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"Level of Thinking Skills Among Tenth Grade Students and its Relation to Achievement in Mathematics and Mathematical Self-concept"

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Abstract:

This paper aimed at measuring the extent to which tenth grade students possess the thinking skills as well as examining the relationship between the level of possessing these skills and achievement in mathematics and mathematical self-concept in Bethlehem Governorate. To achieve these objectives, the researcher developed a list of the most important thinking skills for learning mathematics (n=15), a test to measure the thinking skills (n=45), an achievement test and a self-concept scale for mathematics. The sample consisted of (211) tenth grade students distributed over six sections (three sections for the females and three sections for the males) in Bethlehem Directorate of Education. The analysis of the collected data revealed a low mean of thinking skills among the10th grade students (14.52). The results also revealed statistically significant differences in favor of the females in the level of 10th grade students' possession of thinking skills. Furthermore statistically significant correlation was found between the 10th grade students' possession of thinking skills and their achievement in mathematics as well as their mathematical self-concept. In light of these results, the researcher recommended the necessity of training teachers to measure students' thinking skills, and to provide the teachers' manuals with as set guidelines on how to deal with the thinking skills.

Keywords: Thinking skills, Mathematical self-concept, Achievement, Tenth grade.

Introduction

Thinking is one of the most complex cognitive abilities which results from the human endeavor to process symbols and concepts to use them for solving the problems in different learning and life situations. Thus, thinking refers to internal processes, such as information processing and encoding, that cannot be observed and measured directly like the motor behaviors, but can be inferred from the apparent behavior of individuals when they are engaged in addressing a particular problem.

Examining the nature of thinking or formulating a theoretical model for thinking processes is considered a controversial issue for many researchers and thinkers. Some people tend to consider thinking as a cognitive process or a mental activity by which a person acquires or processes knowledge. Thinking is also seen as the mental processing of sensory resources used to form, infer and judge ideas. These definitions are linked several kinds of behavioral factors that require a high level of thinking from the thinker (Yunus, 1997). By the same token, Hayes (1981) defines thinking as the ability to read between the lines, evaluate and then make judgments. However, De Bono (1986) argues that thinking refers to the process of exploring experience as a means to understand, decide, plan, solve problems, and make judgments. The person's ability to solve problems is seen as a key component of thinking (Hayduc, 1987) which represents the mental processing of sensory inputs with the intent of forming and building ideas to perceive things clearly in order to judge them (Costa & Lowery, 1989). These definitions go in parallel with (Barell (1991) who maintained that thinking involves a series of mental activities processed by the human brain when a stimulus exists and received by one or more of the five senses to obtain a meaning of the situation and experience. Furthermore, thinking refers to a variety of mental processes used inside the brain to collect, preserve or store information by means of analyzing, planning, evaluating, and arriving at conclusions or decisions (Wilson, 2002).

In this respect, Saadeh (2003) argues that thinking involves specific intentional mental processes used for processing information and data to achieve various educational goals ranging from remembering information, describing things, taking notes, to predicting, classifying, evaluating, solving problems, and arriving at decisions and conclusions. Marzano (2001) proposed the following interrelated dimensions of thinking: thinking about thinking, critical and creative thinking, thinking processes, core thinking skills, and the relationship of academic content to thinking. As for the thinking processes, Marzano suggested eight thinking processes, namely: concept formation, conceptualization, understanding, problem solving, decision making, research, drafting, and verbal discourse.

With regard to the thinking skills, Marzano (2001) suggested eight basic skills that cover twenty-one sub-skills as follows: (1) concentration skills: specifying problems and objectives; (2) data collection skills: observation and questions formulation; (3) coding skills: /coding encoding and retrieval; (4) organization skills: comparison, classification, synthesis, and representation; (5) analysis skills: specifying attributes and components, specifying types and relations; identifying main ideas, error analysis (6) generative skills: prediction, generalization, reasoning and deduction; (7)integration skills: reconstruction, summarizing; (8) evaluation skills: criteria building and verification.

Thinking is a comprehensive process through which we mentally process sensory inputs and information to form and infer ideas that can be judged. Nevertheless, this process is not fully comprehensible since it integrates perception, previous experience, conscious processing, embracing and intuition in addition to involving multiple skills, each of which contributes to the effectiveness of the thinking process to achieve a specific goal (Al-Moghrabi, 2017).

Research has revealed that everyone possesses all thinking skills, but at different levels. However, some people may possess creative thinking skills more than other skills and may be characterized by creativity, while other people may possess critical thinking skills more than other skills to the extent that one might by characterized by critical thinking (Marzano, 1996).

With regard to enhancing the thinking skills for the purpose of promoting students' achievement, Marzano, Pickering, and Pollock (2001) proposed nine instructional strategies to enhance students' achievement across all grade levels and subject areas. These included: identifying similarities and differences, summarizing and note taking, reinforcing effort and providing recognition, homework and practice, non-linguistic representations, cooperative learning, setting objectives and providing feedback, generating and testing hypotheses, providing cues, questions, and advance organizers. Meanwhile, Jarwan (1999) argues that teaching thinking means teaching students, directly or indirectly, how to implement well-defined thinking skills such as observation, comparison, classification, application and others, independently of the content of the study materials or within its framework.

