Research Article

Depth of mathematical knowledge and its relationship to information processing among secondary school students

Maryam Rahim Hashem Al-Saadi[1], Prof. Dr. Hassan Kamel Resan Al-Kinani[2]

[1]University of Baghdad / College of Education for Pure Sciences - Ibn Al-Haytham
[2]University of Baghdad / College of Education for Pure Sciences - Ibn Al-Haytham
[1]mryrh10@gmail.com,[2] dr.hassankamil@gmail.com

Article History: Received: 5 April 2021; Accepted: 14 May 2021; Published online: 22 June 2021

Abstract: The current research aims to study the relationship between the depth of mathematical knowledge and information processing for secondary school students,In order to verify the goal, the researchers adopted the descriptive approach in line with the nature of the research, and the following null hypothesis was formulated:There is no statistically significant correlation at the significance level (0.05) between the depth of mathematical knowledge and information processing for the fifth literary grade students.The research community, represented by the literary fifth grade students in the Rusafa 2nd, Education Directorate, was identified, and the sample was chosen in a stratified random manner, as it consisted of (400) students and the construction of the two research tools are the Mathematical Knowledge Depth Test and the Information Processing and Application Test on the Sample, statistical analyzes were conducted for the two test items, to ensure the psychometric properties, and the use of appropriate statistical tools and package (spss) to analyze the results of the application of the two tests, which resulted in the existence of a correlation between the depth of mathematical knowledge and information processing.In light of the results of the research, several recommendations were made, most notably the interest in ways and methods that can develop the levels of depth of mathematical knowledge and information processing among secondary school students in general, as well as the diversity of activities given to students of the fifth literary grade, which develop their depth of mathematical knowledge and information processing skills.

Keywords: depth of mathematical knowledge, information processing**.**

1. Chapter One: Introduction to Research

First: Research Problem

In light of the continuous changes that mathematics curricula are witnessing to keep pace with the successive modern developments and to achieve meaningful learning by linking these curricula to real life, changes occurred in mathematics itself, as this broad development included all branches of mathematics and its relationship with other knowledge systems, this change was also accompanied by a development in the quality and quantity of mathematics used in school stages to continue its role in raising individuals with a purposeful education, the literature has shown that there is a deficiency in the levels of depth of knowledge among students of the preparatory stage, and the reason for this deficiency is due to the use of traditional methods, and it was confirmed by the researchers' testing a sample of fifth-grade literary students, also, an open questionnaire was directed to a group of teachers that included a number of questions related to the topic of the research, therefore, the researchers saw that the current research seeks to answer the following question:

What is the strength of the correlation between the levels of depth of mathematical knowledge and information processing skills for fifth literary grade students?

Second: Research Importance

The levels of depth of knowledge include many complex and simple mental abilities, as well as many future thinking skills, higher thinking skills, as well as basic thinking skills, and because they are in line with the principles of constructivism, they take into account the amount of previous knowledge of the learner, and also enhance the levels of depth of knowledge independence in learning, and it is linked Directly with the level of desire to learn among students, and that these levels are also suitable for use in specific and non-structured topics and fields. (Al-Fayl, 2019: 251).

The importance of the current research stems from the benefits it offers to students of knowing the levels of depth of mathematical knowledge in terms of the practical aspect and how they are compatible with information processing, this research may also contribute to assisting researchers and those in charge of writing mathematics books, and mathematics teaching staff from the tests prepared by the researcher or submitting proposals, it may also contribute to raising the learner's competencies and abilities, as the levels of depth of knowledge and information processing skills provide a different approach to organizing knowledge, in which this depth of knowledge varies in complexity according to the class, and what the student must know, and what he must be able to transfer to different situations.

Third: Research Objective

The current research aims to study the correlation between the depth of mathematical knowledge and information processing among the literary fifth grade students in the Rusafa 2nd, Education Directorate.

Fourth: Research Hypothesis

* There is no statistically significant correlation at the significance level (0.05) between the depth of mathematical knowledge and information processing for the fifth literary grade students.

Fifth: Research Limit: This research was limited to:

1_ Directorate of Education of Baghdad Governorate, Rusafa 2nd.

2_ Students of the fifth literary grade for the academic year 2020-2021 within the directorate.

3_ levels of depth of mathematical knowledge (remembering and reproduction, application of concepts and skills, Strategic thinking, extended thinking).

4_ Information processing skills (observation, interpretation, summarization, recognition of mathematical relationships and patterns, application, evaluation).

