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Graph Theoretical Data Analysis Approach For Mathematical Thinking Skills Of School Students

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***Abstract*—The objectives of this research are to explore critical mathematical thinking and creative thinking of mathematical skills. The research methods and properties used at the beginning of this study, particularly in the school level mathematics skills, consisted of theoretical and literature studies, considering the rational, empirical studies conducted. When testing teaching materials and instruments that are interactive of critical and creative thinking mathematical skills. The sample in this research were mathematics education students who took courses in school math; The total of 154 Students. Data was collected to measure the ability to think critically and creatively, mathematically, through a measure of questionnaire with the Likert scale. The results of the research indicated that a character-based interactive learning media facilitates self-regulated learning in the course of mathematics. The ability of students to think critically and creatively, mathematically, was adjusted at a high-level qualification. The highest error of mathematic critical thinking made by students was at the focus indicator, while the highest error of mathematic creative thinking was at the originality indicator.**

Keywords—Mathematics, Creative thinking skills, Critical thinking skills, Self-learning

I. INTRODUCTION

In developing countries, computers and electronic gadgets have been part of the learning process in the classroom. However, in Oman, the fact that a fast-growing number of schools are equipped with computer labs and smart class rooms, the use of computers for learning, including for mathematics, is still not optimal. Therefore, research on the effectiveness of utilizing computers in teaching is necessary and the use of computers for educational purposes, especially mathematics education, can be further improved.

The Curriculum should be designed with the aim to prepare the Omani people to have the ability to live as a person and a citizen who believes, is productive, creative, innovative, and effective and is able to contribute to the society, nation, state, and world civilization. To satisfy these objectives, students as mathematics teacher candidates should be prepared themselves to be part of the development of technology. The advantages of interactive multimedia applications of mathematics in explaining a concept can require students to analyze, try out and explore the concept, as well as the principles contained in the object problem.

The presence of the developing science and technology provides opportunities for all students to the unimpeded access of information relevant to their needs and demands; to explore and find their own mathematical concepts contained in the computer program given. This will touch up an optimal utilization of the ability of students, so mathematically critical and creative thinking will be increased.

The one objective of the Faculty of Teacher and Education teachers in middle and high school in accordance with the needed quantity and quality. While one of the missions of Mathematics Education is organizing a quality education to

prepare skills in mathematics education professionals. Based on this fact, students in Mathematics Education, as mathematics teacher candidates, need to prepare themselves to the maximum to be able to fill up the mission of Mathematics Education. This subject discusses more depth some selected topics in mathematics and secondary school, as well as the way they are presented in accordance with the secondary school mathematics curriculum and secondary regulations. The scope of the subject includes the topics middle school math and essential and common misconception, or a topic that is considered difficult for students and teachers in middle school math.

To facilitate self-learning students, the use of instructional media is one of the alternatives in the development process of learning to be better. Using instructional media, independently, students better understand certain materials that seem abstract by becoming more easily visualized. In addition, students are expected as mathematics teacher candidates to be motivated and able to actively participate in classroom learning. The self-learning is the application of information technology as a medium of

learning mathematics, which provides opportunities for students to learn independently and interactively via programmed instructional materials .

Previous research has had a significant impact on interactive media teaching. Currently, each class already has the available means to support learning based on Information and Communication Technology. In the current circumstances, the lesson should no longer be a tedious thing, as it was a few decades ago. Thanks to the rapid development of information technology, teaching materials can be presented with sounds and images that are dynamic, not boring, as well as provide solid information. Therefore, the development of Information and Communication Technology is based learning is expected to improve the quality of the learning process in the classroom.

UNESCO 2002 states that the use of Information and Communication Technology in teaching has three objectives: (1) to build "knowledge-based society habits", such as problem-solving skills, communication skills, the ability to find or manage information, and transform the information into new knowledge to inform others; (2) to develop the ability to use Information and Communication Technology or " Information and Communication Technology literacy"; and (3) to improve the effectiveness and efficiency of the learning process. Media can literally be interpreted as an intermediary or introduction. The media is a channel of Communications, derived from the Latin word for 'between', the term refers to anything that carries information between a source and a receiver. Moreover, it states that the media is “a tool to provide incentives' for learners that learning occurs”. Media in the learning process tends to be interpreted as graphics tools, photographic, or electronically to capture, process, and reconstruct the visual or verbal information. With the presence of media in learning, students can learn the material independently and are provided an opportunity to discover mathematical concepts and develop their creativity.

