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MIDDLE EAST UNIVERSITY
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Metacognitive Awareness about STEAM Education among Teachers for the Primary Stage in Jordan

مستوى الوعي ما وراء المعرفي لمعلمي المرحلة الأساسية في الأردن بمنحى STEAM في التعليم

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Curriculum and Instruction Methods

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Authorization

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Declaration

I hereby declare that this thesis represents my work which has been done after registration for the degree of Academic Administration and Curriculum at The Middle East University and has not been previously included in a thesis or dissertation submitted to this or any other institution for a degree, diploma or other qualifications.

This thesis is a presentation of my original research work with committing to all ethics of scientific research. The work was done under the guidance and supervision of Dr. Ahmad A.S Tabbieh.

Fareeda Bernardos Haddad

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Dedication

To the soul of my beloved mother who had always praised me and encouraged me to continue with my higher education

To the soul of my beloved father who had always urged me to learn, study, and never stop

To the soul of my dear sister who had always embraced me and was my second mother

To Jihad Zabalawi, a friend who suddenly appeared at the beginning of my Master journey and accompanied me all through it; sent from the heaven to support me and give me advice when I needed it, and for whom I would approve what is always said that

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To Dana, Zina, and Yazan, my precious daughters, and son, my true fortune, who have always supported me all through my two-year journey,

And to my life–long companion, who believed in me and welcomed my dream, who never turned me down and was always there when I needed help. If it were not for the satisfaction of my Lord, and without him, I would not have achieved the dream of my life; with his support, I went through the impossible and the past dream has become a reality; to Gahtan Haddadin, my dear husband.

To all those who supported and loved me, I dedicate this humble work

Table of Contents

List of Table

List of Figures

List of Appendices

Metacognitive Awareness about STEAM Education among Teachers for the Primary Stage in Jordan

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Abstract

This study aimed to investigate the level of metacognitive awareness about STEAM education among teachers for the primary stage in Jordan. It also aimed to identify the impact of school type, experience, and specialization on the level of Metacognitive awareness. A purposive sample was selected of (370) teachers from public and private school teachers in Amman and Madaba Governorates with the following specializations {Science, computer science, social science and humanities, Mathematics} and have already known about the STEAM approach. The researcher developed a Five-Likert scale Metacognitive awareness inventory for teachers (MAIT) to measure metacognitive awareness level among primary school teachers about the STEAM approach built by (Balcikanli,2017). The researcher verified the content validity by presenting the instrument to a group of specialists in curricula and teaching methods to determine the extent of the clarity and comprehensiveness of the items. The researcher applied the questionnaire to a pilot study of 30 teachers from outside the sample members, to calculate the constructive validity and reliability. The results of the application showed a constructive validity ranging between (.65 and .82). The researcher concluded that the level of Metacognitive Awareness among teachers with 3-5 years of experience and more who work in the private sector is higher than those who work in the public sector. The results showed as well that there was no significant difference in the level of Metacognitive Awareness attributed to the specialization variable. The researcher recommends that the Ministry of education should prepare a successful education reform process in addition to adopting a unified reform plan with clear educational goals and outcomes.

Keywords: Metacognitive Awareness, Metacognition, Primary Teachers, STEAM education.

الوعي ما وراء المعرفي لمعلمي المرحلة الأساسية في الأردن بمنحنى STEAM في التعليم

جامعة الشرق الاوسط

كلية العلوم التربوية

ماجستير مناهج وطرق تدريس

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الملخّص

هدفت هذه الدراسة إلى قياس مستوى الوعي ما وراء المعرفي حول تعليم **STEAM** بين معلمي المرحلة الأساسية في الأردن. كما هدفت إلى التعرف على اثر نوع المدرسة والخبرة والتخصص على مستوى الوعي ما وراء المعرفي. تم اختيار عينة قصدية من (370) معلمًا من معلمي المدارس الحكومية والخاصة في محافظتي عمان ومأدبا بالتخصصات التالية {العلوم ، وعلوم الكمبيوتر ، والعلوم الاجتماعية والإنسانية ، والرياضيات} ممن سبق لهم التعرف على منحى **STEAM** .طورت الباحثة استبيانا لقياس مستوى الوعي ما وراء المعرفي مبني على مقياس ليكرت الخماسي الذي بناه **Balcikanli** في (2017). وقد تحققت الباحثة من صدق المحتوى من خلال عرض الأداة على مجموعة من المتخصصين في المناهج وطرق التدريس للوقوف على مدى وضوح البنود وشمولها. وطبقت الباحثة الاستبانة على عينة مكون من 30 فردًا من خارج العينة المستهدفة لحساب الصدق والثبات. وأظهرت نتائج التطبيق صدق بنّاء يتراوح بين (.65 و .82). وخلصت الباحثة إلى أن مستوى ما وراء المعرفي حول منحى ستيم لدى المعلمين الذين لديهم 3–5 سنوات من الخبرة وأكثر ممن يعملون في القطاع الخاص أعلى من أولئك الذين يعملون في القطاع العام. كما أظهرت النتائج عدم وجود فروق ذات دلالة إحصائية في المستوى المنسوب لمتغير التخصص. توصي الباحثة بضرورة قيام وزارة التربية والتعليم بإعداد عملية إصلاح تعليمي ناجحة بالإضافة إلى اعتماد خطة إصلاح موحدة ذات أهداف ومخرجات تعليمية واضحة.

الكلمات المفتاحية: الوعي ما وراء المعرفي، ما وراء المعرفة، منحنى ستيم، معلمي المرحلة الأساسية

Chapter one:
Introduction

1.1 Background of the Study

Teachers have been following the same procedures inside classrooms for many decades during which they send information and students receive it. Teachers are the center of the teaching - learning process. Students retrieve information to answer questions of the exams. Results have been always below standards.

Educational experts around the world have been reconsidering the construction of educational systems *(Beach et al., 2014).* They think that curriculum integration is emergent so that teachers and students cope with the skills of the 21st century. Learning – Teaching systems must be transformed to fulfill this integration *(Sedova et al., 2016).* The goals are beyond achieving high scores in Math and Science, it is the idea of a generation able to self-regulate, learn, and merge in societies professionally. *Kelley and Knowles (2016)* say that modern trends like STEM education have appeared to fulfill this integration. The STEM acronym was introduced in 2001 by scientific administrators at the U.S. National Science Foundation (NSF) (and, 2022). The organization previously used the acronym SMET when referring to the career fields in those disciplines or a curriculum that integrated knowledge and skills from those fields. However, they later preferred the term STEM instead.

STEM education is an approach that focuses on the integration of four subjects together, science, technology, engineering, and math in an applied approach (*Hom, 2014*). This integration is based on real-world applications.