Sixth: Define terms

1- Depth of mathematical knowledge:

Webb (2002) defined it as an educational process that requires teachers to explain the depth in which the teaching takes place, and teachers must reflect this depth and define the purpose of their education to students, and thus evaluate students on the information that must be retained for lifelong learning. (Webb,2002:88)

The researchers define it procedurally as: a critical examination of ideas and facts and placing them in the knowledge building and making several links between them and it is measured by answering the items of the depth of knowledge test that were prepared for them.

2- Information processing: defined by (Schmeck, 1983): It is the process that contains organizing and dealing with many activities within the brain that individuals prefer to perform, and these processes range from superficial to the depth in which this information is processed. (Schmeck, 1983: 221)

The researchers define it procedurally as: It is the ability of the literary fifth students to receive information and make modifications to it and store it to recall it when needed, this is known by answering the items of the information processing test prepared for them.

2. Chapter two: theoretical background and previous studies

First Axis: Theoretical Background

First: Depth of Mathematical Knowledge

The depth of knowledge is one of the models of thinking based on the organization of knowledge in the mental structure of the student with a path of varying complexity to the occurrence of meaningful learning, as it depends on the way of thinking that the student walks in linking the new problems with his experiences and the old in a more complex way than he follows in other ways of thinking because this style of thinking depends on the student's previous knowledge and his ability to build recent experiences and generalizations. (Viator, 2010: 23)

The literature indicated that the levels of depth of knowledge are four levels:

First level: Remembering and Reproduction: This level includes the person remembering the facts and information that exist mainly in his cognitive structure, and the person can also perform some cognitive operations on what he may remember. (Webb, 2006: 95)

Second level: the application of concepts and skills: In this level, it requires comparing events, places and concepts, and reformulating information from one form to another, it also asks to sort and classify things into meaningful categories, to explain or describe problems, issues, and patterns, and to clarify the relationships between importance, cause and effect, this level goes beyond the first level, as this level requires more than recalling, describing, answering or explaining information and answering questions (why or how). (Mississippi State University, 2009)

Level Three: Strategic Thinking: At this level, students make specific and specific plans to solve the problems they encounter, whether these problems are on the ground or scientific, by coordinating skills and knowledge, as it requires higher levels of thinking such as synthesis, analysis, evaluation, and logic. (Khadri, 2014:297)

Fourth level: Extended thinking: It is also called extended strategic thinking, this level requires the use of higher-order thinking processes such as reflection, synthesis, modification and evaluation of plans over time, in conducting investigations to solve real-world problems, students participate, with unpredictable results, this level has a key feature which is the sustainability and employment of strategic thinking processes for a longer period of time to solve the problem. (Hess, 2013: 6-20)

Second: information processing

The cognitive processes of students are related to individual differences, as they are represented in their different ability to summarize, interpret and find relationships between information and how to retrieve it, which

causes different levels of information processing for them and also differ in cognitive processes in all different situations (Wilson, 1988:323)

The information processing orientation considers cognitive processes thinking, perception, attention, memory, concept formation, decision making and problem solving as related activities of the cognitive activities that the learner may perform in different situations in his life, therefor understanding the functions of these processes and their mechanism of action, as well as their relationship to other processes, which is the scientific study of the method of forming and processing information. (Al-Sharqawi, 199960)

Information processing skills: Information processing skills are divided into several sections:

1- Observation skill:

Through observation, it is possible to communicate with the world through the senses, and there are two types of observation, which are indirect observation and direct observation that can be observed from the incidents and behaviors around us, as for the indirect, it emerges when reading a specific topic in a book, because through this information, our environmental information will expand, when the individual notices a situation or experience, he retrieves his existing or stored notes and will link them together to reach the correct decision. (Ghanim, 1995: 212-211)

The effectiveness of this skill is the effectiveness of the five senses and their ability to take information. (Ali, 2008: 14)

Observation means taking impressions about the things around them where you need the learner to be attentive and aware of the variables that occur if a certain situation occurs on a new issue, and here comes the role of the teacher in developing the learner's observation skill by encouraging and directing them to use all their senses. (Al-Issa, 2009: 19)

Observation is also defined as the person obtaining information from the environment by employing one or more of his senses, as the human senses are windows to the outside world and observation is the focus of the cognitive focus of the human being, on the other hand, observation is an important skill in various subjects, as it is important in many scientific processes such as scientific inference, hypothesis formulation, and classification. (Abu Jadu and Muhammad, 2010: 83)

