The Impact of Blended Learning on the Development of the Cognitive and Metacognitive Thinking Skills in Mathematics of the (ECT) Students

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ABSTRACT

This study aims to determine the impact of blended learning on the development of the cognitive and metacognitive thinking skills of the Emirates College of Technology (ECT) students through the analysis of the theoretical basis and previous studies related to this subject. This study has identified the list of cognitive and metacognitive thinking skills. In this study, the researchers used a math achievement test consisting of 20 questions. Researchers showed that students using the blended learning instruction performed significantly better in cognitive and metacognitive thinking skills than students using the conventional instruction. High achievement students performed significantly better in cognitive and metacognitive thinking skills than low achievement students. Blended learning instruction was found to help students with low achievement in cognitive and metacognitive thinking skills.

Keywords: Blended learning, Thinking Skills, Cognitive, and Metacognitive.

Introduction

The knowledge of today doubles exponentially, which adds a further burden on the educational institutions to keep track of the accelerated developments. What should be taught and how to choose the best learning content from this tremendous knowledge? What are the educational means to teach the selected knowledge? What is the learners' role and how can they retain and recall the learning? More importantly, how can learners employ the learning, develop and build on the knowledge attained? These questions and many others indicate educational concerns in the 21st century. In response, educators have been concerned with the questions like How to teach students to become self-learners to attain the competencies and skills needed in this age. Against the interest of education with such questions, there has been greater interest in enhancing the skills needed for learners at the higher education institutions such as higher thinking skills, problem-solving, cognitive thinking, and metacognitive thinking skills (Alabsi, 2016). Because of the increase in the bulk of knowledge, teaching methods have changed. Teachers are prepared to teach, starting from teaching based on the idea that science is a cognitive object that is offered to learners to pay attention to the ways by which the learner accesses and uses these sciences and scientific knowledge. Educational institutions have been racing to develop their educational systems to enhance the quality of their education to attract more students, especially when the technology of education has contributed to changing the way learners think. Educational institutions aim at preparing children for the fast-evolving future using the skills of higher thinking and metacognitive thinking skills (Shatat, Aldalalah & Ababneh, 2017). Interest increased in the learner's possession of the skills of using computer technology to be able to access and use knowledge in a way that shortens efforts and time in learning. It has become one of the pillars of teaching scientific materials to teach learners how to think, control their thinking, and how to master the skills of thinking and metacognitive thinking (Jbeili, 2014). One of these methods is blended learning, a method of education based on the use of technology in the teaching-learning process; it works on organizing learners' knowledge, skills, and information; and evaluates their performance, attitudes, and educational experiences provided to learners through the latest technology, and thus learners are enabled to use the skills of metacognitive thinking and utilize what is provided by the blended learning through facilities that improve the learning process (Aldalalah & Gasaymeh, 2014). It is found that a learner, through proper, education exploits the skills of cognitive thinking and metacognitive thinking skills and works on the development and promotion due to integrating the student in these educational situations, which stimulates and deepens the process of learning (Qarareh & Hajeh, 2013).

It is noted that blended learning takes into account the principle of the individualization of education, each student is a self-learner according to his ability, as blended learning provides distinctive learning by providing the teaching material, which enables the learner to solve the problems that are presented to him according to the skills of metacognitive thinking. Blended learning is attached with the skills of metacognitive thinking in that it works to achieve the goals faster by motivating positive and effective participation and achieving the required activities

saving time and effort in processing the teaching materials that mimic the different thinking patterns of the learner, and thus stimulates the cognitive thinking skills and the skills of metacognitive thinking in him which were difficult to be stimulated and activated traditionally; the learner works individually and communicates with the teacher to provide him with advice and direct and indirect guidance; hence, the learner is more flexible and interactive in learning well and is allowed to use the skills of metacognitive thinking in solving problems presented to him as he sees suitable (Alshahwan, 2014).

Blended learning provides learners with the ability to communicate with the teacher and other fellow students through the means of social communication through the Internet and the various educational programs provided by the technology, which is reflected in the skills of metacognitive thinking. The student finds an answer to every question in his mind, making it easy to move from one task to another; what is confirmed by the study of Husamah (2015) indicates that directing learners to ask questions before, during, and after application helps them link new experiences with previous ones in their knowledge structure. Further, Jbeili (2004) indicated that these questions help students discover their ambiguous aspects, correct their misconceptions, and thus construct meaning as a result of the interaction between their knowledge and the new experiences; therefore, they convey their acquired knowledge and experiences to similar situations, creating a certain mental orientation for students and guidance that directs them in learning and processing information. Sadalla (2014) points out that this is effective learning: as blended learning gives learners the freedom to invest their potential and capacities to focus on learning objectives and be able to repeat. The students' employment of metacognitive thinking skills has helped make guided and systematic use of educational software production. Moreover, the studies of Najjar (2007) suggest that students who employ metacognitive thinking skills are more aware of their learning steps and cognizant of their thinking when performing a particular task and can employ this awareness in selecting materials and tools that are required and appropriate for their learning.

Qarareh and Hajeh (2013) indicate that blended learning has a big role in the learner's understanding of the importance of what he learns, in performing activities and experiences, visiting websites, solving working papers, and making positive dialogue through these sites, in addition to applying what he has learned in new situations; where the learner sets the steps of solution and work (stages Implementation of activities). A learner can also mention the obstacles encountered and this is what is found in the implementation and solving of problems based on the use of the skills of metacognitive thinking. Husamah. (2015) points to the contribution of blended learning to understanding the obstacles encountering the learner and how he can overcome them personally or by using different sources of knowledge through the Internet or by the help of others in the lesson or face to face; or through electronic media that increased learner understanding of the learning material and activities. The methods and strategies used in blended learning, whether individual learning (offline) through PowerPoint presentations, video clips,

flash clips, websites, e-books, or connected learning face to face through direct teaching methods, training programs, practice, simulation, scientific presentations, and the accompanying feedback and the Internet have made it is easy for the learner to understand the purpose of learning. And this would enable him to apply what he has learned in other learning, making it easier for learners to understand and comprehend the skills of metacognitive thinking.