Media is classified into five groups: (1) human-based media, such as teachers, instructors, tutors, role playing, group activities, field-trip; (2) print-based media, such as books, guides, exercise books or workbooks, work tool, and loose pages; (3) visual-based media, such as books, work tools, charts, graphs, maps, drawings, transparencies, slides; (4) based on audiovisual media, including video, film, slide-tape program, television; and (5) computer-based media, such as computer aided teaching, interactive video, hypertext. Thinking involves two major aspects of the critical and the creative. Both types of thinking use reasoning to build a variety of ideas. According to Fisher (2005) thinking happens in everyone mental activity that serves to formulate or solve problems, make decisions, or gain understanding. Judging from the dimensions, Marzano (1988) found thinking includes the five dimensions of metacognition, critical and creative thinking, thinking ability of the core, and the relationship between thinking with particular knowledge. In line with these opinions, Fisher (2005) argues that thinking critically and creatively involves aspects of the mind, and both are used in reasoning and to build ideas. Additionally, thought is to be involved in any mental activities that help to formulate or solve a problem, make a decision or to build understanding, and then through thinking, it can be interpreted as something.

The critical thinking is a thought process with the aim of making sensible decisions about what is believed to be or do. Moreover, there are six basic elements of critical thinking including focus, reasons, inference, situation, clarity, and an overview. There are five key elements in critical thinking; they are practical, reflective, reasonable, beliefs, and actions. Combining the five key elements into a definition for thinking, critical thinking is a reflective mind that is focused on deciding what is believed to be or do. In addition, the notion of critical thinking is something reasonable; reflective thinking that is focused on what is believed to be the decision, or done. The mathematical creative is the ability to solve problems and to develop the structures of thought to the nature of deductive logic. The resulting concept is to integrate into the things that are important in mathematics. The creativity as a process that results are not unusual, in the solution of the problem given and regardless of the level of complexity. It also suggested that creativity can be applied in the classroom. Thus, these issues are not only about the motivation and perseverance, but also have a very broad level of reflection.

Mathematical creative thinking is the ability to find and resolve problems with components of mathematical proficiency or fluency, flexibility, and originality and elaboration of detail. Fluency is the ability to put forward similar ideas to solve a mathematical problem. Flexibility is the ability to produce a wide variety of ideas to solve problems outside of the usual categories. While the new thing is the ability to provide responses that are unique and unusual. Therefore, this research aims to explore mathematical thinking: critical and creative thinking mathematical skills.

II. OBJECTIVES

This Research perform a didactic proposal based in graph theory, to provide school students useful and motivational tools for problem solving. The students, who were skilled in mathematics, worked on some graph theoretical concepts like map coloring, Eulerian cycles, star polygons and other related topics. The students they can applied a wide range of strategies to solve problems, such as look for a pattern, counting strategies or draw the associated graph, among others. Thus, that graph theory successfully increases motivation of students towards mathematics and

allows the appearance and enforcement of problem-solving strategies.

The presence of the developing science and technology provides opportunities for all students to the unimpeded access of information relevant to their needs and demands; to explore and find their own mathematical concepts contained in the computer program given. This will touch up an optimal utilization of the ability of students, so mathematically critical and creative thinking will be increased.

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III. METERIALS AND MATHODS

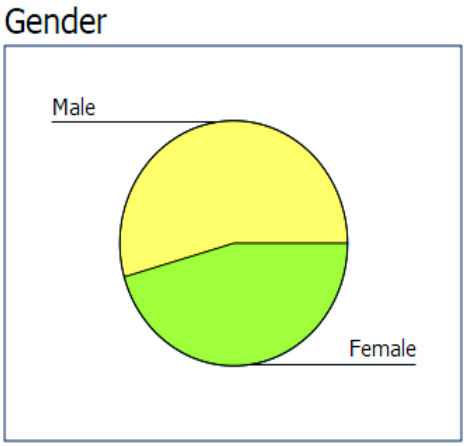
The trial results about the ability to think critically and creatively, mathematically, demonstrated that all matter is valid. This included the test results on the questionnaire of independence, which declared valid student learning with as many as 14 statements. The results of the observations during the learning process, student enthusiasm and the spirit of learning, indicated an interactive learning media motivated students to learn. In addition, an interactive learning media can facilitate self-learning students, both at school and at home. To enhance the learning motivation of students, lecturers should devise their own interactive learning media in accordance with the condition or characteristics of the students, so that students are able to learn independently. In addition, students must be trained in higher order thinking, such as critical and creative thinking skills.

IV. RESULTS AND DISCUSSION

The survey questionnaires were collected, tabulated, organized and using statistical tool the information's were analyzed. Based on the results the graph theoretical interpretations were obtained. The mathematical Creative thinking includes indicators fluency, flexibility, originality, and elaboration. The mathematical Critical thinking included indicators focus, reason, inference, situation, clarity, and overview.