Taking mathematics into consideration, it is widely common that mathematics is based on deduction and induction due to its abstract nature. As a science, it employs both analytical and synthetic skills to arrive at accurate and true results. Thus, mathematics with its own features in terms of content and method makes an excellent field for training students on patterns of reasoning and sound thinking due to two important features. The first is that mathematical language is distinguished from ordinary language by its accuracy, clarity and conciseness. The second is that mathematics has the potential to develop objective thinking, due its logical aspect, clarity of facts, and the absence of emotional factors. Upon these features, teaching mathematics are expected to provide students with various ways of thinking that will stick with them throughout their academic lives and their daily life, as well (Hindam, 1982).

Within students' academic life, the concept of academic self-concept is considered as one of the main aspects of the general self-concept, which is based on the learner's perception about his/her academic abilities as a result of interaction with academic experiences and situations (Al-Kahaly, 2005). The Academic self-concept relies heavily on the students' success and failure in the early years of school, others' evaluation of students' achievement, whether it is correct or exaggerated (Al-Maghazi, 2004), and on student's awareness of his academic position as well as his beliefs about his own ability to accomplish various tasks compared to his peers in the class (Al-Kahaly, 2005). Consequently, the academic self-concept is important as it corresponds to one of the internal factors of the student, which has an effective impact on his motivation and adaptation to the school and classroom environment. Therefore, knowing students' self-esteem and the way they perceive their achievement helps in planning appropriate programs for them to achieve better academic self-concept that affects the individual's concept of himself in academic fields (Al-Jizani, 2012). Meanwhile, many students face some difficulties which are not due to their weak mental abilities, but because they have formed an idea about themselves that they are unable to work properly towards their optimal academic achievement (Habib, 2003).

All in all, the mathematical self-concept falls under the academic self-concept especially when it involves the individual's knowledge and thinking about his academic past and future which is closely related to academic achievement (Lozano, 1997). Achievement is defined as the result of what the learner acquires from the educational material organized in certain ways and achieved according to the specific instructions for each organization, and also measured by the score that the student obtains in the achievement test after learning the subject (Al-Batanoni, 2005: 40).

Statement of the problem and questions of the study

The problem of this study lies in constructing a list of thinking skills that can be used in learning mathematics in addition to constructing a scale for these skills to measure the level of students' possession of these skills. Besides, it is important to examine the relationship between the thinking skills and students' level of achievement and their academic self-concept in mathematics among tenth grade students in particular. Specifically, the study seeks to answer the following questions:

1) To what extent do the 10th grade students in Bethlehem Governorate have thinking skills?

2) Are there any statistically significant differences in the level of 10th grade students' possession of thinking skills due to gender?

3) Is there a statistically significant correlation between the level of 10th grade students' possession of thinking skills and achievement in mathematics?

4) Is there a statistically significant correlation between the level of 10th grade students' possession of thinking skills and mathematical self-concept?

Objectives of the study

The aim of this study is to measure the extent to which 10th grade students in Bethlehem Governorate possess some thinking skills by using a scale developed by the researcher to study the relationship between the level of possession of these skills, achievement in mathematics and the mathematical self-concept. Specifically, this study aims to:

1. Identify the most important thinking skills used in mathematics.

2. Construct a scale for thinking skills in mathematics.

3. Identify the extent to which 10th grade students possess some thinking skills.

4. Explore the relationship between possessing thinking skills and achievement in mathematics.

5. Explore the relationship between the level of thinking skills and mathematical self-concept.

Significance of the study

The importance of this study from the fact that it seeks to keep abreast of the modern views and methods of teaching to prepare generations capable of coexisting with the changes of the twenty-first century and keeping pace with scientific development and explosion of knowledge. Thus, it is hoped that the results of this study contribute to the introduction of radical educational development including new teaching methods and pedagogies based on motivating and encouraging students to think by placing them in educational situations that require employing a variety of thinking skills at all levels. Moreover, the results are hoped to directing the attention of those in charge of developing education in Palestine to the importance of thinking skills in learning mathematics in addition to move the teachers' attention to employing thinking skills in learning mathematics.

Limitations

The current study involves three types of limitations. The first one is the human limitation which is the tenth grade students. The second limitation is the spatial limitation which is identified by the schools of the Directorate of Education in the Bethlehem Governorate. The third limitation is concerned with time which is limited to the second semester of the academic year 2020/2021.

Literature review

Several previous studies were conducted in the field of mathematical self-concept and students' attitudes the levels of thinking skills. To start with, Alabdulaziz and Alhammadi (2021)aimed to measure the effectiveness of using thinking maps through the Edmodo network to develop achievement and mathematical connections skills among middle school students. A purposeful sample consisting of 102 second-year middle school students were divided into two groups: experimental (n = 49) and control (n = 53). 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.

Üredi and Kösece (2020) explored the relationship between critical thinking skills and mathematical problem solving achievements of the secondary education students. The population included 429 students chosen randomly from the 5th, 6th and 7th grades of state schools in Adana province in Turkey in 2018-2019 academic year. As data collection tools, "Critical Thinking Scale" and "Problem Solving Success Determination Test" were used. Results revealed that there was a positive significant relationship between problem solving achievements and critical thing skills scale. Moreover, the 7th grade students were more successful than the 5th grade students in terms of mathematical problem solving achievement. However no significant difference was found between critical thinking skill levels in terms of gender.

Kim and Sax (2018) examined how positive faculty support is associated with mathematical self-concept development among students in STEM fields and how the association differs for male and female students. The study utilized data from the 2003 Freshman Survey and the 2007 College Senior Survey (CSS) and a sample of 2184 students across 27 institutions nationwide. Results found that positive faculty support was significantly and positively related to STEM students' mathematical self-concept development in general; however, this positive connection held for male STEM students only. Findings also suggested that female STEM students' mathematical self-concept remained significantly below males' throughout college and positive faculty support did not narrow the persistent gender gap in this area.