2- Interpretation skill: Interpretation is the mental processes through which a person judges the proposed conclusions, and whether they will be logically arranged with the information provided to him or not? Provided that this information is correct. (Ali, 2008: 98)

Interpretation works to identify the problem or situation and to identify logical explanations, it also decides later whether these results based on the information are acceptable or not and also represents the expression of broad indications of standards, experiments, rules, procedures or data. (Al-Atoom,:2004 217)

Interpretation is a mental process aimed at adding meanings to our experiences or extracting meanings from them, as it explains the meaning that the new information has revealed, as it gives details that support our interpretation of an experience, it may take the form of pictures, maps, data, or tables, so he interprets what he is looking at, and these explanations may be sufficient or insufficient and they may be only guesses. (Abdul Aziz, 2009: 182)

3- Summarization skill: It is the ability to reformulate the visual, written or even audio material by scanning concepts, ideas and vocabulary, distinguishing what is essential and non-essential, and treating the ideas and concepts contained in the language of the person who summarizes its purpose to obtain a summary of the basic ideas in it and express them clearly and concisely, and it depends on reading between the lines, linking, abstracting and revising the salient points, and reformulating the main ideas or idea that are the heart of the subject and what is required in the analysis to analyze the scientific material and determine the importance of its components and take a decision on what can be omitted or kept in it. (Jarwan: 1999 217)

It is an important skill for the learner’s comprehension process, so learning and training it is important, especially in the written summary. (Abu Jadu and Nofal, 2010: 103)

4- The skill of recognizing relationships and mathematical patterns: The Council of Mathematics Teachers NCTM, 1989 emphasized that one of the important competencies is the awareness of relationships and their

patterns, as it indicated that mathematics curricula must contain continuous growth to discover relationships and patterns, as the student acquires the abilities to represent relationships and their patterns and derivation as well as Describe laws, geometric shapes, and graphs, as well as analyze relationships and mathematical patterns, to show how a change that occurs in a certain quantity results in a change in another quantity, and the possibility of using open sentences to indicate different relationships. (NCTM,23-82:1989)

Jarwan referred to it as perceiving and understanding the elements of a problem or situation in a way that leads to its reformulation, structure, understanding and solution, this process takes many forms, including the identification of mathematical relationships and patterns through mathematical inference, verbal reasoning, numerical reasoning, spatial reasoning, or solving problems involving the loneliness of mind or insight. (Jarwan, 1999:69)

5- Evaluation: is the ability of the learner to make a judgment about the ideas in the text and work to convince others of them. (Shehata, 1991: 211)

Jarwan referred to it as "a thinking process that includes a careful examination of the subject in order to identify the strengths and weaknesses in it by analyzing the subject and evaluating it based on criteria taken as a basis for criticism and judgments, and these criteria may be specified before the evaluation process is exercised, in the case, the criteria may not be implicitly understood from the reality of the phrases used." (Jarwan, 1999: 315)

3. The second axis: previous studies

First: Studies that dealt with the depth of mathematical knowledge

1- Al-Fayl study, Mohamed Helmy (Egypt, 2018): which aimed to identify the effect of a proposed program to employ the scenario-based learning model in education in developing levels of depth of knowledge and also to identify the effect of the proposed program in reducing mental wandering and finally revealing the sustainability of the program's effect The proposal to employ the scenario-based learning model in developing the levels of depth of mathematical knowledge among students of the Faculty of Education for the quality of the University of Alexandria

2- Study of Abdel Malak, Maryam Moussa Matti (Egypt, 2020)

Which aimed to study the effect of using the realistic mathematics strategy to develop the levels of depth of mathematical knowledge and improve the desire to learn mathematics among secondary school students in Kharga city in the New Valley

3- The study of Abdel Rahim, Mohamed Hassan Abdel Shafi (Egypt, 2020):

Which aimed to identify the effect of using generative learning in developing the levels of depth of mathematical knowledge and confidence in the ability to learn mathematics among third-grade students in the preparatory stage.

4. The research followed the experimental method

Second: Studies that dealt with information processing:

1- Al-Jawahiri, Muhammad Abbas (2015):

The aim of the research is to identify the effect of mathematical information processing strategies on the achievement of secondary school students and their inferential thinking in mathematics.

2- Al-Mayouf, Rafid Bahr, and Areej Khader Hassan (2012):

It aimed to know the effect of teaching mathematical information processing skills on decision-making skills among students of mathematics departments in the colleges of education at the University of Baghdad.