Cognitive and Metacognitive Thinking Skills

Thinking is a mental process practiced by humans spontaneously. Thinking, therefore, is an essential part of our daily life by which we can set goals, plan and solve problems we encounter (Albado, 2017). Thinking is the main feature in humans that can be nurtured through education, training, and practice, so the concept, thinking has attracted the interest of education and educators attempted to conceptualize the concept of thinking in different ways (Haydar, 2011). As noticed, the thinking skills needed for a learner are varied and diversified, and that should be sharpened to deal with the current voluminous quantity of knowledge in various areas of life. The interest in thinking skills is critical to sharpen intelligence and solve problems of the day. The present study, therefore, deals with the cognitive and metacognitive thinking skills that are needed for everyone (Alkhawaldeh, 2015). In cognitive thinking, the cognitive repertoire owned by an individual is employed in practical life to explore facts since cognition and cognitive thinking are associate with the ability to perceive facts, collect data, and process (Zimmerman, 2007). There are several ways to acquire cognitions including the five senses in humans, analysis/ reflection, and experimentation (Alksab, 2016). The cognition acquired through experiment enhances the practical cognitive skills of learners by building a sequential structure of learning skills such as attention, memorization, thinking, thereby the develop the capability of processing physical and abstract facts, synthesis and analysis, and evaluation (Alcoba, Mostajo, Legaspi, Ebron, & Paras, 2018; Takala, 2006). As a result, learners become able to make inferences and link between the relationships to find out solutions for the problems encountered (Turkmen & Sertkahya, 2014).

The concept of metacognitive thinking skills is directly linked with intelligence theories, learning, problem-solving strategies, and decision making and the effect of all of that on effective learning (Hamdi & Ahmed, 2017). As a result, the interest in teaching learners' metacognitive thinking skills has increased for learners to become able to think in their thinking, comprehend and understand one's ideas, self-speech, and the ability of conscious planning to solve the problems encountered (Abdullah, Rahman & Hamzah, 2017). Thereby evaluates the efficiency of thinking for oneself. In the conclusion, the interest is not about the facts and information, but in the thinking itself, thereby the learner's creativity increases and becomes able to build the process the knowledge rather than passive recipients of the facts and information and retrieve them on the test without processing (Elmekawy, 2014). As for the concept of metacognition, earlier psychology research was focused on memory and met memory, mindfulness with the thinking process or thinking in the thinking that there are multi definitions of metacognition due to interference between cognitive and metacognitive processes (Sedhu, Ali

& Harun, 2017; Jbeili, 2013). John Flavell described metacognitive thinking processes as the ability to think in one's thinking; it is therefore the knowledge of one's cognitive processes and divided metacognitive thinking processes into three interrelated variables: individual, task, and strategy (Flavell, 1979). On the other hand, Pedone, Semerari, Riccardi, Procacci, Nicolò, & Carcione (2017) conceptualized metacognitive thinking processes as higher-order control processes aiming at planning, monitoring, and evaluation of one's performance while solving a problem. The function is guiding and managing one's thinking.

Schraw& Dennison (1994) defined metacognitive as one's awareness of his/her learning and the ability to set plans to achieve specific goals and select the most appropriate strategy to accomplish the goal, and the ability to review and reevaluate one's thinking continuously. Oneil & Abedi (1996) stressed the procedural component of metacognition viewing metacognitive thinking as the process in which individuals think in their thinking of developing effective learning strategies and solving problems including planning, self-monitoring, and awareness with the cognitive strategy used. Abdalqader (2012).Defined metacognition as the thinking of learners in their thinking and ability to employ learning strategies to solve certain problems. Jarwan (2007) referred to metacognitive thinking as intricate high-order mental skills used in data processing, and control different thinking activities directed at solving a problem and employ one's cognitive capabilities effectively in the thinking process (Alahmmady, 2012). Metacognitive thinking is thinking in one's thinking to become able to control self-thoughts and rebuilding them to contribute to learning and problem-solving. (Even, 2017). A glance at the earlier definitions one can notice that the various definitions of metacognitive thinking are revolving around the individual's ability to think its thinking, and the ability to direct, manage, control, and evaluate his thinking using the cognitive skills more effectively (Berizzi, Barbora &Vulcani, 2017). As noticed, there is educational importance of employing metacognitive thinking skills at the higher education institutions and the universities, as they provide a learning environment that motivates creative thinking, and develop problem-solving strategies among learners, which will reflect positively on the acceptance of the instructional content, not specifically for memorization of facts and information to retrieve in the examinations, but to practice mental exercises that increases mental joy and reflects on learner's thinking by increasing attention and interest and employ the learning in similar instructional situations (Bruckermanna, Aschermannb, Bresgesc & Schlüter, 2017; Aboulatifa, 2015; Qarareh & Hajeh, 2013). The selection of metacognitive thinking skills to solve problems has a far-reaching effect on student learning and thinking of obtaining feedback during every step of the learning process, thereby strengthening strengths and avoids weaknesses (Alahmmady, 2012). The development of metacognitive thinking skills relies on training of the faculties and students on the mental processes, and various tasks that stimulate higher-order mental functions that increase awareness of learners during thinking and solving problems, and the related planning setting strategies, implementation, continual assessment, guidance provided by professors to their students with the training on how to develop plans, implement them and assessment to solve a problem (Al-Saleem, Al-Rbabaah& Al-Khawaldeh, 2012). In addition to the interest in making the classroom an attractive environment, lively and effective by employing metacognitive thinking skills, brainstorming and generating creative ideas (Sedhu, Ali, & Harun, 2017). A study by Aljarah &

Obeidat (2011) revealed a disparity in metacognitive thinking skills among college students associated with specialty studied, achievement, and year of study. However, Altimimi & Jafar (2015) argued the metacognitive skills practiced by teachers and their students were mostly centered in the planning skill domain. Essentially, metacognitive thinking skills include three major skills: planning, implementation & organization, and assessment, each of which has a set of sub-skills. The assessment focuses on the extent of accomplishing the goal, accuracy of results, appropriateness of methods used for the task, evaluation of how to overcome the difficulties and errors faced, and learner's ability to interpret decisions made, assess how effective is the implementation of the plan, retention and storage of the information for a new and similar task in the future (Jbeili, 2013; Al-Saleem, Al-Rbabaah& Al-Khawaldeh, 2012).