Abu-Qayyas (2017) aimed to explore the relationship between students' attitudes towards mathematics and their motivation towards learning mathematics at the upper basic stage in Qabatiya Governorate. The random sample consisted of 720 male and female students. The results revealed that students' estimation of the importance of mathematics and the total score of students' attitudes towards mathematics were all high. It was also found that there is a positive relationship between students' attitudes and motivation towards learning mathematics, and between attitudes and self-concept in learning mathematics, and also between motivation and self-concept, whereas a negative relationship between motivation towards learning mathematics and anxiety about learning it and self-concept was found.

Arens et al. (2016) explored the math self-concept of German preschool children (n = 420) with respect to its differentiation into competence and affect components, cross-sectional and longitudinal relations to early math achievement, and invariance across gender. Findings demonstrated that preschool children's math self-concept can be separated into competence and affect components, with the competence component displaying higher relations to early math achievement than the affect component. The competence component but not the affect component was found to be related to prior math achievement, providing evidence of the skill-development model of self-concept–achievement relations in the preschool years. Boys and girls demonstrated similar self-concept–achievement relations and mean levels in the competence and affect components of math self-concept.

Al-Moghrabi (2014) conducted a study to identify the degree to which 7th grade students employ Mazano's thinking processes and its relationship to achievement and attitudes towards mathematics. To achieve the objectives, the researcher administered a thinking process test, an achievement test, and a scale of attitudes towards mathematics on a sample of (184) seventh-grade students Hebron Governorate. Results revealed that the degree of employing the basic thinking processes is low among the students although the results showed a positive, statistically significant correlation between the possession of thinking processes and achievement as well as attitudes in mathematics.

Poddiakov (2014) aimed to identify the primary patterns of classification processes of the pre-school children. The results of the study showed that the most common classification patterns at this stage are: quantities and sizes, as these classifications help children to determine the characteristics and advantages of things and organize experiences, and they constitute the logical framework in thinking. It was also found that there is a positive relationship between the employment of these classifications and the development of the child's mental abilities.

Al-Mansour (2011) aimed to explore the relationship between achievement in mathematics and performance on the thinking skills scale among a sample of 6th grade students (n= 241) in Damascus. An achievement test in mathematics and scale of thinking skills (Analysis, abbreviation, synthesis, producing solutions, discrimination, comparison, flexibility, conclusion, decision-making, expansion, proof, generalization). The results showed a positive correlation between achievement in mathematics and performance on the thinking skills scale.

Karam El-Din and Sabri (2011) aimed to identify the impact of a proposed program on the development of logical thinking processes of kindergarten children. The study used the experimental method on 60 children who were divided into two groups: control and experimental. Results showed significant differences between the control and experimental groups on the scale of logical thinking processes in favor of the experimental group.

Eid (2009) aimed to examine the effect of a proposed program based on both sides of the brain on developing some thinking skills in mathematics among fifth grade students in Gaza. The sample consisted of (77) students who were divided into two groups, the control group and the experimental group. After applying the proposed program to the experimental sample, the results showed that there were statistically significant differences between the average scores of the students of the experimental group and the average of their peers in the control group in the test of thinking skills in mathematics in favor of the experimental group. The results also showed significant differences between the mean scores of the experimental group with both sides (right, left, and both sides) in math thinking skills test in favor of students with both right and left sides.

Hassan (2009) aimed to construct a program for teaching analytical thinking, with the aim of developing reading comprehension and awareness of thinking processes among first-year preparatory students. The program targeted two units of the Arabic language textbook in Egypt in the 2008/2009 academic year. The program was conducted on a sample of (90) middle school students divided into two groups, control and experimental. Results showed statistically significant differences in both reading comprehension and awareness of thinking processes due to the application of the program in favor of the experimental group.

Muhammad (2008) aimed to find out the relationship between academic achievement, critical thinking and problem solving in mathematics among first year secondary school students. The study was applied to a sample of (11658) male and female students distributed over (151) schools in Egypt. The researcher also applied measures of achievement, critical thinking and problem solving. The results revealed weak achievement of the students in mathematics and a correlation between achievement and critical thinking and achievement and problem solving.

McGuinness C. et. al. (2007) conducted a three- year longitudinal study to identify the impact of Activating Children Thinking Skills- ACTS- program designed to develop the skills of (meaning - searching, decision-making, problem solving, critical thinking, creative thinking, and metacognition) in Northern Ireland. The study sample was divided into three categories: the first included 292 students in 12 sections who studied the project for three years. The second category involved 412 students in 17 sections who studied the project for two years. The third category included 548 in 25 sections who did not study the project. The results of the study showed statistically significant differences in knowledge and metacognition skills in favor of the students who studied using the project, and statistically significant differences in knowledge and metacognitive skills in favor of the students who studied the project for three years versus those who studied for two years, while the greatest impact was on high achievers.

Al-Rubaie (2001) aimed to identify the effect of using electronic tables on developing observational skills, data organization, analysis and conclusion among third graders. The experimental method was used in this study on as sample consisted of (56) female students who were divided into two groups: a control group (n= 27) and the experimental group (n= 29). Findings revealed a correlation between the student's acquisition of the skill of thinking and the skill of using electronic tables.

