
The effectiveness of a training program based on brain research principles in developing teaching mathematical proficiency skills among primary school mathematics teachers

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ABSTRACT- The study aimed to develop the mathematics proficiency teaching skills of primary school mathematics teachers through a training program based on the principles of brain-based learning; the experimental method was used; the sample consist of (20) primary school mathematics teachers. Findings: There are statistically significant differences at the significance level ($\alpha \geq 0.05$) between the mean scores of mathematics teachers in the primary stage for the skills (planning, implementation and evaluation) in teaching mathematical proficiency in the pre and post applications of the observation card in favor of post application with a high degree, where the mean gain ratio between the pre and post applications, for the teaching skills in mathematics proficiency as a whole (1,27), the skills of teaching mathematical virtuosity separately in planning the teaching of mathematical proficiency (1,26), implementing the teaching of mathematical proficiency (1,30), evaluating the teaching of mathematical proficiency (1,23), all values are greater than (1.2).

KEYWORDS: Principles of Learning Based on Brain Researches, Teaching Skills, Mathematical Proficiency.

I. INTRODUCTION

The current era is witnessing a great acceleration towards scientific achievements, which are based on recent developments, especially in the field of teaching mathematics. The mathematics teacher is an active and influential element in any educational system. The interest in preparing, qualifying and in-service training became a guarantee of obtaining effective educational outcomes and access to learners who were characterized by mathematical competence in their thinking and abilities, and who possessed skills in solving mathematical problems. This is achieved by preparing teachers and in-service training, developing their knowledge and teaching skills based on latest global trends, and improving their teaching methods. This helps teachers to be proficient in mathematics and achieve success in math learning and teaching.

In this context, the National Council of Teachers of Mathematics (NCTM) stated that the main objective of teacher's professional development is to improve learner learning through improving teaching (NCTM, 2010). NCTM determined several axes for professional growth: building the teacher's mathematical knowledge, the ability to employ it in teaching skills, this supports that the teacher's mathematical knowledge has a fundamental impact on learners' achievement in mathematics (Hill, Rowan& Ball, 2005; Jacobs, Franke, Carpenter, Levi& Battey, 2007).

The National Research Council of the United States of America indicated in its document issued (NRC, 2001) that during the twentieth century the meaning of success in learning mathematics underwent several transformations in response to societal and educational changes; success in learning mathematics means the skill in performing arithmetic operations in various mathematical topics while emphasizing the understanding of these operations, and the associated algorithms.

Mathematical proficiency investigation requires the presence of a teacher capable of managing the educational process and achieving its objectives, characterized by his ability to communicate the necessary concepts to learners, enabling them to acquire the skills and various procedures necessary for those concepts, and the ability to enable learners to formulate a mathematical problem, identify its requirements and solve, and this is not achieved without teachers understand how to develop learners' mathematical proficiency (Kilpatrick, Swafford & Findell, 2001).

According to Kamla Al-Omari (2017) the mathematics teacher must be able to master mathematical proficiency, as if we want to develop the teaching process, and introduce new teaching concepts and skills, it is necessary to focus on the presence of these skills and to establish it well with the teacher, which is one of the main pillars in achieving the goal of providing learners with mathematical proficiency.

The educational process is closely related to the learning theories that guide its work, and brain based learning theory based has emerged as a comprehensive approach to teaching and learning. So that it makes learners more productive, teachers less frustrated, and changes teachers' view of learners, and this theory is based on the structure and function of the brain, as long as the brain is not prevented from performing its natural processes, learning will occur, which is not only supported by neuroscience, but it backed by cognitive psychology research; Therefore, research based on linking brain science with cognitive psychology increases understanding of the basic processes of learning and memory, and this should lead to applications that can improve education, improve quality of life and increase productivity, as there are expectations about brain science and neuroscience that brain science will accommodate all behavioral sciences and cognitive sciences (Susan Kovalik and Karen Olsen, 2004).