3- Karim's research, Safa Khudair (2017):

The aim of this research is to find out the relationship between the skills of mathematical information processing with high-order thinking for students of mathematics departments in the faculties of education.

5. Chapter Three: Research Procedures

First: Research Method

The descriptive approach has been adopted because it is concerned with studying phenomena and events as they are in terms of their forms, characteristics and the factors affecting them, where the present of these phenomena and events is known through their description and accompanying all aspects and dimensions in order to derive solutions and determine the causes and relationships that caused the emergence of these events as well as identifying the relationships with each other and the influencing factors out. (Dashley, 2016: 41)

Second: Research Community

The community in this research is represented by all secondary school students in the morning study in the Baghdad Governorate / Al-Rusafa 2nd, which is affiliated with the Rusafa 2nd, Directorate for the academic year 2020/2021.

It was restricted to male schools without females, as the number of students of the Rusafa 2nd, Education Directorate reached (131,721) students distributed among 298 schools.

Third: Research sample: The statistical analysis sample was chosen by random method, and the sample size was (400) students from the literary fifth stage in the Rusafa 2nd, Education Directorate.

Fourth: Research Tools: The main objective of this research is to study the relationship between the levels of depth of mathematical knowledge and information processing skills for the secondary stage, the construction of two tests requires a test that measures the levels of depth of mathematical knowledge and another that measures information processing skills, the construction process requires going through several stages:

1- Determine the purpose of the two tests:

The primary objective of the two tests is to measure the levels of depth of mathematical knowledge and information processing skills for fifth-grade literary students.

2- Determining the levels of depth of mathematical knowledge and information processing skills:

In determining the levels of depth of mathematical knowledge and information processing skills, the researchers relied on the educational literature and consulting arbitrators in mathematics and methods of teaching mathematics.

3- Presenting the levels of depth of knowledge and information processing skills to a number of arbitrators:

After the levels of the depth of mathematical knowledge and information processing skills were determined, they were presented to a number of arbitrators in the field of mathematics and methods of teaching mathematics to express their opinions on the extent and suitability of the research sample and in the light of their opinions, the researcher identified these appropriate levels for her research and the agreement of arbitrators was (88%).

4- Determining the scientific material:

Determining the scientific material that will be the test items by looking at the content of the scientific material for the stage and on other sources that are useful in this aspect.

5- Formulation of items **for the two tests: (**28) items were formulated to test the levels of depth of knowledge, and (24) items were formulated to test information processing.

6- Drafting instructions for items:

The instructions for the two tests have been formulated, which contain how to read the questions and not leave any item, and the answer will be on the question paper as well as trying to finish the two tests to the end and also will need intuitive speed and perception to answer these items, as the instructions for the two tests are for the purpose of scientific research and students must answer all items .

7- Applying the test to the sample: After verifying the possibility of applying the two tests and the clarity of the instructions in them, the two tests were applied to a sample of (400) students from the literary branch distributed among a group of boys' schools affiliated to the Rusafa 2nd, Education Directorate on February 14, 2021.

8- Correcting the two tests: after presenting the typical answers to the items of the depth of mathematical knowledge and information processing for a number of arbitrators in mathematics and methods of teaching mathematics to ensure that they are typical solutions for these items and to rely on them in the correction, the distribution of scores for the test items varied, so the scores ranged between (2-6) so that each item took its appropriate degree of scores, and accordingly, the total score of the Mathematical Knowledge Depth Test became (89) degrees, accordingly, the total score for the test became (50) degrees.

9- Statistical analysis of the two test items: the researchers arranged the students' answers in descending order after completing the correction of the two tests, and the percentage of the upper group was (27%) of those with higher scores, as for the percentage of the lowest group (27%) of those with lower grades, the number of students in each group was 108 students. The indicators of statistical analysis include the following:

A- Difficulty coefficient for the two test items:

The calculation of the difficulty coefficient is necessary in the statistical analysis of the items of the two tests, and through it, the deletion of the item that is difficult or very easy is determined, the difficulty coefficients for testing the depth of knowledge ranged between (0.58-0.31) and the difficulty coefficients for the information processing test (0.57-0.33) and from the solution of extracting the results it was found that all the items of the two tests are acceptable and within the specified range as indicated by many sources, as indicated by (Odeh and Fathi, 1987) that the item that is within the distribution of the difficulty coefficient whose range ranges between (0.80-0.20) is acceptable. (Odeh and Fathi, 1987: 128)