Novak (2001) aimed at identifying the extent to which Slovenian primary schools were able to shift to teaching according to the new method of "learning and thinking" in mathematics, language and social studies. The study was conducted on a sample of three schools of (8) years of age who apply the old curriculum and three schools of (9) years of age who apply the modern curriculum. The results revealed a shift in teachers' attention from the content of the curriculum to students' interests, experiences, and learning objectives in addition to few differences in the level of learning and thinking among students of 9 years.

Cotton (1991) reviewed 56 research papers consisted of (33) applied research and (23) theoretical research on thinking skills. The results pointed to the following: providing students with thinking skills is important for several reasons, the most important of which is that students, in general, do not develop their own self-reflection skills ; teaching thinking skills promotes intellectual growth and promotes academic gain; research calls for an educational approach to encourage thinking and develop skills; multiple experiments across educational thinking skills programs have demonstrated improvement in student performance on intelligence and achievement tests; training teachers to teach the thinking skills has the potential to bring benefits to students; thinking skills cannot be taught separately from the curriculum, and both can improve student performance synergistically; thinking skills require a lot of time to be effective, and administrative support and commitment are essential to the success of the program.

The aforementioned review of literature indicates a gap in the studies conducted in the Palestinian context to deal with thinking skills and their relationship to achievement and the mathematical self-concept of tenth graders. This is what

distinguishes the current study from previous studies. Nevertheless, the researcher benefited from previous studies in preparing the research theoretical background, constructing the research tools and in interpreting the findings in the current research.

Methodology

To achieve the study objectives, the descriptive approach was used.

Population and sample

The population consisted of all tenth grade students in Bethlehem Directorate of Education in the second semester of the academic year 2020/2021(n= 4326). On the other hand, the sample consisted of 211 male and female students divided into six groups, three for the males and three for the females who were chosen purposively to find teachers who are ready to cooperate. Table (1) below shows the distribution of the sample.

Table 1: Distribution of the sample

Gender / Section	Male	Female
1st section	32	35
2nd section	37	36
3rd section	34	37
Total	103	108

Instruments

1. Thinking skills list

To construct an appropriate list of the most important thinking skills that help to achieve the study objectives, the researcher reviewed many lists of thinking skills (Marzano et al., 2004) and chose twenty thinking skills that are most commonly used in learning mathematics. These were presented to six expert arbitrators who agreed on fifteen of them.

2. Thinking skills scale

This scale is a test prepared by the researcher to measure the extent to which tenth grade students possess the thinking skills mentioned in the list of thinking skills. To construct this scale the following procedures were used:

a. The researcher formulated three questions for each of the thinking skills in the list of thinking skills, depending on the mathematics content of the tenth grade curriculum, and thus the number of the scale items was (45) items.
b. The scale was presented to seven expert arbitrators in the field of teaching mathematics including educational supervisors and mathematics teachers, to give their comment and suggestions and about the scale items. Their suggestions were taken into account when producing the last version of the scale.
c. The reliability of the scale was measured using Cronbach's alpha and it was (0.81), which is an acceptable value for research purposes. In its final form, the test consists of (45) items distributed over (15) skills, with three items for each skill.

3. Achievement test:

For the study purposes, the researcher adopted the results of the standardized achievement test for the tenth grade in the first semester of the academic year 2020/2021 in the Directorate of Education / Bethlehem.

4. Mathematical self-concept scale

This scale was in a form of a questionnaire consisting of (25) items to measure the mathematical self-concept which was prepared by the researcher. Its validity was confirmed by presenting it to six arbitrators with experience in psychology and mathematics teaching, while its reliability was measures using internal consistency. The scale reliability coefficient was (0.76), which is an acceptable value for scientific research purposes.

Procedure

The study was applied according to the following steps:

1. Preparing the study tools: a list of thinking skills, a scale of thinking skills, and a scale of mathematical self-concept.

2. Selection of the study sample.

3. Holding a meeting with the teachers of the study sample to clarify the objectives of the study and the method of applying the tools.

4. Applying the tools to the study sample.

5. Analyze the results.

6. Drafting the study report

Methods of grading

With regard to the items of the thinking skills test, one mark was given to each correct answer and zero for the wrong answer, so that the maximum mark for each skill is 3 and the minimum mark is zero, and the maximum mark for the test as a whole is 45 and the minimum mark is zero. The levels of skill acquisition were adopted as shown in Table (2) below. As for the Mathematical Self-Concept Scale, 4 scores were given to the very high responses, 3 scores were given to the high responses, 2 scores were given to two medium responses, 1 score was given to low responses and zero to "None" responses, taking into account the scale inverse of the negative paragraphs, so that the maximum mark of the scale is (100) and the minimum mark is (zero). The levels of mathematical self-concept were adopted as in the following table (2):

Table 2: Scoring Criteria

Test/Scale	Score	Estimation
Thinking Skills Test	Below 15 15 – 30 30 and more	Low Moderate High
Mathematical Self-Concept	Below 33 33 – 67 67 and more	Low Moderate High

Statistical Analysis

The collected data were statistically analyzed using the Statistical Package for Social Sciences (SPSS) program by calculating the means, standard deviations, T-test, Pearson correlation coefficient and reliability coefficients.

Results

Both descriptive and analytical statistics were used to analyze the data, and the following is a presentation of the research results:

Results related to the first question:

To what extent do the 10th grade students in Bethlehem Governorate have thinking skills?

To answer this question, the means and standard deviations were calculated, and the results are shown in Table 3 below.