Blended Learning

The technological advancements taking place every day and every live field, including education, reshaped our world (Aldalalah & Fong, 2010). The teaching-learning process has largely been influenced by the fact that increased interest in teaching learners how to learn, and to create self-learners able to develop one's thinking skills by employing the modern teaching-leaning (Shatat, Aldalalah &. Ababneh, Z. 2017) Approaches including blended learning. Blended learning is a form of learning what merges electronic learning with traditional classroom teaching within one framework, and in which the electronic learning facilities that depend on the computer and the web are used in lesson delivery, and face-to-face interaction between teacher and student occurs much of the time (Cameron, 2005). Aslan (2015) referred to blended learning as a new type of learning that integrates with the typical teaching approaches in which online learning is merged with traditional leering within one framework inside the classroom or on the internet with aim of reducing the negatives of purely online learning. As a result blended learning is the learning that combines characteristics of traditional classroom learning and online learning within an integrated model that benefits from the available technologies for both methods (Milheim, 2006; Kitchenham, 2005).as an example, the university teaching that is based on blended learning represents a model combining traditional and modern teaching (Long, Vignare, Rappolds & Mallory, 2007).the earlier definitions of blended learning imply that it is the learning approach that merges features of traditional learning such as face-to-face interaction between teacher and learner to that of electronic learning like using modern technology of computers, internet, chat rooms, electronic mail, etc. To improve the instruction process. Blended learning characterizes by saving time, effort, and cost while improves achievement level, and provides an attractive instructional and training environment enabling students to interact with their teachers and classmates face-to-face, and strengthening social and human ties (Badawi, 2009). (Gulbahar & Madran, 2009) was consistent with the related literature in that four essential domains shall be taken into account when developing the blended learning environment: technology, teacher, student, and pedagogy. Similar to traditional learning, blended learning requires the organization of the content to be easily accessible, and to accomplish effective learning that links previous knowledge with the learning (Altun, Gulbahara & Madran, 2008). However, Myllymaki (2010) argues that blended learning provided unprecedented opportunities to learn by employing video clips besides face-to-face teaching in the classroom

which enhances student participation more effectively. Further, studies (Schwenger, 2017) indicated that because of its positive effects on learning, attractiveness added to the learning environments at college, blended learning will become widely used in the world (Orhan, 2008). On the other hand, Aldalalah & Gasaymeh (2014) stressed two aspects in the application of online and blended learning: first, selection of qualified learning designers and teachers, selection of appropriate blended learning strategies, emphasizing effective learning, and individual practices to enhance learning. The other aspect supports cooperative online learning groups. Abu A-Reesh (2013) revealed that blended learning can be employed in the teaching process via four methods: in the first method one or more lessons from the textbook can be delivered using normal classroom learning methods, while other lessons can be taught using online learning tools, and assessment can be accomplished by applying summative assessment whether normal or electronic. In the second method, electronic learning and classroom teaching plays interchangeable roles in delivering the same lesson. First, classroom teaching is introduced, followed by online learning, and the learning is assessed using the normal or electronic summative assessment methods. Similarly, in the third method, both classroom teaching, and online learning play interchangeable roles in delivering the same lesson, where the teaching is introduced using online learning, followed by the classroom teaching, and student learning is evaluated using whether the traditional or online summative assessment methods. Finally, the fourth method the classroom teaching and online learning play interchangeable roles to deliver the same lesson, but the rotation is made more than once for the same lesson, and student learning is evaluated using traditional or online summative assessment methods (Feras, Osamah & Ziad,2017). Blended learning can be beneficially described on a continuum where traditional (simple) learning lies at one extreme and the electronic (more intricate) learning on the other, where the new learning combines the features of both traditional and online learning, and can be separated into four distinctive levels: synthetic, integrated, participatory, expanded or distributed (Mohammad, 2017). Al-jasem (2011) emphasized critical factors for the success of blended learning, which included teacher-student communication, teamwork, and role-playing to ensure effective interaction among all participants. Blended learning encourages student self-learning, and allows for various flexible choices for learning irrespective of place, time, or previously held knowledge by students. The learning situation provided by blended learning enables a student to attend the lessons studied by his/her mates without a delay; it can be used with learners who have chronic diseases, and appropriate for fast learners by offering large size of information (Solera, Solera & Arayab, 2017). Al-ghamdi (2010) argues that for blended learning to succeed, students should be engaged in the selection of the methods most appropriate to them, and enhance continual communication among all those involved in eh teaching-learning process. The teaching, therefore, should be presented in different ways and displayed various models ranging between traditional, online learning, video-based, and other content display means.

Statement of the Problem

University students need cognitive and metacognitive thinking skills not only during their higher education years but also at the workplace because they provide them innovative skills in dealing with students and other colleagues. As a subject of research, the interest in developing methods

to enhance thinking skills among students has proliferated. However, there is a dearth of studies that address the cognitive and metacognitive skills and blended learning and learning strategy among Arab students, essentially at the ECT. The current study deals with this gap by investigating the relationship between blended learning and cognitive and metacognitive skills. As the scientific and humanistic courses at the university level largely depend on practical and applied aspects, the researchers felt the need to pay attention to a strategy that assists students to retain the knowledge that has to do with their practical skills in the disciplines they study, this strategy selected was blended learning because it requires cognitive skills pre, during and post use of the strategy. Several studies indicated earlier suggested that the optimum, use of a blended leering strategy requires active interaction. The problem addressed by the current study investigates the extent to which ECT students acquire cognitive and metacognitive thinking skills and their relationship with blended learning.

Study Questions

The present study attempts to answer the following questions:

- What are cognitive and metacognitive thinking skills should be acquired by the ECT students?
- What is the influence of blended learning on both cognitive and metacognitive thinking skills in mathematics acquired by the ECT?
- Are there statistically significant differences in the ECT students' acquisition of cognitive thinking skills in mathematics attributed to achievement level (High, Low)?
- Are there statistically significant differences in the acquisition of cognitive and metacognitive thinking skills in mathematics of low-achieving students at the ECT attributed to the teaching method (traditional, blended learning)?

Methods & Procedures

The Study Sample

For the qualitative part of the study, lecturers of (31) faculties of various academic ranks of the ECT participated in the study. The sample was selected using the simple randomization method. A purposeful sample of (95) students enrolling in the Abu Dhabi ECT during the second semester of the academic year 2017/2018 enrolled in the mathematics course (College Mathematics) participated in the quantitative part of the study as one of the researchers is a faculty member the ECT and participants were assigned to the groups using the simple randomization method. The blended learning group consist (55) students and the traditional group consists (40).

Study Variables

This study investigated the following variables:

- Independent Variable: teaching method (blended learning versus traditional learning)

- Dependent Variable: an extent of the students' acquisition of the thinking skills in mathematics, having two levels: (cognitive/ metacognitive)
- Moderator Variable: previous achievement associated with the academic grand point average GPA (high/low).

Methodology

To answer the study questions, the researchers adopted a mixed methodology of quantitative and qualitative approaches. The researchers applied the descriptive-analytical method to develop the inventory of cognitive and metacognitive skills that college students should possess based on interviews with the lecturer at the scientific and humanistic faculties at the ECT. Quantitatively, the researchers used a quasi-experiment design to identify how effective was blended learning and the effect of achievement on the acquisition of cognitive and metacognitive thinking skills in mathematics by the ECT students.