B- Discriminatory power of the test items: the researchers used the appropriate equation for the discrimination factor and found that the degree of discrimination for the items of the mathematical knowledge depth test ranged (0.65-0.30), while the discrimination coefficient of the information processing test items ranged (0.54-0.30) and all items were acceptable, as it indicates (Al-Dhahir et al., 1999) that the item is acceptable if its discrimination coefficient is (20%) or more, and it is weak when it is less than this percentage, and it is recommended to delete it, accordingly, all test items are acceptable in their distinction. (Al-Dhahir et al., 1999:132)

10- Ascertaining psychometric properties: it includes validity and stability

A- Validity: The validity of the test was verified in two ways:

1- Face validity: All items of the two tests were presented in their initial form to the arbitrators in the field of mathematics and methods of teaching mathematics to verify the extent to which the items represent and suit the field to be measured and for the test as a whole.

2- The validity of the construction of the two tests: The validity of the construction was verified by using the following methods:

- The correlation coefficient of the scores of each item with the scores of its field:

It was verified by finding the Pearson correlation coefficient between the degree of each item with the degree of its field. The results ranged in the depth of mathematical knowledge test (**0.672-**0.454) and in the information processing test (**0.627-**0.436), which is statistically significant.

- Correlation coefficient between the scores of each field and the overall test score: The Pearson correlation coefficient was based on the scores of each field of the total test score, and it ranged in the Mathematical Knowledge Depth Test (**0.534-**0.263), as for the information processing test, it ranged (0.593-**0.261) and it was found that all the coefficients are statistically significant.
- Correlation coefficient between the scores of each item and the overall test score:

It was verified by using the Pearson correlation coefficient between the scores of each item with the overall test score, and it was found that all correlation coefficients are statistically significant, the results of the mathematical knowledge depth test ranged (**0.734-**0.667) and in the information processing test (**0.689-**0.589), it was found that all the coefficients are statistically significant.

B - Stability: The researchers relied on the stability of the mathematical knowledge depth test on the Alpha-Cronbach equation to find the stability of the mathematical knowledge depth test to the degrees of the statistical analysis sample in order to ensure the homogeneity and consistency of the answers to the general test items, the coefficient of stability of the mathematical knowledge depth test reached (86%), as well as the use of the Alpha-Cronbach equation to find the stability of the information processing test, as it reached (84%), as (Al-Assaf, 2003) indicates that the test is characterized by stability if the value of its stability is (67%) and above. (Al-Assaf, 2003:237)

Fifth: The final application of the two tests on the research sample:

After the researchers verified the possibility of applying the two tests and the clarity of the instructions in them, the two tests were applied to a sample of (400) students of the fifth preparatory grade of the literary branch distributed over a group of boys' schools affiliated to the Rusafa 2nd, Education Directorate on February 15, 2021.

6. Chapter Four: The results and its interpretation

First: Presentation and interpretation of the research results:

This chapter includes a presentation of the results related to the research objectives by answering the following question:

What is the strength of the correlation between the levels of depth of mathematical knowledge and information processing skills among secondary school students?

The hypothesis has been derived (there is no statistically significant correlation at the significance level of 0.05 between the depth of mathematical knowledge and information processing among fifth-grade literary students).

Variable	Arithmetic mean	standard deviation	Calculated correlation coefficients	tabular correlation coefficients	indication
Depth of mathematical knowledge	33.39	19.75	0.196	0.098**	There is a relationship
Data processing	18.84	9.875			

From the above table, it was found that the arithmetic mean for the depth of mathematical knowledge is (33.3850) and with a standard deviation (19.7507), while the arithmetic mean for information processing is (18.8350) and with a standard deviation (9.87479) and when Pearson's correlation coefficient was used to reveal the relationship between the two research variables, it turned out that (**0.098), which is significant at the level of significance (0.05), which is a positive correlation because the correlation coefficient ranged between (1_0) and this indicates that there is a correlation between the depth of mathematical knowledge and information processing, meaning that when students increase their depth of mathematical knowledge, their possession of information processing increases.

Second: Conclusions: From the results of the research, the following can be concluded:

1- Literary fifth grade students do not have a deep mathematical knowledge.

2- Literary fifth grade students do not have information processing skills.

3- There is a correlation between the depth of mathematical knowledge and information processing.