Table 3: Means and ranking of levels of thinking skills

No.	Skill	Mean	Rank	Estimation level
1	Identify the given data	1.06	6	Moderate
2	Decoding	0.97	9	Low
3	Remembering	1.72	1	Moderate
4	Comparison	1.57	2	Moderate
5	Classification	0.76	10	Low
6	Ranking	1.52	3	Moderate
7	Identifying patterns & relations	0.48	13	Low
8	Identify errors	0.58	12	Low
9	Reasoning	0.31	15	Low
10	Application	1.36	4	Moderate
11	Deduction	1.03	8	Moderate
12	Induction	0.75	11	Low
13	Transforming problems into outlines	0.43	14	Low
14	Verification	1.10	5	Moderate
15	Evaluation	1.04	7	Moderate
	Total	14.52		Low

Table 3 shows that the tenth grade students' possession of thinking skills scored a low mean (14.52), indicating that the students do not possess any high level of thinking skills. Furthermore, they possess eight thinking skills at a moderate level and seven skills at a low level. The highest skill was remembering with a mean (1.72), while the lowest was scored by the reasoning skill with a mean (0.31).

This result might be attributed to the lack of interest among teachers of mathematics in thinking skills and lack of focus on thinking skills within the curricula. Most teachers tend to focus on the performance of mathematical procedures and their steps, without giving much attention to the skills of analysis, explanation, interpretation or linking, to name a few. On the other hand, the reason for the students' low levels of thinking may be due to the process complexity of the thinking process through which students mentally process sensory input and translated information to form ideas, infer or judge them. In this respect, the thinking process is not fully understood as it includes perception, previous experience, conscious processing, embracing and intuition in addition to a variety of multiple skilss, each of which contributes to the effectiveness of the thinking process, which, according to Al-Moghrabi (2017) requires an integration of certain skills within a holistic strategy in a specific situation to achieve a goal. This result agrees with the results of Moghribi (2014) and Cotton (1991); however, the result seems to disagree with the results of Lowry (2006).

Results related to the first question:

Are there any statistically significant differences in the level of 10th grade students' possession of thinking skills due to gender?

To answer this question, the means and standard deviations of the thinking skills of tenth grade students were calculated, and the results are shown in Table 4 below.

Table (4): Means, standard deviations, ranking and levels of thinking skills

No.	Skill	Males			Females		
		Mean	Rank	Estimation level	Mean	Rank	Estimation level
1	Identify the given data	1.00	7	low	1.11	6	moderate
2	Decoding	0.91	9	low	1.09	7	moderate
3	Remembering	1.44	1	moderate	1.97	1	moderate
4	Comparison	1.28	2	moderate	1.83	2	moderate
5	Classification	0.75	10	low	0.77	11	low
6	Ranking	1.22	3	moderate	1.80	3	moderate
7	Identifying patterns & relations	0.41	13	low	0.54	13	low
8	Identify errors	0.56	12	low	0.60	12	low
9	Reasoning	0.25	15	low	0.37	15	low
10	Application	1.13	4	moderate	1.57	4	moderate
11	Deduction	1.00	7	low	1.06	8	moderate
12	Induction	0.66	11	low	0.83	10	low
13	Transforming problems into outlines	0.41	13	low	0.46	14	low
14	Verification	1.06	6	moderate	1.14	5	moderate
15	Evaluation	1.09	5	moderate	1.00	9	low
	Total	13.03		low	15.89		moderate

Table 4 reveals that the mean of tenth grade male students' possession of thinking skills was (13.03) indicating a low mean, while the mean of females possession of thinking skills was (15.89) indicating a moderate mean. The table also shows that the males possess six skills at a moderate level and nine skills at a low level, while females possess nine skills at a moderate level and six skills at a low level.

Results of the first hypothesis (Related to the second question)

There are no statistically significant differences at ($\alpha \leq 0.05$) in the tenth grade students' possession of thinking skills due to gender.

To test this hypothesis, t-test for independent samples was used to compare the means of the thinking skills between the males and females and Table (5) shows the results.

Table 5: Results of t-test to compare the means of thinking skills due to gender

Test	Gender	Mean	SD	Degree of freedom	t-value	Sig
Total test of thinking skills	Males	13.03	3.56	209	2.26	0.027
	Females	15.89	6.27			

Table (5) shows that the significance level is (0.027) which is less than (0.05), thus, we reject the null hypothesis and accept the alternative hypothesis. This result indicates that there are statistically significant differences in tenth grade students' possession of thinking skills due to gender and the differences were in favor of the females. In order to identify the source of these differences, t-test was used to compare the means of each individual skill for both males and Table (6) shows the results.

Table (6): t-test to of the means of each thinking skills due to gender

No.	Skill	Gender	Mean	SD	DF	t-value	sig
1	Identify the given data	Male	1.00	0.25	**209**	**1.02**	**0.310**
		Female	1.11	0.58			
2	Decoding	Male	0.91	0.53	**209**	**0.91**	**0.367**
		Female	1.03	0.57			
3	Remembering	Male	1.44	0.72	**209**	**2.89**	**0.005**
		Female	1.97	0.79			
4	Comparison	Male	1.28	0.58	**209**	**3.33**	**0.001**
		Female	1.82	0.75			
5	Classification	Male	0.75	0.51	**209**	**0.15**	**0.881**
		Female	0.77	0.65			
6	Ranking	Male	1.22	0.49	**209**	**2.99**	**0.004**
		Female	1.80	0.99			
7	Identifying patterns & relations	Male	0.41	0.50	**209**	**1.11**	**0.270**
		Female	0.54	0.51			
8	Identify errors	Male	0.56	0.50	**209**	**0.29**	**0.773**
		Female	0.60	0.55			
9	Reasoning	Male	0.25	0.44	**209**	**1.06**	**0.292**
		Female	0.37	0.49			
10	Application	Male	1.13	0.34	**209**	**3.46**	**0.001**
		Female	1.57	0.65			
11	Deduction	Male	1.00	0.25	**209**	**0.55**	**0.587**
		Female	1.06	0.54			
12	Induction	Male	0.66	0.48	**209**	**1.33**	**0.188**
		Female	0.83	0.57			
13	Transforming problems into outlines	Male	0.41	0.50	**209**	**0.41**	**0.680**
		Female	0.46	0.51			
14	Verification	Male	1.06	0.25	**209**	**0.76**	**0.450**
		Female	1.14	0.55			
15	Evaluation	Male	1.09	0.30	**209**	**0.87**	**0.389**
		Female	1.00	0.54			