Research Framework

The Research framework in Figure 1 shows the relationships between the different variables under investigation. The research frameworks are divided into three variables:

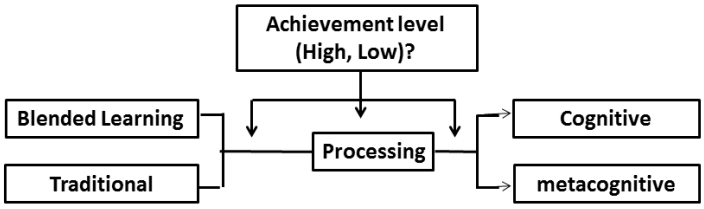

Figure 1: Research Framework

Independent variables are the 2 treatments teaching method (traditional, blended learning). The dependent variables are cognitive and metacognitive thinking skills. The moderator variables are l to achievement level (High, Low). The moderator variable is presented in this study and it gives a strong contingent effect on the independent and dependent variables' relationship. The effect of using the two treatments, treatments on learning will be identified by measuring the overall development of the Cognitive and Metacognitive Thinking Skills in Mathematics of the (ECT) Students.

Instruments

(1) Cognitive and Metacognitive Thinking Skills

To identify the cognitive and metacognitive thinking skills acquired by ECT, the researchers developed the inventory of cognitive and metacognitive thinking skills depending on their own experience, relevant literature review (Abdullah, Rahman &Hamzah, 2017; Berizzi, Barbora & Vulcani, 2017; Bruckermann, Aschermann, Bresges & Schlüter, 2017; Hamdi, & Ahmed, 2017; Sedhu, Ali, Suraini, &Harun, 2017; Evin-Gencel, 2017; AbouLatifa, 2015; Al-Timimi &Jafar,

2015; Jbeili, 2014; Qarareh &Hajeh, 2013; Al Ahmmady, 2012; Abdalqader, 2012; Al-Saleem, AL-Rbabaah & AL-khawaldeh, 2012; Al-Jarrah, Abdelnaser & Obeidat, Alaa, 2011), and interviews conducted with 21 lecturers of the ECT. The lecturer was asked what cognitive and metacognitive thinking skills college students should acquire. The inventory of cognitive thinking skills measured 5domains: the focus measured by 4 items; Collecting and remembering information measured by 4 items, Organization and analysis of information measured by 5 items, generative and installation of ideas measured by 4 items, and finally the domain of Evaluation and measured by 4 items. The instrument included an inventory of metacognitive thinking skills and covered three main domains: planning and measured by 20 items, implementation, and control and measured by 9 items, and final assessment and measured by 11 items.

(2) Pretest and posttest

The researchers reviewed the listing inventory to build the test of cognitive and metacognitive thinking skills in mathematics. The test consisted of 20-questions, the correct answer was assigned (1), and incorrect or no response was given (0). The test was applied as a pretest and posttest. Specifications of the test were tabulated, and questions were distributed as percentages on the cognitive and metacognitive domains, where the test covers the contents of the mathematics (College Mathematics) Polynomial and Rational Functions unit used for this grade. Table (1) shows the distribution of Cognitive and Metacognitive in the mathematics test.

Table 1: Specifics for Mathematics Test

Num	Lesson	%	Mark	Questions	Cognitive		Metacognitive	
					Mark	Questions	Mark	Questions
1	Polynomial function of degree greater than 2	20%	4	4	2	(4),(5)	2	(13),(17)
2	Properties of division	20%	4	4	2	(20),(9)	2	(10), (2)
3	Zeros of Polynomials	20%	4	4	2	(11),(15)	2	(3),(18)
4	Complex and rational Zeros of Polynomials	20%	4	4	2	(1),(6)	2	(12),(14)
5	Rational function	10%	2	2	1	(7),	1	(16)
6	Variation	10%	2	2	1	(8)	1	(19)
Total			20	20	10	10	10	10

The researchers, then, investigated the text on the discrimination and difficulty index, where items 0.30<and >0.80 were deleted from the pretest and posttest.

The correlation coefficient R = 0.770** (Table2) indicated a high positive relationship between the pre-test scores and the post-test scores. Table 2 shows the degree of relationship between the pretest score and post-test score. A correlation coefficient of R= 0.770** indicates a high positive relationship between the two tests.

Table 2: Correlation between Pre-test Scores and Post-test Scores

		Pre-test	Post-test
Pre-test	Pearson Correlation	1	0.770**
	Sig. (2-tailed)		0.000
	N	95	95
Post-test	Pearson Correlation	0.770**	1
	Sig. (2-tailed)	0.000	
	N	95	95
**. Correlation is significant at the 0.01 level (2-tailed).			

To reduce the statistical error, the pre-test scores were used as the covariate variable and a comparison was made among the groups.

(3) Validity

a) Face Validity

To test for face validity, the initial version of the instrument was validated by a group of judges (14) who have established knowledge and experience in the domains measured by the instrument. Opinions were elicited from the judges regarding the instrument items and domains to ensure they measure what they were designed to measure. Items were modified in terms of wording, intelligible, ordinal rank, deletion, and addition in light of the comments provided by the judges.

b) Reliability

The measure the instrument reliability, a pilot study was applied to 34 students selected from without the original sample. The researchers used the test-retest method, and the reliability coefficient using Chronbach alpha for the cognitive skills domain was (0.81), and internal consistency was (0.86). However Cronbach alpha for the metacognitive skills domain was (0.82), and the internal consistency (0.88). The reliability coefficient for the overall instrument using Cronbach alpha was (0.80) and internal consistency (0.93). As a result, the instrument was found valid for application in light of the study goals.

Procedures of the Study

The study was applied according to the following procedures:

- Obtaining the approval of the ECT principal and the lecturers who will apply the study. The researchers talked with them about the study, its objectives, and its importance to provide the necessary facilities to conduct the study.
- To identify the cognitive and metacognitive thinking skills acquired by ECT, the researchers developed the inventory of cognitive and metacognitive thinking skills

depending on their own experience, relevant literature review. The researchers applied the descriptive-analytical method to develop the inventory of cognitive and metacognitive skills that college students should possess based on interviews with the lecturers at the scientific and humanistic faculties at the ECT.