However, the desire to integrate subjects did not stop. There was an essential need to integrate the Arts and design into the other four subjects. This desire has brought to the

world a broader educational system, STEAM. *Riley (2021)* defines STEAM Education as an approach to learning that uses Science, Technology, Engineering, the Arts, and Mathematics as access points for guiding student inquiry, dialogue, and critical thinking. STEAM provides teachers, especially primary stage teachers, with the power that enables them to employ project-based learning *(Taylor, 2019)*

This power also helps them create an inclusive learning environment in which all students can engage, participate, and learn confidently. Teaching would become more collaborative where teachers of different subjects team to end up with exclusive outcomes. This collaboration will come up with experienced cooperative teachers that reflect a positive image to their students to imitate *(Chu et al. 2019).*

According to the Ministry of Education in the USA, in an ever-changing and increasingly complex world, young people are willing to bring knowledge and skills to solve problems, understand information, and know how to implement it. It is more important than ever to collect and evaluate evidence to make decisions *(Taylor, 2019)*. The Ministry of education in Jordan has recently started to introduce the idea of STEAM education gradually to school books.

The STEAM approach is a new trend. It has not yet entered our educational systems in Jordan except for one or two schools that have adopted the STEAM approach on their own. These attempts do not live up to the expectations. Therefore, the need to adopt this approach has emerged strongly among those schools that are interested in educational issues, starting with the primary stages (Saleem, 2021). The researcher needs to know first how teachers think about this system, what it is, how it will be applied, and whether they have enough awareness about this approach *(Riley, 2021)*.

Knowing the level of metacognitive awareness of teachers in the primary stage is the first step that the researcher needs to measure the educational systems that imposed themselves globally and locally soon.

Therefore, specialists cannot go into the mechanisms of implementing the STEAM approach, before realizing the extent to which teachers are aware of such systems *(Margot and Kettler, 2019).* Consequently, this study seeks to measure the level of metacognitive awareness of primary school teachers in Jordan about the STEAM approach.

1.2 Statement of the Problem

STEAM Education is a new global trendy approach *(The, 2020).* Although it is getting more and more popular, Jordan has recently started to realize its importance. The Ministry of Education was keen to provide the newly developed textbooks with some activities supported by instructions for implementation through the STEAM approach.

Primary education will witness an important transformation with its methods and approaches, which include mainly STEAM Education *(Yakman, 2008).* This process certainly requires identifying the level of Metacognitive awareness among primary school teachers about its nature and its implementation. Moreover, its creative activities within this area need to be investigated as well *(Garcia, 2016)*. There are not many studies all over the world, which evaluated the metacognitive awareness among teachers about STEAM education. Even most Arab countries that have similar educational systems to ours have not recognized the STEAM approach yet. This leads to a necessity to evaluate the level of metacognitive awareness among teachers in Jordan about this approach before deciding to adopt it and evaluate its validity.

1.3 The purpose of the study

This study aimed to investigate the level of metacognitive awareness about STEAM education among teachers for the primary stage in Jordan. Besides, It aimed to identify the differences in the level of teachers' metacognitive awareness about the STEAM approach according to the variables School type, Experience, and specialization

1.4 The Questions of the Study

1- What is the Metacognitive level of awareness about STEAM education among primary school teachers in Jordan?

2- Is there a significant difference in the Metacognitive awareness level about STEAM education among Jordanian Primary school Teachers, according to School type, Experience, and Academic specialization?

1.5 Significance of the Study

The theoretical importance: This study presents recommendations to the decision-makers in the educational systems regarding the actual level of metacognitive awareness about STEAM approach among primary school teachers. It will also help them to determine their level of Metacognitive awareness about the STEAM approach. This study will provide benchmarking comparisons about the level of metacognitive awareness of the STEAM approach among primary school teachers according to their experience, specialization and school type.

The practical significance Suggesting guidelines for a comprehensive training awareness program for primary school teachers in Jordan about STEAM depending on their level of metacognitive awareness they have about this system

1.6 Definitions of Terms

Metacognition is defined as simply thinking about one's thinking. More precisely, it refers to the processes used to plan, monitor, and assess one's understanding and performance *(Heyes et al, 2020).*

Metacognition in psychology is what you know about your thoughts. Metacognition is a deeper level of thinking that includes your ability to think, how you understand, adapt, change, control, and use your thought processes *(Drigas and Mitsea, 2021)*

Metacognitive awareness refers to a system of knowledge about the basic manifestations of intellectual activity in general and about one's cognitive possibilities. *(Jaleel and P, 2016)*

-Metacognitive awareness means procedurally the average of the responses of primary school teachers to the Metacognitive Awareness Inventory (MAI) *(for, 2021).* It is measured through a questionnaire specially prepared for this purpose, which involves six domains: Procedural Knowledge, conditional knowledge, Declarative knowledge, planning, monitoring, and evaluation.

STEAM Education is an educational approach to learning that uses Science, Technology, Engineering, the Arts, and Mathematics as access points for guiding student inquiry, dialogue, and critical thinking *(Pears et al., 2019)*

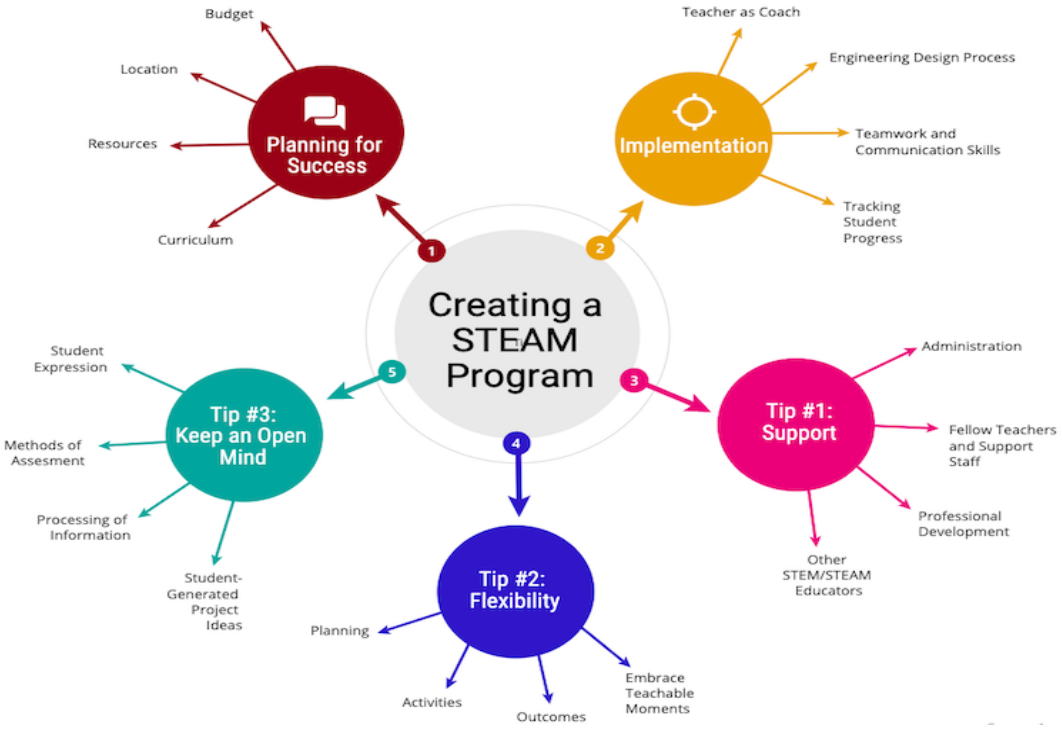


Figure 1: shows the idea of how the STEAM approach can be applied

Primary school Teachers

Primary school teachers are those who teach students from grades one to six, and their ages range from (6 – to 12). Successful primary school teachers need to have a deep interest to inspire young minds and a strong belief that every child has the power to reach his goal (*Demirel et al., 2016*)

Primary schools need to start STEAM education with primary students aiming to prepare them for active participation in the future.