Table (6) shows that the level of significance of the differences between the means of the skills of remembering, comparison, ranking and application is less than (0.05), and thus there are statistically significant differences in tenth grade students' possession of these skills due to gender and the differences were in favor of the females. As for the rest of the skills, the significance level is greater than (0.05), meaning that there are no statistically significant differences between the males and females in these skills.

The researcher thinks that the reason for this result may be due to the fact that females outperform males in scrutinizing matters, inductive reasoning, and in some numerical skills, and outperform males in monitoring and following up on changing situations, which led to the presence of statistically significant differences in the level of some thinking skills in favor of the females specifically in relation to remembering, comparison, ranking and application skills.

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Results related to the third question:

Is there a statistically significant correlation between the level of 10th grade students' possession of thinking skills and achievement in mathematics?

To answer this question, the following null hypothesis related to this question was tested.

There is no statistically significant correlation at ($\alpha \leq 0.05$) between tenth grade students' possession of thinking skills and achievement in mathematics.

Table (7) below shows the value of the correlation coefficient between the scores of the thinking skills test and the achievement test in mathematics and its level of significance.

Table (7): Correlation coefficient between thinking skills and achievement in mathematics and its level of significance

Variable	No.	Correlation coefficient	sig
Thinking skills ► achievement in mathematics	**211**	**0.712**	**0.000**

Table (7) reveals that the value of the correlation coefficient between the tenth grade students' possession of thinking skills and achievement in mathematics is (0.712) , which represents a strong linear correlation between the two variables, whereas the level of significance of the correlation coefficient is (0.000). Accordingly the null hypothesis is rejected indicating that there is a correlation between the extent to which tenth grade students possess thinking skills and achievement in mathematics.

To explore which of the thinking skills is more related to achievement, Table (8) represents a matrix of correlation coefficients between achievement in mathematics and each of the thinking skills.

Table (8): Correlation coefficient between achievement in mathematics and thinking skills

No.	Skill	Correlation coefficient	Sig
1	Identify the given data	0.510	0.000
2	Decoding	0.542	0.000
3	Remembering	0.637	0.000
4	Comparison	0.618	0.000
5	Classification	0.479	0.000
6	Ranking	0.438	0.000
7	Identifying patterns & relations	0.495	0.000
8	Identify errors	0.390	0.001
9	Reasoning	0.385	0.001
10	Application	0.608	0.000
11	Deduction	0.501	0.000
12	Induction	0.406	0.001
13	Transforming problems into outlines	0.369	0.002
14	Verification	0.227	0.065
15	Evaluation	0.192	0.120
	Total		

Table (8) shows that all correlation coefficients between achievement in mathematics and thinking skills are statistically significant, except for the verification and evaluation skills. It also shows that the highest correlation coefficients were between achievement and both remembering, comparison and application. With reference to this result, the researcher postulates that the reason for this result may be due to the fact that the top three thinking skills were themselves among the highest thinking skills among students, and perhaps the reason behind this is that the curricula and achievement tests focus on these skills more than other thinking skills.

This result tends to be in line with the results of (Al-Moghribi, 2014; Poddiakov, 2012; Al-Mansour, 2011; Mohammed, 2008; and Lowry, 2006; Alabdulaziz, and Alhammadi, 2021; Üredi, and Kösece, 2020)) while disagrees with the results of Novak (2001).

Results related to the fourth question

Is there a statistically significant correlation between the level of 10th grade students' possession of thinking skills and mathematical self-concept?

To answer this question, the following null hypothesis related to this question was tested and Table (9) shows the value of the correlation coefficient between thinking skills and mathematical self-concept and its level of significance.

There is no statistically significant correlation between the level of tenth grade students' possession of thinking skills and mathematical self-concept.

Table (9): Correlation coefficient between thinking skills and mathematical self-concept and its level of significance

Variable	No.	Correlation coefficient	sig
Thinking skills ► mathematical self-concept	**211**	**0.333**	**0.006**

Table (9) shows that the value of the correlation coefficient between the tenth grade students' possession of thinking skills and mathematical self-concept is (0.333) and the significance level is (0.006). Therefore, the null hypothesis is rejected indicating that there is a statistically significant correlation between the extent of students' possession of thinking skills and mathematical self-concept. To identify which of the thinking skills are more related to the mathematical self-concept, Table (10) represents the matrix of correlation coefficients between the mathematical self-concept and each of the thinking skills.