- Researchers have built a test in mathematics based on cognitive and metacognitive thinking skills.
- The sample of the study was randomly selected, and they were randomly distributed to both groups.
- Training lecturers: Before the beginning of this study, the lecturers assigned to the experimental groups participated in three days of training sessions that focused on education issues in mathematics teaching. The lecturers were informed that they would be part of an experiment in which new instructional methods will be tested. They worked with the new methods and learned how to use them with their students. In the present study, the focus was on the cognitive and metacognitive thinking skills in mathematics.
- The groups of lecturers were prepared unequivocally on using blended learning in the teaching of mathematics. They were presented with how to use the computerized materials and train students to use them in their learning. The procedures and methodology of selecting groups and assigning group members were explained to the lecturers. The researchers met the lecturer for feedback and assessment regarding the application of the teaching method.
- Dividing the study sample into two groups: the experimental group (blended learning) and the control group (traditional).
- Calculating the total grades of students at the end of the first semester to divide the students into the (high and low) achievements.
- The pretest was distributed to students (blended learning group and traditional group)
- Teaching the experimental group using the blended learning material at the beginning of the second semester 2017 / 2018. Blended learning was performed in different ways since it is adaptable. However, it centers on the individuality of students' needs as well as lecturers' adequacy. The blended learning group was educated utilizing station rotation, lecturers partitioned the study hall into little gatherings; each gathering was given a particular assignment, in which they were altogether appended to the principle point of the module yet, to address understudies' issues. Understudies, by utilizing this technique, used innovation in playing out the errands. Then again, the Whole Group Rotation strategy enabled understudies to perform one undertaking at any given moment overall gathering. And Flipped Classroom utilized in educating students appeared planned materials for example videos, power point presentation or texts, and pictures, they were approached to give certain reactions or perform assignments relying upon the material given to them, the reactions were conveyed utilizing the web.
- Teaching the traditional group was done through the ordinary instructive material (textbook, whiteboards) utilizing the conventional technique. This depended on the

lecturers' endeavors and efforts to convey the data expected to the students. The main assets utilized were the lecturer's book, the student's book, and the workbook. Any additional exercises instructors utilized likewise relied upon the activities given toward the finish of every unit.

- After the completion of the teaching process for the experimental and control groups, students' post-test was distributed to students (blended learning group and traditional group) total scores were calculated to find out the effect of blended learning in comparison with the traditional method.
- Analyzing the results and concluding in light of the questions of the study.

Group's Equivalence:

The purpose of the pre-experimental study was to test the assumption that the participants across the groups were equivalent of cognitive thinking skills and metacognitive thinking skills in math for the ECT students. To achieve this purpose, a pre-test that measures before the beginning of the study. To examine the equality between groups (Blended Learning & Traditional) and (low & High) achievement, the ANOVA procedure was used results have been shown that there is no significant difference in the pre-test scores in (Blended Learning & Traditional) groups and (low &High) achievement groups. This means that the groups have the same level of prior knowledge of cognitive thinking skills and metacognitive thinking skills for the ECT students.

General Results and Discussion

Results Related to the first Question: *What is the cognitive and metacognitive thinking skills that should be acquired by ECT students?*

To answer the research questions: the researchers have followed the following: based on the literature review of the trends in cognitive thinking skills and metacognitive thinking skills, and previous experience of the researchers, the researchers developed the list of thinking skills. After determining the list of standards in this research (Arabic version) the validity of the list of thinking skills consisted of a review panel of several. To express their views on the clarity of the wording of each thinking skill and scientific validity, and the adequacy of thinking skills and items, and relevance of items thinking skills belonging to it, and add, delete or modify the thinking skills and items as they see fit.

The thinking skills list was evaluated during the development of the research study. The feedback and comments received from the panel of experts were employed to establish the necessary clarifications, changes, and modifications. Meanwhile, the research thinking skills list items were translated by two bilingual experts who reviewed both the English and Arabic versions. The Arabic version of the thinking skills list was checked and translated back into English by an independent translator to ensure there was no loss of meaning during the translation. The purpose of translating the thinking skills list from the English version into the Arabic version is to make it easier for participants to answer the questions.

To ensure that the translation of the thinking skills list is accurate, the list was professionally translated from the survey to ensure the validity of the thinking skills list. To answer the study question the researchers collected the opinions of experts and compare responses to see the degree of agreement, the results showed a high degree of agreement between the experts as shown in table 3 and table 4

Table 3: The cognitive thinking skills list

The focus
Identify the problem
Identify the main objective to be achieved
Select the sub-goals
The ability to observe
Collecting and remembering information
Take notes and arrange them
Ask questions to collect more information
The ability to access information and previous experiences
Ability to store information in long-term memory
Organization and analysis of information
The possibility of comparison between things
The ability to categorize objects in groups
The ability to arrange things
Determine the characteristics and components that distinguish between objects
Identify patterns and relationships between objects
Production and installation of ideas
The ability to things and conclusion of the information
The ability of prediction
Develop available ideas and information to reach new results
Ability to summarize the findings and information in an efficient way
Evaluation
Determine the criteria that achieve the goal
Ability to validate results
Identify the errors that affected by the results
Accuracy in the results

Table 4: The Metacognitive Thinking Skills List							
No	**Planning**	11	Develop learner methods, methods, and strategies necessary to implement the goal	1	Organizing the learner for his ideas before performing the task	2	The ability of the learner to determine the extent to which the main objective has been achieved accurately
1	Read the learning for the problem	12	Learner selection of new methods, methods, and strategies required to implement the goal	2	the learner's conviction and confidence in his ability to implement the plan	3	To judge the accuracy of the results and the possibility of benefiting from them.
2	The ability to conceptualize the problem	13	Generate learner's internal questions on the subject	3	Focus the learner on the goal to be achieved.	4	How effective and suitable methods, methods, and strategies are used
3	Understanding the learner of the problem	14	The learner's formation of conceptual maps.	4	The steps and processes of the solution proceed logically.	5	The effectiveness of the methods, methods, and strategies used to overcome the emergency difficulties.
4	Determine the nature and aspects of the problem	15	The learner develops a logical sequence of steps to solve the problem achieving the goal.	5	Go to the next step after you finish the previous step successfully	6	The overall effectiveness of the plan
5	Identify the main goal to be achieved (formulation of the problem)	16	To conceive obstacles and difficulties that can occur.	6	Evaluate the success of each sub-task before moving beyond.	7	Determine whether the plan can be used to resolve similar and similar problems in the future.
6	Analyze the problem for simple parts setting sub-targets	17	Develop proposed methods and strategies to overcome obstacles and difficulties that can occur.	7	The focus of the learner is on the time of achieving the sub-goals.	8	Determining the learner's retention and utilization of results and solutions for the future.
7	Identify the learner of previous experiences associated with the problem	18	Predicting the Learner of the results to be obtained	8	Determine the learner of the difficulties and errors encountered in the implementation.	9	Results are the same as expected.
8	Learner gather information about the problem	19	The learner's assessment of the plan's progress, effectiveness, and applicability.	9	Use proposed methods to overcome difficulties in a manner that does not affect the results.	10	The extent of innovation and creativity in the solution.
9	Learner gathers information about the problem.	20	Identify materials and tools for implementation		**Evaluation**	11	The flexibility and sequence of the solution steps in the plan.
10	The learner's awareness of the methods and strategies he used in a similar problem	No	**Organization and implementation**	1	The ability of the learner to self-assess its results.	12	

Results Related to the Second Question: *What is the influence of blended learning on both cognitive and metacognitive thinking skills in mathematics acquired by the ECT*?