1.7 Limitations of the Study:

We can summarize the limitations of the study by the validity and reliability of the Metacognitive awareness instrument used in the study. Moreover, the seriousness of the

sample members in their responses can be another limitation that affects the results of the study.

1.8 Delimitations

The study was conducted on Primary school teachers in the public and private schools in Madaba and Amman. The researcher implemented the study on school teachers who have already known about The STEAM approach during the second semester of the school year 2021-2022.

Chapter TWO:
Review of Related Literature

2.1 Conceptual Framework

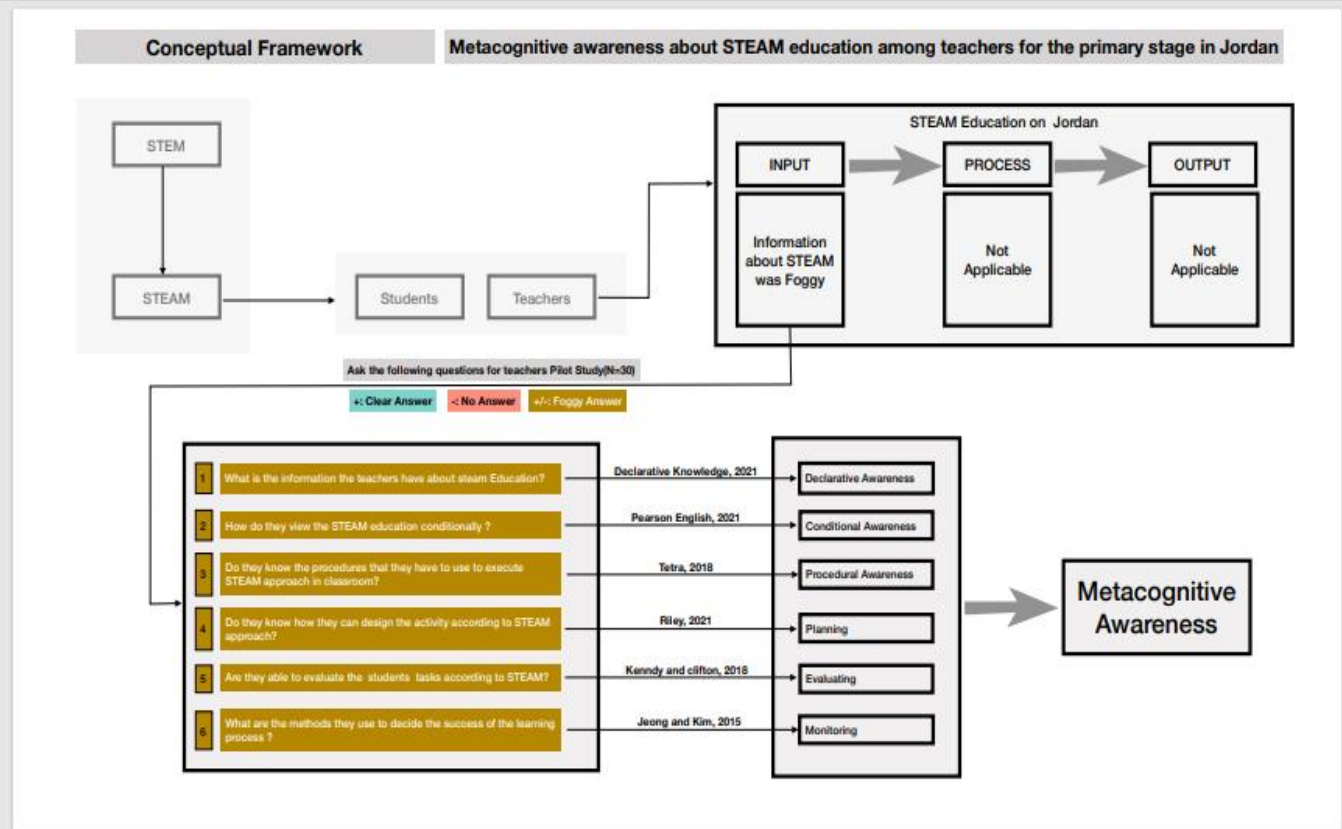


Figure 2: The conceptual framework of the study

This conceptual framework summarizes the problem of the study .It started with the concept of STEM as an educational system which integrates science , technology , engineering and math together inside classrooms and how it developed and became STEAM after adding ARTS into the STEM approach. As the educational systems in Jordan needs such creative systems to be added to the curricula, the researcher asked some metacognitive question to 30 teachers to evaluate their level of metacognition about STEAM .The results showed that their knowledge is foggy .

2.2 Theoretical Framework

Metacognition and Metacognitive Awareness

Metacognition, a term that was introduced by John H. Flavell in 1979, is thinking about thinking. Metacognition is very important for teachers. With metacognition, teachers get to be mindful of their teaching process and try hard to reach the personal and the proficient development. Metacognition gives the power to teachers to reflect on who they are, what they know, what they need to know, and how they can get to that point. *(Rovers et al., 2019)*

“Metacognition" is derived from the Greek root word "Meta" which means "beyond" and the Latin word "cognoscere” which means, "getting to know". Metacognition refers to a person’s ability to be aware of what they are thinking about; it’s a useful thought process” *(Ali et al., 2021).*

Owen and Vista (2017) state metacognition as a widely applicable concept that refers to knowledge, which focuses mainly on one’s amount of knowledge. *Tarricone, (2011)* added that metacognition is a teachable skill that is basic to other skills such as problem-solving, decision-making, and critical thinking.

Metacognition describes the processes through which teachers plan, monitor, evaluate and make changes to their methods of teaching and thinking. Metacognition helps teachers who have difficulties in planning, self-organizing, and directing their teaching process to manage their teaching processes easily and more skillfully *(Bernacki and Perera, 2020).*

Metacognition is a type of higher-order thinking that entails active control over the cognitive processes that occur during learning. Metacognitive activities include deciding

how to approach a specific learning activity, measuring comprehension, and evaluating progress toward completing a task.

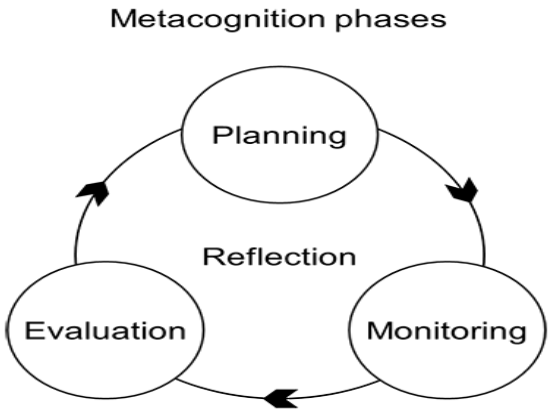


Figure 3: shows the metacognition phases (Metacognition Self-Directed Project, 2017)

Metacognitive awareness

Metacognitive awareness is derived from metacognition. According to (Jia et al., 2019) the development of metacognitive awareness can help in creative problem solving. Therefore, it is up to the teachers to provoke the amount of metacognitive awareness that students have (Chon and Shin, 2019). It is equally important for the teachers to acquire the awareness of metacognition, which will enable them to improve their instructional practice. In other words, teachers are required to think beyond thinking to ensure that they can teach metacognitive thinking.