Table (10): Correlation coefficients between the mathematical self-concept and each of the thinking skills

No.	Skill	Correlation coefficient	Sig
1	Identify the given data	0.301	0.013
2	Decoding	0.212	0.085
3	Remembering	0.287	0.019
4	Comparison	0.267	0.029
5	Classification	0.277	0.023
6	Ranking	0.089	0.475
7	Identifying patterns & relations	0.220	0.074
8	Identify errors	0.285	0.019
9	Reasoning	0.320	0.008
10	Application	0.146	0.240
11	Deduction	0.234	0.057
12	Induction	0.209	0.090
13	Transforming problems into outlines	0.170	0.170
14	Verification	0.020	0.870
15	Evaluation	0.198	0.108

Table (10) reveals that the correlation coefficients between the mathematical self-concept and thinking skills are not high, as the highest correlation coefficient score (0.320). It also shows that the correlation coefficients between the mathematical self-concept and the skills of reasoning, identifying data, remembering, identifying errors, classification and comparison are statistically significant, while the rest of the correlation coefficients for other skills were not statistically significant. Hence, the researcher assumes that this result is logically related to the previous result which maintained that the relationship between thinking skills and achievement was positive, that is, the higher the students' thinking skills are, the higher their achievement. Thus, it is natural if we claim that when students' achievement in mathematics increases, an increase in their image about mathematical abilities will also increase and the level of mathematical self-concept will increase. This result seems to be consistent with the results of (Abu Qiyas ,2019; Cotton, 1991; Kim and Sax ,2018; Arens et al. ,2016).

Conclusion

The aim of the current study was to measure the extent to which tenth grade students possess the thinking skills as well as examining the relationship between their level of possessing these skills and achievement in mathematics and mathematical self-concept in Bethlehem Governorate. Result showed a clear weakness in the students' thinking skills, especially in the high –order thinking skills. Nevertheless, as studying mathematics requires higher thinking skills, this explains the positive, statistically significant correlation between the possession of thinking skills and achievement in mathematics. Thus, it can be assumed that the higher the level of possession of thinking skills is, the higher the level of achievement will be, and the lack of thinking skills at a high level may lead to a lower student achievement in mathematics This explains the low level of academic self-concept among students, and also clarifies the connection between the three variables - thinking skills, achievement and mathematical self-concept.

In addition, the results showed a positive correlation between the level of thinking skills and the mathematical self-concept. It was evident that when the students' thinking skills are low, the level of their academic self-concept will be low. Therefore, it is necessary for those in charge of preparing mathematics curricula and teachers as well to pay more attention to thinking skills. These calls are hoped to enrich the curricula with teaching/learning activities that improve students' thinking skills, on one hand, and raise the level of their achievement and mathematical self-concept, on the other hand. These insights go in line with many psychologists who called for teaching thinking skills as a means to raise students' possession of problem-solving skills or other types of thinking. In this respect, mathematical thinking can help us understand the complex crises in our lives, and can be a way to perceive the world and make it meaningful. Hence, when we teach mathematics in general, we teach problem solving in particular, and teaching problem-solving methods is based mainly on transforming the mathematical content itself into problems of a specific nature. Through solving these problems the student learns a lot of facts, skills, concepts and generalizations. In addition, students can learn some methods, strategies and suggestions to help them solve the general problems they might encounter in their daily life (Schoenfeld 1992).

Recommendations

In light of the study results, the researcher recommends the following**:**

1) Training teachers on how to measure the extent of students' possession of thinking skills and how to develop students' thinking skills.

2) Developing guidelines for the teachers to deal with thinking skills within the manuals of teaching mathematics prepared by the Ministry of Education.

3) Conducting similar studies on other samples of students.

4) Conducting other studies to find out the relationship of thinking skills with other variables.

5) Conducting content- analysis studies that target the new curricula to determine the thinking skills they include.

References

Abu-Qayyas, Y. (2017). Attitudes and motivation towards learning mathematics, their self-concept and their feelings during learning in the upper basic stage in Qabatiya Governorate, (Unpublished MA thesis), An-Najah National University, Nablus, Palestine.

Alabdulaziz, M.; Alhammadi, A. (2021). Effectiveness of Using Thinking Maps through the Edmodo Network to Develop Achievement and Mathematical Connections Skills among Middle School Students. Journal of Information Technology Education: Research, V.20 p.1-34.

Al-Batanoni, F. (2005). The effect of the interaction of intelligence with some methods of presenting information on the achievement and retention of a sample of basic education students, (Unpublished Ph.D. dissertation, Faculty of Education, Al-Azhar University, Cairo.

Al-Jizani, M. (2012). Self-concept and social maturity between reality and idealism, 1st Edition, Dar Safaa for Publishing and Distribution, Amman, Jordan.

Al-Kahali, S. (2005). Academic self-concept and test anxiety and their relationship to academic achievement among 11th grade students in the Sultanate of Oman, Unpublished MA thesis, College of Education, Sultan Qaboos University, Muscat.

Al-Maghazi, I. (2004). Self-concept between education and society, Jazirat Al-Ward Library, Mansoura, Egypt.

Al-Mansour, G. (2011). Achievement in Mathematics and its Relationship with Thinking Skills: A field study on a sample of sixth grade students in the public schools of Damascus. Damascus University Journal, Damascus University, 27(3) 19-69.

Al-Moghrabi, N. (2018). Dimensions of Learning, 1st Edition, Deanship of Scientific Research, Al-Quds Open University, Ramallah, Palestine.

Al-Moghrabi, N. (2014). Level of 7th grade students' employment of the basic thinking processes according to Marzano model and its relationship with achievement and attitudes towards mathematics, Al-Quds Open University Journal of Educational and Psychological Research, 2(6), 11-139.

Al-Raymouni, H. (2008). Effect of training programs for people with learning disabilities on academic achievement and self-concept, Dar Al-Hamid, Amman, Jordan.