The following results were obtained based on the survey; The majority of the participants were girls compared to boys. Most of them has very a smaller number of mathematics and science books in their family it will shows their less interest and involvement in the subjects. But most of the student's family has a greater number of Electronics and digital gadgets that is also one of the reasons there not spending more them in the digital equipment's rather than studying or thinking math and science concepts.

Based on the survey results we obtained most of the students' parents both mother and father were completed their secondary level school education only, also the students spent time in side the schools and outside the school is very less time that also one of the reasons for the students thinking and understanding level less

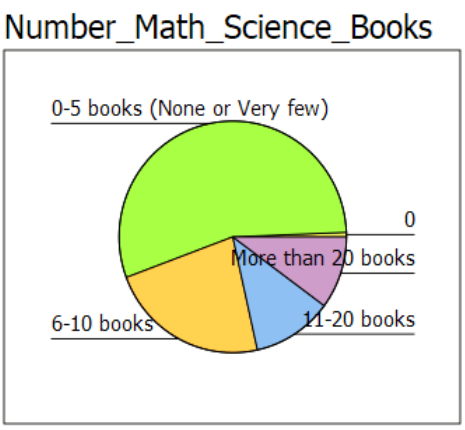


Figure`1:Number of Boys and Girls

Gender

Value Label	*Value*	*Frequency*
Male	1	86
Female	2	72
	Total	158

Table`1: Number of Boys and Girls



Figure`2: Number of math and Science books in each student family

Number_Math_Science_Books

Value Label	*Value*	*Frequency*
	0	1
0-5 books (None or Very few)	1	87
6-10 books	2	36
11-20 books	3	18
More than 20 books	4	16
	Total	158

Table`2: Number of math and Science books in each student family

Number_Digital_Devices

Value Label	*Value*	*Frequency*	*Percent*
None	0	12	7.59
1-3 divices	1	38	24.05
4-6 divices	2	28	17.72
7-9 divices	3	16	10.13
More than 10 divices	4	64	40.51
	Total	158	100.0

Table 3: Number of Digital devices available in each student family

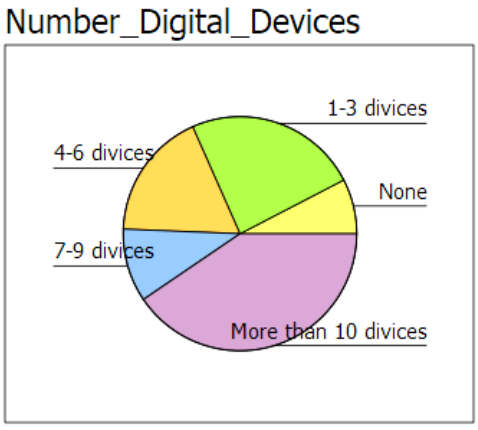


Figure 3: Number of Digital devices available in each student family

Parents_Education_Mother_

Value Label	*Value*	*Frequency*
Dont know	0	22
Did not go to school	1	24
Primary Education	2	29
Secondary education	3	47
Batchulor degree	4	20
Master Degree	5	13
Doctoral degree	6	3
	Total	158

Table 4: Parents-Mother Education level in each student family

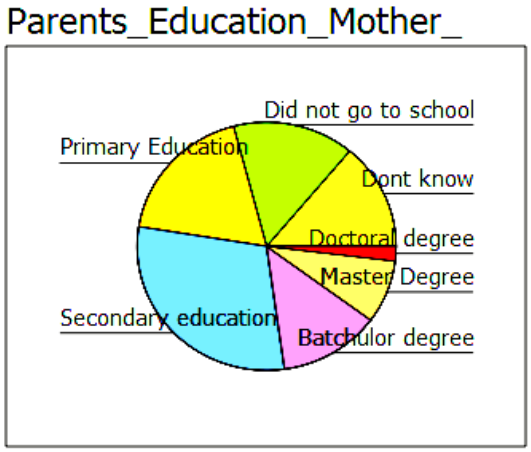


Figure 4: Parents-Mother Education level in each student family

Parents_Education_Father

Value Label	Value	Frequency
Dont know	0	24
did not go to school	1	14
Primary education	2	22
secondary education	3	40
Batchulor Degree	4	39
Master Deegree	5	16
Doctoral Degree	6	3
	Total	158

