnings by integrating higher-order thinking skills to teach and strengthen knowledge building among students.
- The use of several types of thinking maps attracted the attention of learners, which helped speed up the learning and teaching process.
- The thinking maps were effective in developing students' ability to classify, compare, and distinguish. This means they will retain it in memory for a long time, thus raising their level of academic achievement and enabling them to meet the required learning outcomes.
- Thinking maps helped students clarify and organize information in the correct way. This contributes to developing learners' visual abilities by increasing their skills in understanding, synthesizing and evaluating. The Edmodo network provides a space for students to express their opinions freely and break the fear and dread barrier, as a result of which they are encouraged to exchange views and mathematical ideas.

Second Question - Answer and Interpretation

The second question stated: How effective are thinking maps via the Emodo network in developing mathematical connections skills among middle school students? To answer this, the following hypothesis was tested: "There will be no significant difference ($\alpha \leq 0.05$) between the mean scores of the experimental and control groups in the post-test for mathematical connections skills."

To test this hypothesis, arithmetic means and standard deviations were calculated for both experimental and control groups using a T-test for Independent Samples. The results are presented in Table 8.

Table 8. (T) value comparing the mean scores for the experimental and control groups of students in the post-test of mathematical connections skills

Group	Number	Arithmetic mean	Standard deviation	Degrees of freedom	(T) value	Squared Eta	Level of significance
Experimental	49	11.35	2.341	100	7.965	0.388	0.05
Control	53	6.74	3.369				

This shows that the arithmetic average in the post-test for mathematical connections skills for the experimental group is 11.35 and for the control group it is 6.74. The T value is 7.965 at 100 degrees of freedom at a significance level of 0.05. There is therefore a significant difference ($\propto = 0.05$) between experimental and control groups in the scores on the post-test.

It is evident that there is a notable graphical difference between the average scores of students in both groups in the post-test of mathematical connections skills. This is in favor of the experimental group who used the strategy of thinking maps via the Edmodo; therefore, the null hypothesis is rejected.

To show the size of the effect of the independent variables (effectiveness of Thinking Maps strategy via Edmodo) on the dependent variable (mathematical connections skills), ETA square was calculated (2μ). This reached 0.388 for the experimental and control groups which is greater than 0.14. The effect size is very large, strongly indicating that the use of a thinking maps strategy via Edmodo plays an important role in developing students' mathematical connections skills.

This study is consistent with the results of studies that have demonstrated a positive impact of using different teaching methods to enhance achievement (e.g., Al-Barakati, 2008; Al-Kharusi, 2007; Mohammed, 2015).

Explanation of results

The first skill: Recognizing and using the relationships and connections among mathematical ideas. The effective impact of using the thinking maps strategy via the Edmodo network, in terms of the available resources and instruments included in the network, is that it enables the learner to recognize relevant prior knowledge and relate what has already been studied to what will be studied. The Edmodo network contains mathematical topics that are related to topics taken in previous classes and highlights features common to both. This helps create the correct mathematical connections between ideas, which makes students focus on the educational process whereby they interpret new information based on previous information. This in turn helps students understand connections within mathematical subjects.

The second skill: Understanding how to relate mathematical ideas to form an integrated interdependent whole. The Thinking Maps Strategy via Edmodo is a social connection network that contains tools and icons. It therefore helps students organize mathematical information and complete their tasks on the platform. It enables them to organize mathematical ideas and arrange them in a coherent and integrated manner. As a result, they understand how to link mathematical ideas and can perceive the relationships between them. Mathematical topics are included in a cumulative fashion so that there is no gap between mathematical process, measurement, algebra, geometry, and analysis, thus creating an integrated picture of all mathematical topics. This explains the superiority of the experimental group over the control group in the post test of mathematical connections skills.

The third skill: Identifying mathematics, its applications, and using it in external situations. The use of Thinking Maps via the Edmodo in teaching mathematics helped students make mathematical connections between the knowledge they learn and the application of this in public life and other fields of science such as physics and chemistry, thus providing them with an opportunity to enhance their conceptual understanding of mathematics.

THIRD QUESTION - ANSWER AND INTERPRETATION

The third question stated: What is the connection between achievement and mathematical connections skills among middle school students?

To answer this, the following hypothesis was tested: "There will be no significant correlation ($\alpha \leq 0.05$) between achievement and mathematical connections skills among middle school students."