Qatami and Al-Mashaaleh (2007) mentioned that brain-based learning is one of the modern theories and trends in the current century, which consider that learning is the greatest function of the brain, and that learning is the result of physical and actual growth of the brain. Neuroticism grows as the environment is rich. The more the individual interacts in an appropriate and safe manner, the easier, more flexible and deeper the learning situations become.

Also, brain based learning depends on several principles that form the first building block in giving learning its true meaning, and these principles are summarized in: the brain is a living, dynamic system, and the brain is of a social nature. The search for meaning is innate; The brain searches for meaning through patterns. Emotions are important and necessary for the formation of patterns. The brain automatically perceives the parts and the whole. Learning involves both attention and perception of side stimuli. Learning includes conscious and unconscious processes, and everyone has at least two ways of organizing memory. Learning has a characteristic of growth and development, and excitement and challenge enhance learning, and threats and tension suppress and impede it (Afaneh and Al-Jaish, 2009, p. 105).

Educators seek, in light of the tremendous results of research revealed by neuroscience about the structure, dynamics and functions of the brain, to benefit from these results and use them in the educational process. One of this pursuit was the emergence of educational neurology as a modern educational path that seeks to integrate the fields of neuroscience, psychology and education to reach a better understanding of how to learn (Munira Al-Kiyumi & Olayan, 2019).

Accordingly, there is an importance for training the mathematical teacher in the primary stage in-service, and designing and implementing training programs that are consistent with recent developments and trends in mathematical education and learning, and the development of teaching skills that fit with his new roles after changing the view of them in the educational process with the aim of effectively and successfully improving mathematics learning outcomes for learners.

II. METHODOLOGY

The current study followed the experimental method, and the researcher used a quasi-experimental design based on one group of mathematics teachers in the primary school with a pre- and post-application.

A. Study population and sample:

The target population of the current study is all primary school mathematics female teachers who work at

schools affiliated to the Muzahimiyah Education Office in Al Muzahimiyah Governorate, in KSA, which are (59) female teachers. The current study sample consisted of (20) female primary school mathematics teachers who work in government public education schools affiliated to the Muzahimiyah Education Office in Al-Muzahimiyah Governorate.

B. Inclusion criteria:

The trainees were selected according to the following criteria:

- Specializations and qualifications for teaching mathematics at the primary level.
- Has training courses in teaching the developed mathematics curricula of the McGraw-Hill series for the primary stage, and has the specialized, developmental and technical programs of the Mathematics and Natural Sciences Development Project implemented by the Mathematics Supervisor at the Muzahimiyah Education Office or the Training Department.
- They have never received a scientific or theoretical course in the skills of teaching mathematical proficiency.
- They have never been trained in the skills of teaching mathematical proficiency.

C. Data collection:

The researcher designed the study tool, which is the observation card for: "Skills of Teaching Mathematical

Proficiency", which is considered the most appropriate for the nature of the current study problem.

The researcher determined the objective of the observation card in measuring the skills of teaching mathematical proficiency among female mathematics teachers in the primary stage (the study sample) before and after the implementation of the training program. The three areas of skills in the observation card were identified as (Planning - implementation – Evaluation) skills for teaching mathematical proficiency.

The observation card included (52) skills, which were divided into three main domains: The planning skills for teaching mathematical proficiency that consists of (5) sub-skills, and (17) performance indicators. The second domain: The implementation skills for teaching mathematical proficiency that consists of (6) sub-skills, and (21) performance indicators. The third domain: The evaluation skills for teaching mathematical proficiency that consists of (3) sub-skills, and (11) performance indicators. The observation card has been prepared according to the five-point Likert Scale, which includes (very high, high, medium, low, and very low).

D. Training Program Time Plan:

The implementation of the training program takes approximately four weeks, provided that it is four sessions per week, and for a period of four hours for the two sessions per day, with a break of half an hour between them, as the duration of the training program is (32) training hours in total, distributed over eight training days.

III. RESULTS

The first question of the study states: "What is the effectiveness of a training program based on the principles of brain research-based learning in developing planning skills for teaching mathematical proficiency among primary school mathematics teachers?"