As the STEAM approach has recently become a global need, it is important to measure the level of Metacognitive awareness about STEAM education among teachers. It can lead to "lifelong learning" and " self-learning ", due to its importance in psychology *(Bulut,2018)* The results are ensured by applying the six levels of the process *(Quigley et al., 2017).* These levels involve (Procedural Knowledge, conditional knowledge, Declarative knowledge, planning, monitoring, and evaluating). Teachers no doubt face

many difficulties in adapting the STEAM approach, but with the help of the officials, they will control all obstacles *(Conradty and Bogner, 2020)*

STEAM Education

STEAM is the shortened form for Science, Technology, Engineering, Art, and Math. It is an approach to learning, which stimulates students to think more broadly about real-world problems. This intriguing approach has paved the way for important advancements just like the iPhone and the first tablet computer *(Hsiao and Su, 2021)* .

Milara et al. (2020) define STEAM education as an approach to teaching and learning that stimulates inquiry, discussions, and critical thinking.

STEAM Education gives teachers the power to focus on project-based learning in which each of the five subjects is engaged (Riley, 2021). Accordingly, this process fosters an inclusive learning environment in which all students can participate and be interactive parts of the learning process. By making comprehensive classrooms, teachers point to develop learning circumstances that are fair and supportive to each student. Comprehensive learning gives students versatile learning choices and compelling ways for fulfilling targets in classrooms where they become a part of the whole learning process. Through this holistic approach, teachers can exercise both sides of their brains at once in parallel with their students. The students will be exercising their brains as well, but certainly for different aims *(Sharipova, 2022).*

However, knowing something is just one part of the information's value. The simple act of acquiring information is not often as important as knowing what to do once you have it. Being able to think critically means, you know how to apply what you are learning which are basic requirements for using STEAM education inside classrooms. (*Uluçınar and Aypay, 2016)*

O'Hara et al. (2019) claim that teaching with STEAM enables teachers to gain awareness about and control over how they think and teach by planning, monitoring, and evaluation. In addition, it leads to adjusting their instructional goals and teaching strategies to follow their students' needs and their sociocultural context. *O'Hara et al. (2019)* claim that the higher the level of knowledge about the STEAM approach among teachers, the higher the level of their performance inside classrooms. This knowledge empowers them to pick up mindfulness around and control over how they think and teach by arranging, checking, assessing, and altering their directions, objectives and instructing methodologies in understanding their students' needs. Accordingly, teachers empower students to be aware of what they know and do not know with self-regulation.

Depending on the level of their metacognitive awareness, teachers should collaborate to produce a generation interested and skilled in STEAM. They should work through teams integrating the five subjects and depending on their level of Metacognitive awareness. Consequently, they will turn into Metacognitive STEAMERS.

To conclude, evaluating teachers' metacognitive awareness helps us to know how teachers think about STEAM education and their readiness to adopt this approach. The officials will probably find solutions to the obstacles the teachers may face.

2.3 Relevant studies

The following section presents a summary of other studies on Metacognitive Awareness and STEAM education or other relevant studies in master's thesis across universities:

Memnun *and Akkaya, (2009)* believed that the level of metacognitive awareness among primary teachers could affect the success of the learning environment positively or negatively. Therefore, this quantitative study aimed at addressing specific and general knowledge and regulation of cognition among teachers. The study was applied to candidate teachers studying at Uldage university. The researchers did not measure the level of Metacognition about the STEAM approach among teachers. The researcher considered Gender and class levels as variables in the study that may affect teachers' level of Metacognition.

Rowsome et al. (2014) wanted to make it clear that codifying thinking through E-portfolios is a good proof of metacognitive awareness among preservice teachers. The underpinnings of autonomous learning are viewed as metacognition, which involves knowledge of one's cognition and self-regulation of learning. This study was imposed on other researchers to look deep into teachers' abilities and find other strategies to support them. STEM approach was the strategy target to measure.

Park and Prommas (2017) aimed at investigating how metacognitive reflection helped develop and shape teachers' pedagogical reasoning of STEM instruction. The study took the 2015 data of 23 participants. Data includes metacognitive reflection journals of five days and a focus group interview. The results indicated that metacognitive reflection journals were effective in developing teachers' pedagogical logic thinking during the professional development institute.

Sevian et al. (2018) focused on the stimulation of learning STEM subjects within contexts. They focused also, on how the learning process occurs and enhances. In addition, the application of contexts in different settings was also focused on. The researchers used a reflection rubric to apply on 23 participant s The papers show how a professional development approach functions to support STEM teachers to develop CBL materials, and how precise scaffolding is used in the classroom to help students develop more complicated thinking skills

Kohen and Kramarski (2018) believed that if teachers were incapable of activating metacognitive skills, it would be difficult for them to instill these skills in their students. The research indicates that metacognition is not attained spontaneously; it demands explicit scaffolding. The pedagogical metacognitive model is applied through microteaching, which is based on planning, performing, and reflective evaluation of a teaching experience performed by one of the preservice teachers to his peers. They acted as students and recorded the performance in a video-digital laboratory.

Bedar & Al-Shboul (2020) investigated the effect of using the STEAM approach on the motivation towards learning among school students in Jordan. The sample of this study involved 32 high school students; the individuals in the study were intentionally chosen and distributed randomly into two groups: the control group consisted of 19 students who conventionally studied Geography, and the experimental group consisted of 13 students who studied the same content using the STEAM approach. The results showed no significant difference in motivation in all of its constructs except for (Class Anxiety) which was in favor of the experimental group.

Bush et al. (2020) focused on analyzing the perceptions of grades 3–5 elementary students of their STEAM learning experiences. 1,572 student-written open responses to

six prompts by 262 student participants were analyzed. The systematic analysis indicated three primary themes one of which was the presence of Metacognition in STEAM. The study revealed that STEAM students' perceptions provide strong support for STEAM learning experiences

Choy et al. (2020) proved the importance of using teaching approaches that encouraged critical thinking and reflective thinking skills for STEM students. The study was applied to a sample of 958 STEM and 1256 non-STEM students in Diploma and bachelor programs in a Malaysian university. The students took part using the survey questionnaires. The results clarified that STEM students do better than non-STEM students do.

Alt and Raichel *(2020)* conducted a mix-methods study to assess the effect of semi-structured and unstructured reflective journaling (RJ) on undergraduate students' perceptions of their metacognitive awareness. The sample consisted of 97 undergraduate students' perceptions of their metacognitive awareness. Semi-structured RJ was found effective in nurturing students' perceptions of their regulation of cognition

Hughes and *Partida (2020)* implemented a quantitative exploratory study to measure the professional development (PD) experience and the associated Metacognitive comprised preservice STEM education teachers (N = 11) enrolled in a dual teaching certification and Master in Education program. The researcher found it necessary to address the Metacognitive Awareness of the STEM approach and then find methods to promote it.