Table 5: Parents-Father Education level in each student family

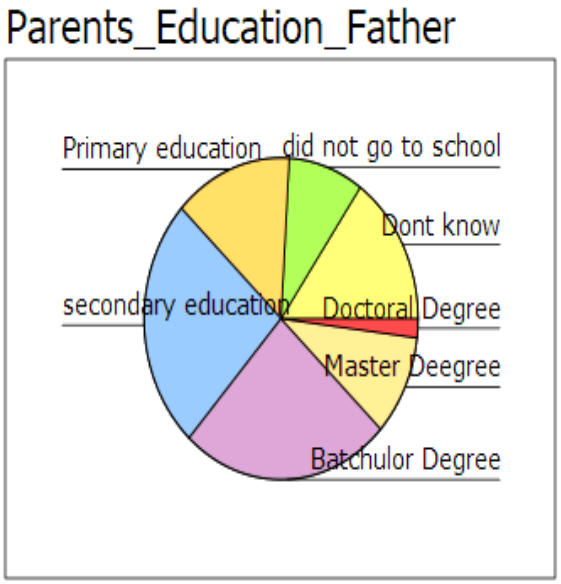


Table 5: Parents-Father Education level in each student family

Math_Time_spend_Class_per_Week

Value Label	Value	Frequency	Percent
	0	5	3.16
3 Hrs	1	31	19.62
4 Hrs	2	95	60.13
5 Hrs	3	14	8.86
More than 5 Hrs	4	13	8.23
	Total	158	100.0

Table 6: Number of Hours per week in a class to spend time for math subject

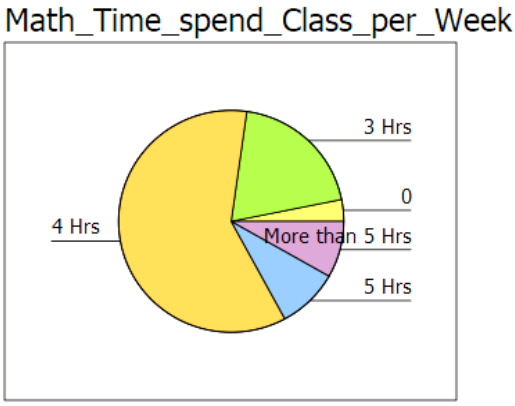


Figure 6: Number of Hours per week in a class to spend time for math subject

Math_Time_spend_per_week_outside

Value Label	Value	Frequency	Percent
None	0	45	28.48
3 Hrs	1	62	39.24
4 Hrs	2	35	22.15
More than 4 Hrs	3	16	10.13
	Total	158	100.0

Table 7: Number of Hours per week in outside the class room spend time for math subject

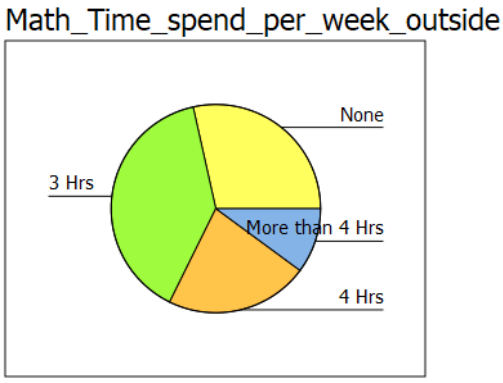


Figure 7: Number of Hours per week in outside the class room spend time for math subject

Interest_Study_Topics

Value Label	Value	Frequency
Dont know	0	4
Mathematics	1	28
Science-Physics and Chemistry	2	34
Science-Biology	3	34
Business and Accounts	4	15
IT and Computer	5	20
Engineering and Technology	6	6
Arts and Humanities	7	11
Other than Science	8	6
	Total	158

Table 8: Students interest course to study in future

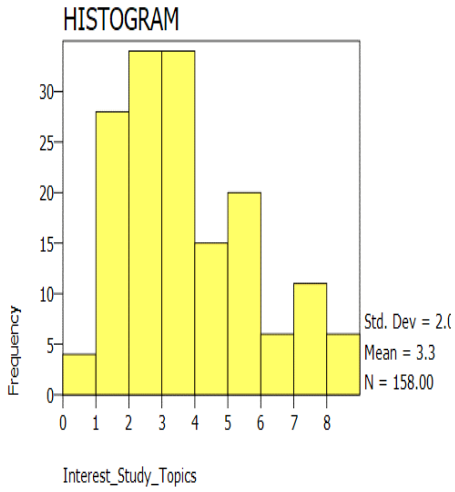


Figure 8: Students interest course to study in future

To test the students' knowledge in the coloring many of them not able to attempt and understand the colorings concept like the regions and how to connect the points (varices) as lines (edges)

V. CONCLUSION

It was concluded that the ability of students to think critically and creatively occurred at a high-level qualification. Students experienced the highest error of mathematical critical thinking on the focus indicator, and the highest error of mathematical creative thinking on the originality indicator. It predicts through the research several strategies for problem solving, such as look for a pattern, trial and error method, counting strategies, induction, use symmetry, associated graph, guess and check method and direct reasoning. Introducing the concept of graphs and some basic results of graph theory allowed participants to graphically represent abstract situations and develop several problem-solving strategies. They also created their own problems by analogy, using a simpler problem, related problem or variation of the problem

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