A comparison was made between Traditional and Blended learning instruction based upon the mean of the post-test scores.

Table 5: Descriptive of the Posttest Score of students in Various Treatment Groups

	Mode	Mean	Std. Deviation	N
Post test scores of Cognitive Thinking Skills	Traditional	13.5000	2.26455	40
	Blended	15.9636	2.43405	55
	Total	14.9263	2.65074	95
Post test scores of metacognitive Thinking Skills	Traditional	13.2500	2.45733	40
	Blended	15.8000	2.39134	55
	Total	14.7263	2.71889	95

(Table 5) showed a difference between the mean of post-test scores of Cognitive and metacognitive thinking skills for groups using the Blended learning.

To reduce the statistical error, the pre- test scores were used as the covariate variable and a comparison was made between the groups (Traditional & Blended learning) using the MANCOVA procedure (Table 6).

Table 6: MANCOVA of the Posttest Score of students in Various Treatment Groups

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	PostC	162.380(a)	3	54.127	9.889	.000
	PostM	165.998(b)	3	55.333	9.521	.000
Intercept	PostC	1463.381	1	1463.381	267.349	.000
	PostM	1474.067	1	1474.067	253.628	.000
PreC	PostC	.298	1	.298	.055	.816
	PostM	.483	1	.483	.083	.774
PreM	PostC	14.304	1	14.304	2.613	.109
	PostM	10.973	1	10.973	1.888	.173
Mode	PostC	136.035	1	136.035	24.853	.000
	PostM	146.741	1	146.741	25.248	.000
Error	PostC	498.104	91	5.474		
	PostM	528.886	91	5.812		
Total	PostC	21826.000	95			
	PostM	21297.000	95			
Corrected Total	PostC	660.484	94			
	PostM	694.884	94			

a R Squared = .246 (Adjusted R Squared = .221)
b R Squared = .239 (Adjusted R Squared = .214)

Table 6 indicated that there were significant differences between Traditional and Blended learning groups in the mean score of the post- test scores with F (1.91) = 24.853, Mean Square = 136.035and p = 0.000. of post-test scores of cognitive thinking skills. And F (1.91) = 25.248, Mean Square = 146.741 and p = 0.000. of post-test scores of metacognitive thinking skills.

Results showed that the experimental group students who were exposed to blended learning outperformed their counterparts in the control group who were exposed to traditional teaching.

To account for this result, the researchers argue that delivering the teaching content by integrating technology with the normal environment will produce learning outcomes greater than the traditional method that employs only the textbook and the board, which facilitates learning. Considering this result, the researchers emphasize that to be effective, blended learning should be meaningfully diversified in terms of activities, means, research methods, assessment,…etc which enhances the positive role of the student as the hub of the teaching-learning process, and develop the cognitive and metacognitive concepts that strengthen the links between theory and practice. Students when they use Blended learning in mathematics it makes them acquire cognitive skills, like identify the main objective in the problem solving to be achieved and they can observe, because Blended Learning is effective and it employs technology in delivering content, which is a new learning environment for most students, and rich with attractive stimuli. This result can be also explained by the structure of a blended learning environment that provides a straightforward track of learning which starts with a review of learning outcomes, learning content, activities, practices, using the multimedia flipped learning in lesson delivery, and ends with the evaluation questions to assess responses, and receive instant feedback from the teacher. This process combines both the normal and electronic environments, noting that teachers in traditional learning might disregard the instant feedback, but in blended learning, the teacher provides students with instant, varied and continual feedback to enhance their learning. For example, students have good skills to categorize and arrange solutions in patterns and identify the relationships between real numbers and complex zeros, in the section of complex and rational zeros of polynomials. Blended learning also appropriates individuation because it responses to individual differences by shortcutting differences into time gaps, thereby a student will learn at his/her own pace without the need to wait for classmates. On the other hand, blended learning has provided a valuable opportunity to break the isolation of students because of time and place. Students, therefore, have access to teaching content provided over learning platforms on the internet, at the places most suitable to them, they can access international libraries, browsing the online library archives, and review references that support their learning, thereby enriching the cognitive repertoire students have which can be employed in face-to-face discussions in the classroom. Blended learning employs multimedia and technology-mediated teaching, such as hypertext, colors, images, animations, graphs, audio-video clips, all of which stimulates the student senses, and paying attention to the instructional content, especially that using two senses is much better than using one sense to acquire the experiences. In other meaning, it helps the students to predict and develop available ideas to reach new results in the zero of polynomials section, in the mathematics unit.

This result can also be explained by the fact that teaching using blended learning in comparison with traditional learning provokes enthusiasm in learners, and attract the attention of learners to participate actively, not only as passive recipients of the information. With blended learning, students learn at their own pace, correct their mistakes by themselves, and discuss their teachers via the online platform or face-to-face without being embarrassed by classmates. Especially, the

rational functions and various sections in the mathematics unit, students organize their ideas before performing the task and focus on the solution to achieve. On the other hand they utilization of results for the variation section, and judge the accuracy of these results.

In addition, the blended learning strategy allows learners to browse the instructional content, review the material more often without feeling bored, and the time most convenient to them. Doing activities and exercises designed under a blended learning strategy to help students acquire the concepts and skills since students work on the activities after receiving training on the skills and receives instant feedback, which improves performance and finally reflects positively on the whole achievement, and helps student concentrate on active learning by repetition of the stimulants and responses arranged for in the program. Students develop methods and strategies to implement the results because they have many practices, exercises, and examples in the mathematics unit by using Blended Learning.

Furthermore, the researchers attribute this result to several factors including the role of IT technology (computer technology) in education and creating interactive learning environments. The research support that computer-based language learning (verbal and writing) remains in memory longer than the content delivered traditionally.