Al-Rubaie, A.(2001). The effect of using electronic tables in developing the skills of observation, data organization, analysis and conclusion among third graders of primary school, Journal of Educational and Psychological Sciences, 2(2). University of Bahrain.

Arens, A.K., Marsh, H.W., Craven, R.G., Yeung, A.S., Randhawa, E., & Hasselhorn, M.(2016). Math self-concept in preschool children: Structure, achievement relations, and generalizability across gender. Early Childhood Research Quarterly, 36, 391– 403. http://doi.org/10.1016/j.ecresq.2015.12.024.

Barell , J. (1991). Creating our Pathways ; Teaching Students to Think and Become Self – Directed**.** In. N. Colangelo. A. Davis (Eds) , Hand Book of Gifted Education (PP. 256 – 270)

Chaplin, J. (1971). Dictionary of Psychology, Ed (4), N.Y. Dell.

Cotton, Kathleen.(1991). Teaching Thinking Skills, Northwest Regional Educational_Laboratory's School Improvement Research Series**,** Available At: http://www.nwrel.org/scpd/sirs/6/cu11.html

Costa, A. L. & Lowery, L. F. (1989). Techniques for Teaching Thinking, Pacific Grove, CA, Midwest Publications.

De Bono, E. (1986). CORT Thinking (Teacher's Guide: Notes and Handbooks), Chicago, IL: Macmilan McGraw-Hill.

Eid, A. (2009). A proposed program based on both sides of the brain to develop some thinking skills in mathematics for fifth grade students in Gaza. Unpublished MA Thesis. Islamic University, Gaza.

Freeman, G. (2008). Academic Achievement, Academic Self-Concept and Academic Motivation of Immigrant Adolescents in the Greater Toronto Area Secondary Schools. Journal of Advance Academic**,** 19 (4) pp. 700-743.

Habib, M. (2003) Modern Trends in Teaching Thinking (Future Strategies for the New Millennium). Dar Al-Fikr Al-Arabi (Arab Thought House), Cairo, Egypt.

Hassan, T.(2009). A proposed program for teaching analytical thinking and its effectiveness on developing reading comprehension and awareness of thinking processes among middle school students. Journal of Studies in Curricula and Teaching Methods, Faculty of Education, Ain Shams University, Issue (144) 46-93.

Hayduc, L. A. (1987). Structural Equation Modeling with Lisler: Essentials and Advances Baltimore, Md: Hohns Hopkins University Press.

Hayes, J. R. (1981). The Complete Problem Solver, Philadelphia, PA: Franklin Institute Press.

Hindam, Y. (1982). Teaching Mathematics, Cairo: Arab Renaissance House.

Jarwan, F. (1999). Teaching Thinking - Concepts and Applications, University Book House, Al Ain, UAE.

Karam El-Din, L. and Ismail, S. (2011). A program for the development of logical thinking processes for a kindergarten child. Journal of Childhood Studies, pp. 61-69. Ain Shams University, Cairo, Egypt.

Kim, Y. and Sax, L. (2018). The Effect of Positive Faculty Support on Mathematical Self-Concept for Male and Female Students in STEM Majors. Research in Higher Education, 59 (8), pp. 1074-1104.

Lowry, A. (2006). The effectiveness of TAPA strategies for teaching higher-order thinking skills: a comparative study, Journal of Educational and Psychological Sciences, Volume (5), Issue (1), University of Bahrain.

Lozano, A. (1997). Accompan Ying Gulliver Personal counselin in Secondary School Education. Unpublished study, University of Sevilla.

Marzano, R. et al. (1996). Dimensions of Thinking: A Framework for Curriculum and Teaching Methods, translated by Yaqoub Nashwan and Muhammad Khattab, Miqdad Press, Amman, Jordan.

Marzano RJ (2001). A new taxonomy of educational objectives. In Developing minds: a resource book for teaching thinking, (ed.) AL Costa. 3rd edition. Alexandria, VA. Association for Supervision and Curriculum Development.

McGuinness, C. (2000). ACTS (Activating Children's Thinking Skills**,** available at:

http://www.leeds.ac.uk/educol/documents/00003276.htm

Muhammad, M. (2008). The relationship between academic achievement, critical thinking and problem solving in mathematics among first year secondary school students. Journal of the College of Education in Ismailia, Issue (12), 139-188.

Novak B. (2001). Teacher's Teaching Styles in the Function of Pupil's Styles in Nine-year Primary Schools**,** Available at: http://brs.leeds.ac.uk/cgi-bin/brs_engine

Poddiakov, N. (2014). Initial Forms of Categorical Thinking Processes in Preschool-Age Children. Journal of Russian and European Psychology, 50 (2), 75-79.

Saadeh, J.. (2003). Teaching thinking skills, 1st ed, Dar Al-Shorouk for Publishing and Distribution, Amman, Jordan.

Wilson, Valerie.(2003).Education forum on teaching thinking skills report,

Available at: www.scotland.gov.uk.

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense-making in mathematics. In D. Grouws (Ed.), Handbook for Research on Mathematics Teaching and Learning (pp. 334-370). New York: MacMillan.

Üredi, L. and Kösece, P. (2020). Investigating the Relationship between Critical Thinking Skills and Mathematical Problem Solving Achievements of Secondary Education Students. European Journal of Educational Sciences, 7 (2) p186-202.

Yunus, F. (1997). Readings in thinking skills and teaching critical thinking and creative thinking, Dar Al-Nahda Al-Arabiya, Cairo, Egypt.