To test this, correlation coefficients were calculated between the scores of both groups in the achievement test and the development of mathematical connections skills, the results of which are shown in Table 9:

Table 9. Pearson Correlation Coefficients between achievement and mathematical connections skills

Group	Number	Correlation coefficient	The critical value
Experimental	49	0.117	0.273
Control group	53	-0.44	0.267

Table 9 shows that the correlation coefficient in the case of the experimental group reached 0.117, greater than the control group (-0.44). There is therefore a positive correlation relationship between achievement and the development of mathematical connections skills among second-year middle school students who used the Thinking maps strategy via the Edmodo network. There is also a negative correlation relationship between these variables among students who studied through the traditional method of teaching, therefore, it is statistically significant and thus the null hypothesis is rejected. Because in a traditional method, students are made to sit passively while the teacher delivers a lesson. This led to students' inability to grasp key ideas and concepts and failed to achieve lesson objectives.

The researchers attribute the existence of a close relationship between achievement and the development of mathematical connections skills to the following. Through practice and training, students were able to link lessons with the reality of daily life and different branches of science and use mathematical ideas to solve problems. This helped learners to understand mathematics in particular and to link it to scientific and daily life in general, positively enhancing their overall understanding. This helped students study mathematics more effectively, which is reflected in their increased level of academic achievement and the development of mathematical connections skills.

This is in line with the findings of Mohammed (2015), who identified a relationship between achievement and mathematical connections skills.

CONCLUSION

The current research explored the effectiveness of using the Thinking Maps strategy via the Edmodo network to develop achievement and mathematical connections skills. To achieve this, the research-

ers employed the experimental approach in its quasi-experimental design comprising both experimental and control groups. They first analyzed the content of the unit (Algebra: Rational Numbers) taken from the mathematics curriculum for the second-year middle school students for the first semester of the year 2019/2020. A test was also designed to develop achievement and mathematical connection skills, and the teacher's guide was designed according to the effectiveness of the Thinking Maps strategy via the Edmodo network. After verifying the validity and reliability of the instruments, they were administered to the research sample.

The researchers employed the following statistical methods to analyze the data: arithmetic mean, standard deviation, difficulty and discrimination coefficient, Cronbach's Alpha to calculate reliability, T-test for two independent samples to compare the mean scores of the sample in pre and post applications, ETA squared to reveal the effect of using thinking maps via the Edmodo network on developing achievement and mathematical connections and the effect size of the independent variable on the dependent variable, Pearson correlation coefficient in both the achievement and mathematical connections skills tests, and between the scores of experimental and control groups on both these tests.

The results showed there was a significant difference between the mean scores of both groups on the post-test of achievement in favor of the experimental group. There was a significant difference between the mean scores of both groups in the post-test of mathematical connections skills in favor of the experimental group. There was a positive relationship between the development mathematical connections skills among middle school students and the use of thinking maps via the Emodo network.

The research has therefore demonstrated the effectiveness of the Thinking Maps strategy via the Edmodo network in developing achievement and mathematical connections skills among middle school students. Based on the results, the researchers make the following recommendations and proposals.

RECOMMENDATIONS

1- Holding courses and training workshops for middle school mathematics teachers that include training on how to use modern learning models enhanced with technology, including the thinking Maps strategy, in the mathematics curriculum.

2- Preparing guidelines for middle school mathematics teachers on how to use Thinking Maps via the Edmodo Network and how to train students in its use.

3- Adopting the use of thinking maps on learning platforms by teachers and mentors for mathematics teaching as an effective method for developing achievement and mathematical connections skills.

4- Benefiting from the applications and experiences of developed countries who have used e-learning in teaching curricula in order to keep pace with contemporary developments.

SUGGESTIONS

1- Study the Effectiveness of the Thinking Maps strategy via the Edmodo network on developing achievement and mathematical connections skills in other subjects and at different educational stages.

2- Conduct similar studies to identify the effectiveness of maps of strategic thinking across Edmodo network variables within other subsidiaries, such as mathematical communication, creative thinking, mathematical proof, mind habits, and so on.

3- Assess the effectiveness of play-based learning strategies via the Edmodo network in developing achievement and mathematical connection skills.

4- Conduct a study that measures teachers' and students' attitudes toward using the Thinking Maps strategy via the Edmodo network.

5- Assessing the effectiveness of using the Thinking Maps strategy via a Edmodo network in achieving and developing creative skills among secondary school students.

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