TABLE (1): WILCOXON TEST (Z) OF PRE AND POST APPLICATION OF PLANNING SKILLS FOR TEACHING MATHEMATICAL PROFICIENCY

Planning skills	Application	N	Arithmetic mean	Standard deviation	Average rank	Total ranks	Z. value	Significance level
Planning Instructional Objectives	Pre	20	1.73	0.472	10.50	210	3.961	0.01
	Post	20	4.20	0.441				Significance
Planning Teaching Content	Pre	20	1.76	0.417	10.50	210	3.933	0.01
	Post	20	4.40	0.425				Significance
Planning Materials and	Pre	20	1.40	0.352	10.50	210	3.938	0.01

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Aids for teaching	Post	20	3.97	0.340				Significance
Planning teaching procedures and activities	Pre	20	1.29	0.168	10.50	210	3.981	0.01
	Post	20	3.99	0.401				Significance
Planning Evaluation methods	Pre	20	1.60	0.297	10.50	210	3.939	0.01
	Post	20	4.10	0.279				Significance
Total	Pre	20	1.56	0.205	10.50	210	3.921	0.01
	Post	20	4.13	0.225				Significance

Table (1) illustrated that the mean scores of primary school mathematics female teachers in planning skills for teaching mathematical proficiency in (Instructional objectives, teaching content, materials and means necessary for teaching, teaching procedures and activities, evaluation methods, and skills as a whole) in the post-application respectively amounted to (4.20, 4.40, 3.97, 3.99, 4.10, 4.13), which is greater than the mean scores of the pre-application, which were (1.73, 1.76, 1.40, 1.29, 1.60, 1.56). This indicates that there is a difference between the mean scores of mathematics teachers at the primary stage in the pre and post applications of planning skills for teaching mathematical proficiency.

To make sure of this, the researcher calculated Black's adjusted gain equation to reveal the effectiveness of the training program based on the principles of learning based on brain research in developing planning skills for teaching mathematical proficiency, among female mathematics teachers at the primary stage, table (2) illustrates this:

TABLE (2): ADJUSTED GAIN EQUATION TO REVEAL THE EFFECTIVENESS OF THE TRAINING PROGRAM BASED ON THE PRINCIPLES OF LEARNING BASED ON BRAIN RESEARCH IN DEVELOPING PLANNING SKILLS FOR TEACHING MATHEMATICAL PROFICIENCY

Planning skills for teaching mathematical proficiency	Average pre-application	average post-application	Final score	adjusted gain
Planning instructional objectives	1.76	4.4	5	1.34
Planning teaching content	1.29	3.99	5	1.27
Planning materials and aids for teaching	1.73	4.20	5	1.25
Planning teaching procedures and activities	1.6	4.1	5	1.24
Planning evaluation methods	1.4	3.97	5	1.23
Planning skills for holistic teaching of mathematical proficiency	1.56	4.13	5	1.26

Table (2) illustrated that the use of the training program based on the principles of learning based on brain research is highly effective in developing planning skills to teach mathematical proficiency among female mathematics teachers at the primary stage.

The second question of the study states: "What is the effectiveness of a training program based on the principles of learning based on brain research in developing implementation skills for teaching mathematics proficiency among primary school mathematics teachers?"

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TABLE (3): THE SIGNIFICANCE OF THE DIFFERENCES BETWEEN THE SCORES OF THE EXPERIMENTAL GROUP MEMBERS IN THE PRE AND POST APPLICATION OF IMPLEMENTATION SKILLS FOR TEACHING MATHEMATICAL PROFICIENCY