Kustiana et *al., (2020)* aimed to analyze the metacognitive skills and creative thinking of students in STEM education in senior high school, 150 students were involved in the

study. The researchers found that practising the biotechnology material by students in senior high school would be more meaningful if shared with STEM education .

Mutambuki et al. (2020) believed that metacognition and active learning have benefits on student performance. They investigated differences in performance in the General Chemistry between (the treatment group) who were exposed to the explicit teaching of metacognition combined with active learning and their counterparts who were exposed to active learning alone (comparison group). The results of the study showed that metacognitive instruction infused with active learning has a significant effect on student performance in General Chemistry.

*ElSayary (*2021*)* investigated the factors that affect teaching and assessing students' creativity. The researcher used a mixed-method design to answer the research questions. The study was carried out in a private school in the UAE. The participants were science, technology, language art, and mathematics teachers (n=30). The findings of this study highlighted the importance of motivation, cognition, and metacognition in attempting to influence students' creativity in STEAM classes.

Kandemir and Karadeniz (2020) believed that mathematical modelling activities did not focus on existing STEM integration practices. They focused their study on Mathematical modelling using STEM integration practices. They added that the theories of both metacognition and social interaction development could promote teachers' abilities to focus better on STEM integration. The participants of the study were pre-service teachers who were in a mathematics-teaching program at a university located in the west part of Turkey.

Mulyani and Arif (2021) supposed that good learning is learning that combines an approach with an appropriate learning model. The study was done to realize the implementation of a learning model with an approach to students' metacognitive thinking

ability **.**The study is conducted with a quantitative experiment, and qualitative descriptive data analysis techniques. Data gathering instruments were written tests with multiple choices. The results recommended at the end the importance of improving metacognitive thinking ability using the right approaches. The study recommended the importance of developing metacognitive activities for pre-service teachers.

Morphew (2021) proved that students need to engage in accurate metacognitive monitoring to make appropriate metacognitive control decisions. The sample consisted of Student learning in introductory Physics Course. The results indicate that some students improve the accuracy of their predictions over a semester. However, low-performing students are less accurate at predicting their exam grades and tend not to improve their metacognitive standards over a semester.

2.4 Gaping Table

Table 1: ***explains what distinguishes the current study from previous studies***

Study Title	Purpose	Sample and Sampling	Methodology
The levels of metacognitive awareness of primary teacher trainees (2009)	This study aims to determine the level of metacognitive awareness of primary teacher trainees and to examine whether there is a difference according to class levels and gender or not	The study was applied to candidate teachers studying at Uludag University	Quantitative
Gap	The mentioned study focused on studying the metacognitive awareness among teachers in general taking class level and gender as variables. In this research, we study the level of metacognitive awareness among the primary school teachers during service about the STEAM approach taking specialization, school type, and experience as the main variables		
Capturing evidence of metacognitive awareness of pre-service STEM educators' using 'codifying' of thinking through E-E-portfolios(2014)	Identify students' metacognitive awareness during a design task	The participants were 1st-year students (freshmen) of a four-year Initial Technology Teacher Education degree program.	an exploratory study
Gap	We focus in our study on the level of metacognitive Awareness about STEAM Education among in-service primary school teachers using the quantitative methodology, while the previous study focused on the level of metacognitive awareness about STEM Education among students using the exploratory method		

Study Title	Purpose	Sample and Sampling	Methodology
Development of Thai Teachers' Pedagogical Reasoning by Utilizing Metacognitive reflections in STEM Professional Development(2017)	Investigating how metacognitive reflection helped develop and shape teachers' pedagogical reasoning of STEM instruction during the institute	23 participants.	a reflection rubric
Gap	The previous study focused on how metacognitive awareness helped develop Thai teachers' reasoning of STEM. Our study focuses on the level of Metacognitive awareness of TEAM among teachers in private and public schools in Jordan.		
How does STEM context-based learning work: what we know and what we still do not know(2018)	stimulation of learning STEM subjects within contexts, how the learning process occurs and is enhanced, and the application of contexts in different settings	STEM teachers	Seven papers
Gap	The above study aimed at stimulating learning STEM subjects within a context. The current study is on the other hand, interested in the level of Metacognition about STEAM education among teachers		
Promoting Mathematics Teachers' Pedagogical Metacognition: A theoretical-practical Model and Case Study(2018)	(a) building a theoretical-practical model of pedagogical metacognition designed for preservice mathematics teachers that focuses on self-regulation processes; (b) applying this model in a technological-pedagogical context, supported by reflection; and (c) examining the implementation of the model.	two preservice teachers' actual teaching are analyzed and compared	with a case study methodology
Gap	The Previous study focused on building a practical model for preservice mathematics teachers while this study focuses on teachers of different subjects like science, computer, computer sciences, mathematics and social studies, and humanities.		
The Effect of Using STEAM Approach on Motivation Towards Learning Among High School Students in Jordan(2020)	This study aimed at investigating the effect of applying integrated Science, Technology, Engineering, Art, and Mathematics (STEAM) approach on motivation among students of grade 10 in a private school in Amman	The sample of this study involved 32 high school students; the individuals in the study were intentionally chosen and distributed randomly into two groups: the control group consisted of 19 students who conventionally studied Geography, and the experimental group consisted of 13 students who studied the same content using the STEAM approach	quasi-experimental method
Gap	In this research, we study the level of metacognitive awareness among primary school teachers with science, computer, languages, and professional education majors during service about the STEAM approach in Jordan. While the previous study focused on investigating the effect of applying STEAM on students in Grade 10 in a private school in Amman.		

Study Title	Purpose	Sample and Sampling	Methodology
Elementary Students' STEAM Perceptions Extending Frames of Reference through Transformative Learning Experiences(2020)	Conducting a thematic analysis of student STEAM survey open responses to provide the field with an examination of grades 3–5 elementary students' perceptions of their STEAM learning experiences	1,572 student-written open responses to six prompts by 262 student participants	qualitative study
Gap	The above study targeted the perception of the elementary students of their STEAM learning experiences. This study aims at evaluating the level of Metacognitive awareness among teachers for the primary stage of STEAM education.		
Metacognitive Knowledge, Metacognitive Experience, and Its Effects on Learning Outcomes for Stem and Non-Stem Malaysian Students) 2020	examined the effects of metacognitive knowledge, metacognitive experience, and quality learning on learning outcomes for STEM and non-STEM Malaysian university students	958 STEM and 1256 non-STEM students on Diploma and bachelor programs	survey questionnaires qualitative study
Gap	The previous study focused on the importance of using encouraging teaching approaches for STEM students in a Malaysian University. The current study focused on measuring the Level of Metacognitive Awareness about the STEAM approach among primary school teachers in Jordan.		
Reflective journaling and metacognitive awareness: insights from a longitudinal study in higher education(2020)	Assessing the effect of semi-structured and unstructured reflective journaling and metacognitive awareness	97 undergraduate students' perceptions of their metacognitive awareness.	mix-methods study
Gap	The previous study focused on the reflection of Metacognitive awareness while this study focuses on evaluating the level of metacognitive awareness among teachers.		
promoting pre-service STEM Education Teachers' Metacognitive Awareness(2020)	This study aimed at addressing specific and general knowledge and regulation of cognition about STEM Education among teachers	11 pre-service STEM education teachers enrolled in a dual teaching certification and Masters in Education program	Mixed methods exploratory study
Gap	The current study focuses on the level of metacognitive awareness among the primary school teachers during service about the STEAM approach, while the mentioned study focused on studying the metacognitive awareness among teachers in general and before service about the STEM system		
The analysis of metacognitive skills and creative thinking skills in STEM education at senior high school for biotechnology 2020	analyze the metacognitive skills and creative thinking of students in STEM education in senior high school	150 senior high school students.	questionnaires and observations
Gap	The previous study aimed at analyzing the Metacognitive skills and creative thinking of students in STEM education. The target of this study was the level of Metacognitive in STEAM education among teachers in primary schools in Jordan.		