Third: Recommendations: Based on the previous results, we recommend the following:

1- Paying attention to ways and methods that can develop the levels of depth of mathematical knowledge and information processing among secondary school students in general.

2- Pushing both teachers and students to pay attention to the levels of depth of mathematical knowledge and information processing skills, and to move away from routine methods of presenting the educational material.

3- The development of scientific curricula and the inclusion of examples with procedural steps using the levels of depth of mathematical knowledge and information processing skills.

4- Attention to training teachers on how to employ information processing skills and link them to practical life.

5- Diversity of activities given to students of the fifth literary grade, which develop their depth of mathematical knowledge and information processing skills.

Fourth: Suggestions

1- Expanding the scope of studies and research for the depth of mathematical knowledge.

2- A study dealing with the depth of mathematical knowledge and its relationship to information processing for the primary classes.

3- Building a training program for secondary school students according to the levels of depth of mathematical knowledge and information processing skills and their impact on some variables.

4- The effect of using information processing skills in developing the levels of depth of mathematical knowledge for students of the colleges of education, department of mathematics.

References

1. Abu Jado, Saleh Muhammad Ali (2009): "Educational Psychology", 7th edition, Dar Al Masirah for Publishing, Distribution and Printing, Amman.
2. Jarwan, Fathi (1999): "Teaching Thinking, Concepts and Applications", Dar Al-Kitab Al-Jami, Amman.
3. Al-Sharqawi, Anwar Mohamed (1999): "Perception in Forms and Information Processing", Ain Shams University, Cairo.
4. Al-Dhahir, Zakaria Muhammad, and others (1999): “Principles of Measurement and Evaluation in Education, Dar Al-thaqafa, Jordan.
5. Al-Atoum, Adnan Youssef (2004): "Cognitive Psychology, Theory and Application", Al-Masirah and Printing, Amman.
6. Al-Assaf Saleh bin Hamad (2003): "The Introduction to Research in Behavioral Sciences", Al-Obaikan Library, Riyadh.

7. Al-Mayouf, Rafid Bahr and Areej Khuder Hassan (2012): "The effect of teaching mathematical information processing skills in decision-making skills among students of mathematics departments in the colleges of education in Baghdad Governorate", published research, Anbar University Journal for Human Sciences, No. 4, Iraq.
8. Al-Fayl, Helmy (2019): "Modern educational variables on the Arab environment", Anglo-Egyptian Library, Cairo, Egypt.
9. Al-Jawahiri, Muhammad Abbas (2015): "The effect of strategies for processing mathematical information on the achievement of secondary school students and their inferential thinking" published research, College of Education - Ibn Al-Haytham / University of Baghdad, Iraq.
10. Ali, Ismail Ibrahim (2008): "Critical Thinking (Between Theory and Practice), Dar Al-Kutb wa Al-Wathaaq, Baghdad, Iraq.
11. HS, S. ., & S, S. (2021). Scientific Approach in Improving Science Learning Activities of Madrasah Ibtidaiyah Students. Middle Eastern Journal of Research in Education and Social Sciences, 2(2), 85-109. https://doi.org/10.47631/mejress.v2i2.227
12. Odeh, Ahmed Suleiman and Fathi Hassan Malkawi (1987): "The basics of scientific research in education and human sciences, its elements, curricula, and statistical analysis of its data", 1st ed., Al-Manar Library for Publishing, Amman, Jordan.
13. Karim, Safa Khudair (2017): "Mathematical information processing skills and their relationship to high-ranking thinking skills for students of mathematics departments in colleges of education", published research, College of Education - Ibn Al-Haytham / University of Baghdad, Iraq.
14. Ghanem, Mahmoud Muhammad (1995): "Children's Thinking: Its Development and Methods of Teaching", 1, Dar Al-Fikr, Amman, Jordan.
15. Webb, N ،L. (2002) Depth of knowledge levels for four content areas language Arts, 28 (March).
16. National Councit of Teachers of Mathematics (NCTM), URL "Curriculum and evaluation standards for school Mathematics" (1989).
17. Wilson.J.E. ,(1988):"Implication of Learning strategy research and training what is has to say to the Practitioner", California, academic press
18. Schmeck , R. R. (1983):"Learning Styles of College Student, Individual Difference in Cognition" .Academic Press Inc, London
19. Hess, K., Jones, B., Carlock, D & Walkup, J. (2009). Cognitive Rigor: Blending the Strengths of Bloom's Taxonomy and Webb's Depth of Knowledge to Enhance Classroom-level Process "Academic Press