Implementation skills	Application	N	Arithmetic mean	Standard deviation	Average rank	Total ranks	Z. value	Significance level
Excitement and activation	Pre	20	1.05	0.154	10.50	210	3.984	0.01
	Post	20	4.25	0.473				Significance
exploration	Pre	20	1.35	0.297	10.50	210	3.934	0.01
	Post	20	4.10	0.440				Significance
Interpretation and clarification	Pre	20	1.52	0.452	10.50	210	3.934	0.01
	Post	20	4.17	0.412				Significance
expansion	Pre	20	1.56	0.201	10.50	210	3.942	0.01
	Post	20	4.17	0.380				Significance
Connectivity and integration	Pre	20	1.70	0.377	10.50	210	3.930	0.01
	Post	20	4.25	0.397				Significance
examination (test)	Pre	20	1.55	0.329	10.50	210	3.935	0.01
	Post	20	4.00	0.375				Significance
Total	Pre	20	1.45	0.162	10.50	210	3.921	0.01
	Post	20	4.16	0.141				Significance

Table (3) illustrated that the mean scores of mathematics teachers at the primary stage in implementation skills for teaching mathematical proficiency in (excitement and activation, activation, exploration, interpretation and clarification, expansion, connectivity and integration, examination, and skills as a whole) in the post application, respectively, amounted to (4.25, 4.10, 4.17, 4.17, 4.25, 4.00, 4.16), which is greater than the mean scores of the pre-application, which respectively (1.05, 1.35, 1.52, 1.56, 1.70, 1.55, 1.45); This indicates that there is a difference between the mean scores of mathematics teachers at the primary stage in the two applications, pre and post, of implementation skills for teaching mathematical proficiency. To make sure of this, the researcher calculated Black's adjusted gain equation to reveal the effectiveness of the training program based on the principles of learning based on brain research in developing implementation skills for teaching mathematical proficiency among female mathematics teachers at the primary stage, and table (4) illustrates this:

TABLE (4): ADJUSTED GAIN EQUATION TO REVEAL THE EFFECTIVENESS OF THE TRAINING PROGRAM BASED ON THE PRINCIPLES OF LEARNING BASED ON BRAIN RESEARCH IN DEVELOPING IMPLEMENTATION SKILLS FOR TEACHING MATHEMATICAL PROFICIENCY

Implementation skills	Average pre-application	Average post-application	The final score	Adjusted gain
Excitement and activation	1.05	4.25	5	1.45
exploration	1.35	4.10	5	1.30
Explanation and clarification	1.52	4.17	5	1.29
expansion	1.56	4.17	5	1.28
Connectivity and integration	1.70	4.25	5	1.28
examination (test)	1.55	4.00	5	1.20
Total	1.46	4.16	5	1.30

Table (4) illustrated that the use of the training program based on the principles of learning based on brain research is characterized by a high degree of effectiveness in developing implementation skills for teaching mathematical proficiency among primary school mathematics teachers.

The third question of the study states: "What is the effectiveness of a training program based on the principles of learning based on brain research in developing evaluation skills for teaching mathematics proficiency among primary school mathematics teachers?"

TABLE (5): THE SIGNIFICANCE OF THE DIFFERENCES BETWEEN THE SCORES OF THE EXPERIMENTAL GROUP MEMBERS IN THE PRE AND POST APPLICATION OF EVALUATION SKILLS FOR TEACHING MATHEMATICAL PROFICIENCY

Evaluation skills	Application	N	Arithmetic mean	Standard deviation	Average rank	Total ranks	Z. value	Significance level
Knowledge recall evaluation	Pre	20	1.55	0.394	10.50	210	3.946	0.01
	Post	20	4.10	0.384				Significance
Employing feedback	Pre	20	1.24	0.175	10.50	210	3.934	0.01
	Post	20	3.82	0.280				Significance
Evaluation tools	Pre	20	1.45	0.330	10.50	210	3.965	0.01
	Post	20	4.04	0.356				Significance
Total	Pre	20	1.41	0.246	10.50	210	3.921	0.01
	Post	20	3.98	0.196				Significance

Table (5) illustrated that the mean scores of primary school mathematics teachers in evaluation skills for teaching mathematical proficiency (knowledge recall evaluation, employing feedback, evaluation tools, and skills as a whole) in the post application amounted to (4.10, 3.82, 4.04, 3.98), which is greater than the mean scores of the pre application, which were (1.55, 1.24, 1.45, 1.41), and this indicates that there is a difference between the mean scores of mathematics teachers at the primary stage in the pre and post applications of evaluation skills for teaching mathematical proficiency. To make sure of this, the researcher calculated Black's adjusted gain equation to reveal the effectiveness of the training program based on the principles of learning, based on brain research in developing evaluation skills for teaching mathematical proficiency among female mathematics teachers at the primary stage, and table (6) illustrates this:

TABLE (6): ADJUSTED GAIN EQUATION TO REVEAL THE EFFECTIVENESS OF THE TRAINING PROGRAM BASED ON THE PRINCIPLES OF LEARNING BASED ON BRAIN RESEARCH IN DEVELOPING EVALUATION SKILLS FOR TEACHING MATHEMATICAL PROFICIENCY

Evaluation skills	Average pre-application	Average post-application	The final score	Adjusted gain
Knowledge recall evaluation	1.55	4.10	5	1.25
Employing feedback	1.24	3.82	5	1.20
Evaluation tools	1.45	4.04	5	1.25
Total	1.41	3.99	5	1.23

Table (6) illustrated that the use of the training program based on the principles of learning based on brain research is characterized by a high degree of effectiveness in developing evaluation skills to teach mathematical proficiency among female mathematics teachers at the primary stage.

IV. DISCUSSION:

The results of the first question indicated that the use of the training program based on the principles of learning based on brain research is highly effective in developing planning skills to teach mathematical proficiency among primary school mathematics teachers. The researcher attributes this result to the fact that the training program based on the principles of brain research-based learning included training activities for female teachers that create meaning for learning during training, focus on the social and emotional aspects of female teachers (trainees), focus

on the whole and the part in learning, and benefit from different types of memory. The female teachers (the trainees), relying on gradualism in the mathematical and structural linkages in planning mathematics lessons in the primary stage. In addition, the classification of planning skills for teaching mathematical proficiency, which is represented in the main skill "thoughtful planning", which is subdivided into the following skills: (teaching objectives, content teaching, teaching procedures and activities, means and techniques for teaching, and evaluation methods), which were trained the mathematics teachers, according to the principles of learning based on brain research, made it more feasible and useful for them, and the program included meditative activities that required dialogue, challenge, excitement, discussion and cooperation among the trainees. The trainer presented sample plans for the mathematics lessons developed according to the McGraw-Hill series to reinforce it with the teachers (the trainees) and discuss it with them, then the trainer (the researcher) asked them during the training to develop teaching plans for some lessons in the primary stage that include the skills of studied planning from the planning skills for teaching mathematical proficiency, which contains the sub-teaching skills. As well as planning to create an rich environment in sensory stimuli such as manuals, means and technical technological programs, as well as planning for the diagnostic, formative and summative evaluation of the components of mathematical proficiency in lessons, all of this contributed to the skillful planning by the teachers and raising their skill performance in teaching planning for mathematical proficiency. These results are in agreement with the results of studies: Abdel Razek (2020); and Azza Al-Ghamdi (2019), Linda Faggins (2010), Abu Bakr et al. (2018), Bahira Al-Rabat (2018), Aly & Abdulhakeem (2016), which revealed that training programs are highly effective in covering the theoretical background of the mathematics teaching.