Study Title	Purpose	Sample and Sampling	Methodology
Metacognition and Active Learning Combination Reveals Better Performance on Cognitively Demanding General Chemistry Concepts than Active Learning Alone (2020)	knowing about the effect of the "explicit teaching of metacognition" combined with active learning on student performance in chemistry courses	students in (treatment group) and their counterparts who were learning alone (comparison group)	a quasi-experimental study design
Gap	The above study aimed at knowing the effect of teaching Metacognition on students' performance. This current study focuses on evaluating the level of Metacognitive awareness among teachers.		
Teaching and Assessing Creativity in STEAM Education 2021	investigate the factors that affect teaching and assessing students' creativity	30 science, technology, language art, and mathematics teachers	mixed-method design
Gap	The previous study focused on investigating the factors that affect teaching and assessing students' creativity while using STEAM Education in UAE. This study on the other hand focuses on the level of Metacognition about STEAM among teachers for the primary stage in Jordan.		
Pre-Service Teachers' Cognitive and Metacognitive Processes in Integrated STEM Modelling Activity(2021)	This paper focuses on cognitive and metacognitive skills, and levels and mathematical content knowledge of pre-service mathematics teachers in a model eliciting task	The participants of the study were pre-service teachers who were in a mathematics teaching program in a university located in the west part of Turkey	Quantitative study
Gap	In this research, we study the level of metacognitive awareness among primary school teachers with science, computer, languages, and professional education majors during service about the STEAM approach in Jordan. While the previous study focused on studying the metacognitive awareness among teachers who teach Mathematics and before service about the stem system in West Turkey.		
Implementation of project-based learning (PJBL) based on science, technology, engineering, and mathematics (STEM) to improve Metacognitive-thinking ability. (2021)	Knowing the implementation of a learning model with an approach to students' metacognitive thinking ability	one group pretest and posttest design	quantitative descriptive methodology
Gap	The previous study focused on using a learning model with an approach to the Metacognitive thinking ability of students. The current study aims at evaluating the level of Metacognitive awareness among teachers.		

Study Title	Purpose	Sample and Sampling	Methodology
Changes in metacognitive monitoring accuracy in an introductory physics course 2021	examined the trajectories in the accuracy of students' metacognitive monitoring over a semester, along with the effect of monitoring accuracy feedback	Student learning in introductory Physics Course	Longitude study
Gap	The previous study aimed at monitoring the level of Metacognitive monitoring over the course among physics students while this current study aimed at measuring the level of Metacognitive awareness about STEAM education among Teachers		

Chapter THREE:
Methodology and procedures

3.1 Methodology

This study followed the descriptive quantitative methodology to measure the Metacognitive level of awareness about STEAM education among primary school teachers in Jordan. The researcher, on the other hand, followed the different descriptive analytic approach to examine the degree of difference in metacognitive awareness about STEAM education among Jordanian Primary schoolteachers, according to School type, Experience, and specialization.

3.2 Population and Sampling

Purposive sampling was used to determine the study sample, which consisted of 370 male and female teachers working in public and private schools in the Amman / Madaba governorates. Choosing this sample was based on their knowledge about the STEAM approach. Table (2) shows the distribution of the sample study according to specialization, experience, and school type.

Table 2: ***shows the distribution of the study sample according to personal and demographic variables***

specialization		**Science(N=60)**		**Computer Science(N=62)**		**Math (N=61)**		**Social studies and humanities N=257**		
School type		Public	Private	Public	private	Public	private	Public	private	
Ex.	1-2	5	11	2	1	5	4	10	26	64
	3-5	11	3	5	9	2	4	9	10	53
	More than 5	15	15	25	20	10	36	88	44	253
	TOTAL	31	29	32	30	17	44	107	80	370

3.3 Study instrument:

The researcher developed a five-Likert scale questionnaire Metacognitive awareness inventory for teachers (MAIT) to measure metacognitive awareness among primary

school teachers about the STEAM approach built by the researcher (Balcikanli, 2017). The questionnaire consists of two parts, as shown below

Part one: **Demographic information**

It was the information of the teachers, who filled in the questionnaire. This information was Type of school type (private, public), Specialization (science, computer science, mathematics, social studies, and humanities), and experience (1-2 years, 3-5 years, and more than 5 years).

Part Two: Metacognitive Awareness of the STEAM approach

It consisted of two main parts, **knowledge about cognition** with the following subheadings Declarative knowledge(8items), procedural knowledge(4 items), Conditional knowledge(5items), and the **Regulation of cognition with** the following subheadings; planning (7items), comprehension monitoring(7items), information management strategies(9 items), debugging strategies(4 items) and evaluation (5 items). The researcher developed the instrument used in the original questionnaire for measuring the level of metacognitive awareness concerning specialists in measurement and evaluation, as the scale of the original questionnaire was binary (0-1), while the scale in the developed questionnaire was quintuple (1-5). Two of the items were deleted according to the recommendations of the referees.

Validity and Reliability of Study Instruments:

1-Content Validity:

The researcher verified the content validity by presenting the ianstrument to four specialists in curricula and teaching methods to determine the extent of the clarity and comprehensiveness of the items, and the degree of correlation between the items and their

domains. The researcher adjusted the instrument according to the specialists' recommendations. The adjustment was little as the instrument was internationally judged.

2-Constructive Validity

Table 3: ***shows the correlation coefficient between the domains of the instrument***

Metacognitive Awareness	**Pearson correlation with overall performance**	**Sig**
Knowledge about metacognitive Awareness	0.7	0.02
Regulation of Metacognitive Awareness	0.82	0.00

Table No. 3 shows that the correlation coefficients between the main domains of the instrument and the instrument as a whole are statistically significant, as they ranged between (0.82 and 0.7). This indicates that the instrument has a high constructive validity over the main domains.