Results Related to the Third Question: *Are there statistically significant differences in the ECT students' acquisition of cognitive thinking skills in mathematics attributed to achievement level (High, Low)?*

A comparison was made between the two groups – students with a low level of achievement, and students with a high level of achievement based upon the mean of the post-test score using the descriptive procedure (Table 7)

Table 7: Descriptive Of Post-Test Scores Of Students With Different Levels Of Achievement (High, Low)

	Achievement	Mean	Std. Deviation	N
Post C	Low	13.4634	2.15752	41
	High	16.0370	2.45690	54
	Total	14.9263	2.65074	95
Post M	Low	13.0488	2.25778	41
	High	16.0000	2.33109	54
	Total	14.7263	2.71889	95

Table 7, showed a difference between the mean of post-test scores of Cognitive and metacognitive thinking skills for high achievement students groups. To reduce the statistical error, the pre- test scores were used as the covariate variable and a comparison was made between the groups (high achievement & low achievement) using the MANCOVA procedure (Table 8).

Table 8: MANCOVA Of The Post-Test Scores Of Students With Different Levels Of Achievement (High, Low)

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	PostC	181.585(a)	3	60.528	11.502	.000
	PostM	223.185(b)	3	74.395	14.352	.000
Intercept	PostC	1406.964	1	1406.964	267.350	.000
	PostM	1413.259	1	1413.259	272.645	.000
PreC	PostC	.062	1	.062	.012	.914
	PostM	.000	1	.000	.000	.994
PreM	PostC	13.477	1	13.477	2.561	.113
	PostM	11.051	1	11.051	2.132	.148
Achievement	PostC	155.240	1	155.240	29.499	.000
	PostM	203.927	1	203.927	39.341	.000
Error	PostC	478.899	91	5.263		
	PostM	471.700	91	5.184		
Total	PostC	21826.000	95			
	PostM	21297.000	95			
Corrected Total	PostC	660.484	94			
	PostM	694.884	94			

a R Squared = .275 (Adjusted R Squared = .251)
b R Squared = .321 (Adjusted R Squared = .299)

Table 8 indicated that there were significant differences between high achievement & low achievement groups in the mean score of the post-test scores with F (1.91) = 24.853, Mean Square = 155.240, and p = 0.000. of post-test scores of cognitive thinking skills. And F (1.91) = 39.341, Mean Square = 203.927and p = 0.000. of post-test scores of metacognitive thinking skills.

Results show that high-achieving students outperformed low-achieving students. Generally, the achievement of students associates with their attitudes. High-achieving students do usually do their best to maintain their placement because they typically enjoy a high level of motivation to achieve, their sense of responsibility is high, greater in self-estimation, and willingness to excel. In case their achievement went down, they will have a negative self-image, which motivates them to work harder towards achievement. This leads them to sharpen their cognitive thinking skills, to duplicate their cognitive repertoire and experience, thereby they become more insightful about the goal they are seeking, and their hardworking will increase, and become more enthusiastic and engaged in the teaching-learning process.

The researchers consider this as a reasonable result, and the difference can be accounted for by the nature of the test used. The test applied included pictures and geometric shapes that high-achievers recognized the relation between pictures and shapes more easily than those low-achievers, given the high correlation between intelligence and achievement. It was clear, the metacognitive questions in the protest, students analyzed the problem, for simple parts by setting sub-solutions in the properties of division for the polynomials by using the remainder theorem or the factor theorem.

On the other hand, high-achieving students typically are challenged by new knowledge, that they become motivated to learn the cognitive learning skills that increase their cognitive repertoire and experiences. Students in their hardworking to increase their achievement tend to use every method or skill that might increase their cognitions and experiences they need in life which will reflect positively on their achievement. Further, the learners who possess the spirit of competition and challenge with their classmates are more apt to acquire the cognitive thinking skills because they save time and effort, and help retain the information learned longer in mathematics sections, and increases motivation and curiosity among learners for exploration.

In addition, this result can be accounted for by the observation that high-achieving students are self-learners, and most consider their success as a result of personal hard work, that they tend to acquire the cognitions and experiences that support their learning. As thinking skills increase student achievement, they become internally motivated to learn and collect more information about the polynomials and rational functions to store it in long-term memory. In general, students wish to be more self-confident and achieve high, which increases creativity and problem-solving skills which in turn improves their motivation to learn. High-achieving students usually set high goals to achieve and consider the previous success as predictors of their high aptitudes. Failure, on the other hand, is viewed as a challenge that they must defeat, which makes students exert greater efforts, and attribute their success or failure to internal factors that motivate them to acquire the thinking skills to sustain their excelled rank.

Results Related to the Fourth Question: *Are there statistically significant differences in the acquisition of cognitive and metacognitive thinking skills in mathematics of low-achieving students at the ECT attributed to the teaching method (traditional, blended learning*)?

From table 8, it can be seen the post-test score of cognitive thinking skills for low achievement students using blended learning mean (M = 14.2609) is higher than the post-test score of cognitive thinking skills for low achievement students using traditional mean (M = 12.4444). The mean post-test score of metacognitive thinking skills for low achievement students using blended learning (M = 14.1739) is higher than the mean post-test score for low achievement students using traditional (M = 11.6111).

Table 9: Descriptive of Post Test Scores of Low Achievement Students in Various Treatment Groups

	Mode	Mean	Std. Deviation	N
PostC	Traditional	12.4444	2.63957	18
	Blended	14.2609	1.25109	23
	Total	13.4634	2.15752	41
PostM	Traditional	11.6111	2.35494	18
	Blended	14.1739	1.40299	23
	Total	13.0488	2.25778	41

To reduce the statistical error, the pre- test scores were used as the covariate variable and a comparison was made between the groups (blended learning &traditional) for low achievement students using the MANCOVA procedure (Table 10).

Table 10: MANCOVA Descriptive Of Post Test Scores of Low Achievement Students in Various Treatment Groups

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	PostC	62.283(a)	3	20.761	6.199	.002
	PostM	85.467(b)	3	28.489	8.900	.000
Intercept	PostC	783.854	1	783.854	234.059	.000
	PostM	777.904	1	777.904	243.022	.000
PreC	PostC	2.601	1	2.601	.777	.384
	PostM	2.935	1	2.935	.917	.344
PreM	PostC	19.114	1	19.114	5.708	.022
	PostM	14.342	1	14.342	4.480	.041
Mode	PostC	24.010	1	24.010	7.169	.011
	PostM	55.184	1	55.184	17.240	.000
Error	PostC	123.912	37	3.349		
	PostM	118.436	37	3.201		
Total	PostC	7618.000	41			
	PostM	7185.000	41			
Corrected Total	PostC	186.195	40			
	PostM	203.902	40			

a R Squared = .335 (Adjusted R Squared = .281)
b R Squared = .419 (Adjusted R Squared = .372)

Table 10 indicated that there were significant differences between (blended learning &traditional) groups for achievement students in the mean score of the post- test scores with F (1.37) = 7.169, Mean Square = 24.010and p = 0.011. of post-test scores of cognitive thinking skills. And F (1.37) = 17.240, Mean Square = 55.184 and p = 0.000. of post-test scores of metacognitive thinking skills.