The results of the second question indicated that the training program based on the principles of learning based on brain research was used with a high degree of effectiveness in developing implementation skills for teaching mathematical proficiency among female mathematics teachers at the primary stage. The researcher attributes this result to the nature of the training program that relied on remote electronic training through Madrasati platform, which contained distinguished presentations in "PowerPoint" and multimedia in various forms, which worked to excite the teachers (trainees) and attract them towards training. The reliance of the training program on more than one teaching strategy through training activities that were based on active learning strategies and constructivist theory attracted the teachers' attention and reduced their boredom and routine. Also, training female teachers in a rich and secure environment via Madrasati platform (online) gave them more challenge to interact with this environment, and the technician enabled them to use the virtual classroom tools in Madrasati platform; It increases their motivation to teach successfully. The role of the training program, which provided the opportunity for the teachers (the trainees) to develop their skills in implementing the teaching of mathematical proficiency, through the training activities included in the program, which required them to teach mathematical ideas and link them together; To form a coherent whole, as well as linking it to the academic subjects and other sciences, as well as the activities included in the program that motivate the teachers and encourage to excite the learners' minds with new mathematical concepts, and encourage them to explore and interpret the various laws and facts, and to benefit from the mathematical knowledge acquired in certain situations to apply it to various mathematical problems of life. The training program relied on challenging the teachers' thinking by presenting mathematical problems from the realities of daily and everyday life, and training on how to teach them which generated desire, enthusiasm and acceptance of the challenge among teachers in implementing solutions to these mathematical problems, and helped develop the productive desire and inclination towards mathematics in their teaching. Sufficient time has been allocated in training, and the involvement of female teachers in developing the skills of teaching mathematical proficiency required by the program by relying on the diversity of training strategies for teachers, it has contributed to the expansion of concepts and the extrapolation of the laws related to them, and the mathematical relations and linking them together, thus developing their ability to teach how to link and integrate mathematical ideas with each other. This result agreed with the results of studies: Abdel Razek (2020); and Azza Al-Ghamdi (2019), Linda Faggins (2010), Hadeel Al-Juhani's study (2018), which confirms that the degree of availability of most mathematical proficiency practices among mathematics teachers is high.

The results of the third question indicated that the training program based on the learning principles based on brain research was used, which is characterized by a high degree of effectiveness in developing evaluation skills to teach mathematical proficiency among female mathematics teachers at the primary stage. The researcher attributes this result to the inclusion of the training program on training activities that require training on how evaluating the recall of conceptual and procedural knowledge, as well as how to employ feedback by considering training as an evolutionary process, as well as how to use various evaluation tools through a holistic and partial focus, during the training process. The nature of the training program that categorized evaluation skills for teaching mathematical proficiency in the main skill "efficient evaluation", which is subdivided into the following teaching skills: (recalling prior knowledge, employing feedback, and evaluation tools), in order to facilitate the training of mathematics teachers in the primary stage, which made them more realistic and vital. Inclusion in the training program of mathematical activities and problems that are appropriate for the teachers, stimulate their thinking, and help link the previous and new sports information, through how to teach recall of previous mathematical information, and build on it to form new knowledge to develop their teaching experiences. The training program included training activities that provide mathematical knowledge in the form of an integrated mathematical structure, in terms of linking previous mathematical knowledge and experiences with new mathematical knowledge, which had an impact on the teachers (the trainees) in clarifying how to teach the usefulness and value of mathematics in their different areas of life; This helped them to gain a deep understanding of the content of the mathematics curriculum during training. The training program includes training activities that help to employ direct feedback, which facilitates them to correct their thinking path and modify inappropriate ones. In addition to providing opportunities to practice diverse styles of thinking; The active positive participation of the teachers (the trainees) in all training situations, and the provision of immediate and feedback, using the trainer's applications for it, and directing the teachers to use them during the teaching evaluation, and this helped increase their enthusiasm and develop assessment skills to teach their mathematical proficiency. The training program included some alternative evaluation tools to gain their use by the teachers (the trainees) in the classroom, such as observations, checklists, periodic tests, quizzes, homework, portfolios and various projects.

Based on the foregoing, this result agreed with the results of Abdel Razeq's study (2020), Al-Taweel (2016), which indicated a high degree of effectiveness in developing evaluation skills to teach mathematical proficiency among female mathematics teachers.

V. RECOMMENDATIONS:

Depending on the results of the study, their interpretation and discussion, the researcher recommends the following:

- Applying the training program based on the principles of learning based on brain research in developing the skills of teaching mathematical proficiency for mathematics teachers in the primary stage, which was prepared by the researcher and working on developing it in proportion to the intermediate and secondary stages.
- Interest in providing training courses for mathematics teachers in the primary stage to develop their mathematical proficiency teaching skills in all areas (planning, implementation, evaluation).