Table 4: ***shows the coefficient correlation between the main domains and the subdomains of the instrument***

Metacognitive Awareness of Knowledge	**Pearson correlation**	**Sig**
Declarative Knowledge	0.63	0.003
procedural Knowledge	0.72	0.000
Conditional knowledge	0.88	0.03
Knowledge about Cognition	**0.7**	**0.02**
Regulation of cognition	**0.82**	**0.00**
Planning	0.88	0.002
Information management	0.81	0.000
Comprehension monitoring	0.77	0.04
Debugging strategies	0.92	0.02
Evaluation	0.71	0.01

Table No. 4 shows that the correlation coefficients between the domains of knowledge about cognition and its sub-domains are statistically significant, ranging

between (0.88_0.63). The table also shows that the correlation coefficients between the regulation of cognition and its sub-domains are statistically significant, ranging between (0.92_0.71), which indicates that the instrument has high constructive validity over the sub-domains.

3.4 The reliability of the study instrument

To measure the reliability of the instrument the Cronbach's alpha coefficient was calculated to measure the reliability according to the pilot sample responses, which consisted of 30 teachers. The overall reliability coefficient of the instrument was 0.92 according to Cronbach's alpha, which indicates that the instrument has high reliability. It also indicates its readiness and suitability to be applied to the study sample.

3.5 Statistical procedures

1-Correlation coefficients and Cronbach's alpha coefficient to check validity and Reliability of the Metacognitive Awareness Instrument.

2-. Frequencies, percentages means, and standard deviations to measure the level of metacognitive awareness among teachers regarding STEAM Education.

3-Three way Anova test to measure the impact of school type, experience, and specialization on the level of metacognitive awareness

3.6 Study Procedures:

To answer the study questions and achieve its goals, the procedures below were followed:

1-Specify the study population, sampling, and sample

2-Develop a metacognitive questionnaire by reference to the original Metacognitive Awareness Inventory (MAI)

3-Examine the validity and reliability of the study instrument and modify it to its final form

4-Apply the questionnaire and collect study data from the responses of the study sample.

5-Code and edit the collected data

6-Analyze data and find the results of the study.

7-Write conclusions and recommendations.

Chapter Four
Findings and Results

This chapter presents the findings of the data collected from the responses to the questions of this research, which aimed mainly at measuring the level of Metacognitive awareness about STEAM approach among teachers for the primary stage in Jordan. It also aimed at measuring the impact of the school type, experience, and specialization on the level of Metacognitive awareness.

4.1*:* The findings of the Metacognitive Level of awareness in knowledge about cognition and regulation of cognition.

To answer this question, the means, standard deviations, and ranks were calculated for the dimensions of the study instrument and their domains as shown in tables (5-17).

4.1.1 The findings of the level of knowledge about cognition and regulation of cognition

Table 5: ***Means and Standard Deviation of teacher responses to the main domains and sub-domains of the Metacognitive Awareness Inventory.***

Subdomains	**mean**	**Standard deviation**	**rank**	**Relative importance**
Declarative knowledge	3.47	0.51	**2**	Medium
Procedural knowledge	2.28	1.11	**3**	Low
Conditional knowledge	3.92	0.67	**1**	High
Knowledge about cognition	**3.32**	**0.51**	**Medium**	
Planning	3.94	0.60	**1**	High
Information management strategies	3.88	0.62	4	High
Comprehension Monitoring	3.88	0.60	**3**	High
Debugging Strategies	2.84	0.94	5	Medium
Evaluation	3.89	0.62	**2**	High
Regulation of Cognition	**3.77**	**0.55**	**High**	
overall performance (Metacognitive Awareness)	3.61	0.51	High	

Low: 1-2.29, Medium: 2.3-3.59, High: 3.6 -5 or higher (oxford, 1990)

It is noted from Table (5) that the mean of Metacognitive Level of awareness about STEAM education among primary school teachers in Jordan from the point of view of the teachers as a whole is (3.61), with a standard deviation of (0.51), with a high degree. The mean of the Regulation as a whole was higher than that of the knowledge of cognition.

The highest area related to Knowledge about Cognition was Conditional knowledge (M=3.92, SD=0.67), with a high degree. Declarative knowledge came in second place (M=3.47, SD=0.51), and with a high degree. In the third place came the Procedural knowledge (M=2.28, SD=1.11), with a low degree. Knowledge about cognition came last (M=3.32, SD=0.51) with a medium degree.

The highest domains related to Regulation of cognition were the planning domain with (M=3.94, SD=0.60), with a high degree, and the evaluation domain came in the second place with (M=3.89, D=0.62), and a high degree, and so on for the rest of the fields. The Debugging Strategies came last (M=2.84, SD=0.94), with a medium degree.

4.1.2 Level of Metacognitive awareness in knowledge about cognition

Table 6: ***Means, standard deviations, and rank of responses for the domain of declarative knowledge***

Item	Mean	Standard deviation	Rank	Relative importance
I realize my strengths and my weaknesses about my ability to use STEAM approach.	3.61	1.10	1	High
I can specify what kind of information could be most important for teaching my students according to STEAM approach.	3.50	1.26	3	High
I'm good at organizing information when teaching according to STEAM approach	3.42	1.27	6	Medium
I know what the student expects me to teach him, which is not against STEAM approach	3.54	1.17	2	High

Item	Mean	Standard deviation	Rank	Relative importance
I am good at remembering the information related to the use of STEAM in teaching.	3.46	1.22	5	Medium
I feel like I have control over my students' teaching, following STEAM approach.	3.36	1.20	8	Medium
I can judge how successful what I taught according to the STEAM approach	3.36	1.23	7	Medium
I teach better, when I pay more attention to using the STEAM approach.	3.49	1.15	4	Medium
Declarative Knowledge	3.47	0.51		Medium

Low: 1-2.29, Medium: 2.3-3.59, High: 3.6 -5 or higher (oxford, 1990)

Table (6) shows that the means for Declarative Knowledge ranged between (3.36 - 3.61), with standard deviations between (1.10 - 1.27). The declarative knowledge as a whole obtained a mean of (3.47) with a standard deviation (0.51) and a medium degree of appreciation. “I realize my strengths and my weaknesses about my ability to use STEAM approach.” came in the first rank, with (M=3.61, SD=1.10), with a high degree of estimate. Item (20) came in the last rank, which states,” I feel like I have control over my students' teaching, following STEAM approach” with (M=3.36, SD=1.20), with a medium degree of Metacognitive Awareness.

4.1.3 The findings of the level of Metacognitive Awareness in procedural knowledge.

The values of means, standard deviations, and ranks were calculated. Table (7) shows the results of the analysis:

Table 7: ***Means, standard deviations, and rank of responses for the domain of procedural knowledge.***

Item	Arithmetic mean	Standard deviation	rank	Relative importance
I try to employ teaching strategies that I used before and that were successful if I taught according to the STEAM approach When teaching	2.33	1.32	1	Low
I have a specific goal for every teaching strategy that can be used in teaching according to the Steam approach	2.26	1.32	3	Low
I am familiar with the strategies I use based on the STEAM approach when I teach my students.	2.31	1.32	2	Low
I find myself automatically using useful teaching strategies that match the STEAM approach.	2.21	1.30	4	Low
Procedural knowledge	2.28	1.11	Low	

Low: 1-2.29, Medium: 2.3-3.59, High: 3.6 -5 or higher (oxford, 1990)

Table (7) shows that the means for the procedural knowledge ranged between (2.21 - 2.33), with standard deviations between (1.30 - 1.32). The procedural knowledge as a whole obtained (M=2.28, SD= 1.11). Item (3) which states" I try to employ teaching strategies that I used before and that were successful if I taught according to the STEAM approach When teaching" came in the first rank, with (M=2.33, SD=1.32) and a low level of Metacognitive Awareness in Procedural Knowledge. Item (33) which states "I find myself automatically using useful teaching strategies that match the STEAM approach" came in the last rank, with (M=2.21, SD=1.30) and a low level of Metacognitive Awareness in Procedural Knowledge.