The result that the achievement of low-achieving students on the posttest was influenced by the blended learning strategy can be attributed to the documented effectiveness of blended learning in supporting student interaction, providing quality instructional material for students with low achievement, creates a motivating learning environment where students feel safe, and provides an interactive environment that provides the content clearly via various applications that allows expression of opinions, and active participation in the classroom discussions, especially, when they use this application to sketch the graphs of a polynomial function of degree 2 or more and to find their zeros. While enhancing student-student, and teacher-student social relations, and further, blended learning is sufficiently flexible to meet the needs of different learners, by their academic achievement levels, time, and learning pace, thereby achieving greater comprehension for learners greater than in traditional learning.

This result can be attributed to the multimedia technology employed in blended learning. The employment of hypertext, animation, audio-video clips stirs the five senses of learners to become alert to the content delivered thereby retention of the educational experiences longer, the possibility of word processing and make modifications, repetition of practices and exercises more than once, and replay of audio-video clips. In addition, blended learning provides an external incentive for learners to summarize the content with the assistance of the electronic files

furnished by the teacher, which can be restructured, reformatted, change color, to enhance the stimuli-response effect, and effectively assimilate the teaching content. On the other hand, blended learning saves time and effort for learners by using audio-video clips that provide digest lectures, graphical figures, and animations, which can be delivered remotely, and easily accessible by online learners to understand the problem and gather information about the problem like, estimating the real zeros of a polynomial, or estimating the coordinates of the turning points on the graph. Most learners know the steps and processes of the solution proceed of an inequality graphically. Besides that they acquired an ability to imagine from our life problems, for an instance, constructing a box, deflections of diving boards, determining temperatures, Medicare recipients, dimensions of a capsule,...etc.

Additionally, blended learning provides a continuous and direct enhancement for learners through the instructional software programs contrary to traditional learning, thereby creating a sort of challenge for learners and self-satisfaction. The assessment in blended learning is varied, including self-summative assessment, where learners receive the feedback in privacy and saves the teacher's time and effort in preparing, applying, and checking the exam sheets. Additionally, assessment in blended learning mitigates learner's test anxiety, reduces frustration, and increases positive feelings due to the motivating educational climate that employs multimedia that supports student feeling of achievement, independence, and trust in achieving the personal targets from the learning. Further, the assessment in blended learning reduces feelings of shame and frustration since it proves self-paced learning and privacy without being exposed to disappointing negative situations, as the learners learn themselves independently and positively while they seek towards specific goals. Another advantage is that blended learning encourages student active participation and exerts every effort by employing multimedia and technology-mediated instruction that supports training, practice, and problem solving through presenting the examples and exercises that relate with the content. As blended learning considerate individual differences, students start to explore individually and learn at their own pace that they regulate the learning time when to expose to learning, how often, they become responsible for their learning. Individual differences are met in the instructional material displayed such as notes, exercises, examples, assessments, video clips, and the enriching website links through which students can access directly, where students search for instructional topics on the Internet from among a wide range of available options thereby saving time and effort which finally will affect student achievement because it forms an external incentive. Blended learning, further, provides students with the lessons they missed in the traditional learning; and presents an opportunity for engagement in the instructional content because of the learning environment it creates, which is free from distractors of the traditional method, which forms another external incentive for learning. Student-teacher communication can be enhanced via email messages more easily than in the traditional method, where a learner can send a question and receive the answer faster than in the traditional method since most students have access to the internet most of the time using their laptops or androids. Finally, this result can be attributed to the fact the blended learning approach offers teachers greater opportunity to keep track with student work, especially students with poor performance, and can improve the achievement of poor students since this approach allows for teacher-learner interaction and engagement with the computer-based instructional material which leads to greater comprehension of the content and increase of achievement.

Recommendation and Implication for Future Research

The use of blended learning has positive effects on the student's metacognitive thinking skills in math such that, planning, organization, and evaluation. Blended learning has also shown an effective role in developing the low achievement students to acquire cognitive and metacognitive thinking skills in math. Therefore should be more attention given to cognitive and metacognitive thinking skills in an academic environment to upgrade students' skills in various specialties. The blended learning should be applied to different samples and subjects, and focus on the training of teachers and students in this type of teaching method**.** That review of the trends in cognitive thinking skills such that collecting, organizing, analyzing the data or information, and evaluating for identifying the errors that are affected by results helps to develop teaching strategies. This study used cognitive and meta-cognitive skills as dependent variables; future research suggests other variables, such as cognitive pattern, learning pattern, student ability, intelligence level, and ability. The need to implement the integration strategy between the use of blended learning and the thinking skills of cognitive and metacognitive when teaching students the skills of math. The researcher recommends educators pay more attention to developing Metacognitive skills, holding workshops for teachers to train them on using these skills before they start to work and in-service to enable them to use these skills in teaching. This training can provide a learning environment that can enable them to practice these skills. The author recommends educators design imitation programs to develop the lacking skills in light of the students' needs, the requirements of society, and the challenges of today. More research needs to be done into the effectiveness of using blended learning in achieving better learning outcomes in various educational programs and courses.

Summary and Conclusions

This study found that the use of blended learning helped students performed significantly better in cognitive and metacognitive thinking skills. It gives support to the effect of blended learning of thinking skills. In other words, the High achievement students performed significantly better in cognitive and metacognitive thinking skills than low achievement students. In short, the study strongly indicated that blended learning was effective in promoting better learning of mathematics cognitive and metacognitive thinking skills. Such that, identify the main ideas, ask questions to collect more data, an ability to arrange patterns and find the relationships between objects in math subjects. It is suggested that blended learning should be integrated into all courseware on the learning of mathematics. Blended learning should be considered in the instructional designer of preparing multimedia mathematics learning courseware for the “disadvantaged- aptitude” students, that is low achievement level students. In general, all the students responded favorably to the development of the cognitive and metacognitive thinking skills in mathematics using courseware-based blended learning. Mathematics learning facilitated blended learning improves cognitive and metacognitive skills of high students. Inquiry through blended learning is made easier with the help of offline and online modules that have been developed by the lecturer. Flipped learning and online communication make it easier for students to discuss and communicate with lecturers, which helped them to solve any problem they may encounter.

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