REFERENCES

1. Abdel Razeq, I. (2020). The effectiveness of a training program based on brain-based learning theory for primary school mathematics teachers and its impact on developing their teaching skills. Unpublished Master's Thesis, Faculty of Education, Fayoum University, Arab Republic of Egypt.
2. Abu Bakr, A. Yusuf, A. Yahya, S. (2018). A training program to develop teaching competencies among students of colleges of education in the Kingdom of Saudi Arabia in the light of a learning theory based on brain research. *International Journal of Educational and Psychological Sciences*, (16), 12-41.
3. Afaneh, I. & Al-Gaiesh, J. (2009). *Teaching and learning with the two-sided brain*. Amman: House of Culture for Publishing.
4. Al-Ghamdi, A. (2019). The effectiveness of a proposed training program based on the theory of brain-based learning to develop the teaching skills of female mathematics teachers at the intermediate stage. *Journal of Mathematics Education*, 22 (9), 48-87.
5. Al-Juhani, H. (2018). An educational program based on the integration of the constructivist theories and brain-based learning and its effectiveness in developing mathematical knowledge for secondary school

- students. Unpublished PhD thesis, College of Social Sciences, Imam Muhammad bin Saud Islamic University, Saudi Arabia.
6. Al-Kiyumi, M. & Olayan, S. (2019). The degree of science teachers' practice of strategies consistent with the principles of brain-based learning in the schools of the second cycle of basic education in the Sultanate of Oman. *The Arab Journal of Educational and Psychological Sciences*, (6), 289-312.
 7. Al-Omari, K. (2018). A degree that enables secondary school mathematics teachers to have mathematical proficiency. Unpublished Master's Thesis, College of Social Sciences, Imam Muhammad bin Saud Islamic University, Riyadh.
 8. Al-Rabat, B. (2018). The effectiveness of a training program for mathematics teachers based on the theory of brain-based learning and the humanistic approach to developing the skills of mathematical investigations among their primary school students. *Journal of Mathematics Education*, 21 (8), 152-321.
 9. Al-Taweel, I. (2016). The reality of the teaching performance of primary school teachers in the light of the theory of education based on brain research. *The Arab Foundation for Scientific Consultation and Human Resource Development*, (53), 1-94.
 10. Aly, H. & Abdulhakeem, H. (2016). Assessment of Training Programs for Elementary Mathematics Teachers on Developed Curricula and Attitudes towards Teaching in Najran-Saudi Arabia. *Journal Education and Practice*, 7 (12), 1-6.
 11. Faggins, L. (2010). Four Elementary Teachers' Journeys into The Understanding And Application Of Mathematical Proficiency. A Dissertation Submitted To The Graduate School In Partial Fulfillment Of The Requirements For The Degree Doctor Of Education.
 12. Hill, H., Rowan, B., & Ball, D.L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Research Journal*, 42(2), 371-406
 13. Jacobs, V. R., Franke, M. L., Carpenter, T. P., Levi, L. and Battey, D. (2007). Professional development focused on children's algebraic reasoning in elementary school. *Journal for Research in Mathematics Education*, 38 (3), 258-288.
 14. Kilpatrick, J. , Swafford, J,& Findell, B. (2001). Adding it up: Helping children learn mathematics. National Academy Press Washington DCR.
 15. Kovalik, S. & Olsen, K. (2004). Exceeding Expectations A teacher's guide to applying brain research in the classroom. 2nd ed, Dammam: House of Educational Book for Publishing and Distribution.
 16. National Council of Teachers of Mathematics (NCTM). (2010). Guiding principles for mathematics curriculum and assessment. Retrieved to: <http://scimath.unl.edu/MIM/coursematerials/files/TEAC%20801/2.%20Handouts/01.%20NCTM%20Guiding%20Principles%20for%20Math%20Curriculum%20and%20Assesment.pdf>
 17. National Research Council (NRC) (2001). Adding it up: Helping Childeren Learn Mathematics, Kilpatrick, J. Swafford, and B.Findell (Eds.). Mathematics Learning Study Committee, Center for Educatiom, Division of Behavioral and Social Sciences and Education, Washington, DC: National Academy Press.