4.1.4 The findings of the level of Metacognitive Awareness in Conditional knowledge.

The values of means, standard deviations, and ranks were calculated. Table (8) shows the results of the analysis:

Table 8: ***means, standard deviations, and rank of responses to the conditional knowledge domain.***

Item	mean	Standard deviation	Rank	Relative importance
I teach better, when I have more knowledge about the subject I will teach following STEAM approach in education.	3.98	0.93	**1**	High
I use different education strategies according to the situation , which suits STEAM approach	3.97	0.87	**2**	High
I can motivate my students to learn according to STEAM approach when they need it.	3.89	0.90	**4**	High
I use my intellectual strength to compensate for my weaknesses in teaching according to STEAM approach I use my intellectual strengths	3.89	0.87	**3**	High
I can decide when to use each strategy that is most effective according to the STEAM approach.	3.85	0.83	**5**	High
Conditional Knowledge	3.92	0.67	High	

Low: 1-2.29, Medium: 2.3-3.59, High: 3.6 -5 or higher (oxford, 1990)

Table (8) shows that the means for the conditional Knowledge ranged between (3.85-3.98), with standard deviations between (0.83-0.93). The conditional knowledge as a whole was obtained (M=3.92, SD=0.67) and a high level of Conditional Level. Item (15), which states, "I teach better when I have more knowledge about the subject I will teach following STEAM approach in education" came in the first rank with (M=3.98, SD=0.93. In addition, item (35), which states "I can decide when to use each strategy that is most

effective according to the STEAM approach" came in the last rank with (M=3.85, SD=0.83), with a high level of Metacognitive Awareness in the Conditional knowledge.

4.1.5. The findings of the level of Metacognitive Awareness in the planning domain.

The values of arithmetic means, standard deviations, and ranks were calculated. Table (9) shows the results of the analysis:

Table 9: ***Means, standard deviations, and rank of responses for the planning domain***

Item	Arithmetic mean	Standard deviation	Rank	Relative importance
I need to increase the frequency of teaching time to save more time to fit in with the STEAM approach.	3.97	0.80	**2**	High
I think about what students need before any learning process starts according to the STEAM approach	4.05	0.82	**1**	High
I am able to set specific targets that correspond to the Steam approach. before the beginning of any lesson	3.94	0.84	**3**	High
I ask myself questions about the scientific subject and the way in which to follow STEAM approach in teaching it, before I start the lesson.	3.94	0.85	**4**	High
I encourage my students to consider several ways to use STEAM approach to solve problems and choose the best.	3.92	0.91	**5**	High
I need to read the instructions showing the sequence of using STEAM approach in activities carefully before I start the task	3.87	0.88	**7**	High
I organize my time to achieve my goals so that they best match STEAM approach.	3.91	0.89	**6**	High
Planning	3.94	0.60	High	

Low: 1-2.29, Medium: 2.3-3.59, High: 3.6 -5 or higher (oxford, 1990)

Table (9) shows that the means for planning domain are between (3.87-4.05), with standard deviations from (0.80-0.91). The Planning domain as a whole obtained (M=3.94,

SD 0.60) and a high level of Awareness of Planning. Item (6), which states," I think about what students need before any learning process starts according to the STEAM approach", came in the first place with (M=4.05, SD=0.92). Item 42, which states "I need to read the instructions showing the sequence of using STEAM approach in activities carefully before I start the task" (M=3.87, SD=0.88), and a high level of Metacognitive Awareness in Planning came in the last place .

4.1.6 The findings of the levels of Metacognitive Awareness in Information management strategies.

The values of means, standard deviations, and ranks were calculated, and Table (10) shows the results of the analysis:

Table 10: ***Means, standard deviations, and rank of responses to the field of information management strategies***

Item	mean	Standard deviation	rank	Relative importance
I slow down when I find important information in the lesson that does not fit the STEAM approach.	3.90	0.83	2	High
I focus my attention consciously on important information in the teaching content based on the STEAM approach	3.97	0.83	1	High
I focus on the meaning and the importance of new information when teaching according to STEAM approach	3.90	0.87	3	High
I create my examples to make scientific content built according to STEAM approach more useful	3.90	0.85	4	High
I need to draw pictures or diagrams to help students understand while learning according to STEAM	3.87	0.87	6	High
I try to transform new information into easier words to match the use of STEAM approach.	3.87	0.85	5	High

Item	mean	Standard deviation	rank	Relative importance
I will use the text organizational structure to help students learn by STEAM approach	3.86	0.85	7	High
I try to divide the STEAM teaching process into smaller steps.	3.84	0.95	8	High
I focus more on the general meaning than the details when teaching according to STEAM approach.	3.79	0.90	9	High
Information management strategies	3.88	0.62	High	

Low: 1-2.29, Medium: 2.3-3.59, High: 3.6 -5 or higher (oxford, 1990)

Table (10) shows that the means for Information management strategies ranged between (3.79-3.97), with standard deviations between (0.85 - 0.95). The Information management strategies as a whole (M=3.88, SD=0.62). Item (13) which states, "I focus my attention consciously on important information in the teaching content based on the STEAM approach" came in the first rank (M=3.97, SD=0.83. Item (47) came in the last rank, which states "I focus more on the general meaning than the details when teaching according to STEAM approach" with (M=3.79, SD=0.90), and a high level of Metacognitive Awareness in the domain of Information management strategies.

4.1.7 The findings of the level of Metacognitive Awareness in comprehension Monitoring.

The values of means, standard deviations, and ranks were calculated. Table (11) shows the results of the analysis:

Table 11: ***Means, standard deviations, and rank of responses for the comprehension control domain.***

Item	Arithmetic mean	Standard deviation	Rank	Relative importance
I ask myself periodically if I am meeting the goals that enable me to teach according to STEAM approach	4.03	0.81	1	High
I consider several alternatives to any problem I might encounter in teaching, according to STEAM approach.	3.96	0.78	2	High
I ask myself if I considered all the options that STEAM can offer when solving a problem	3.90	0.79	3	High
I feel like I have control over my students' teaching, following STEAM approach.	3.77	0.92	7	High
If I teach according to the STEAM approach, I need to analyze the benefits of the strategies used during my teaching.	3.81	0.86	6	High
I feel like I am going to stop regularly to check students' understanding to ensure that their learning is effective according to Steam	3.88	0.83	4	High
I ask myself questions about the harmony and fluidity of my teaching process when I teach according to the STEAM approach.	3.84	0.88	5	High
Monitoring comprehension	3.88	0.60	High	

Low: 1-2.29, Medium: 2.3-3.59, High: 3.6 -5 or higher (oxford, 1990)

Table (11) shows that the means for the Monitoring comprehension ranged between (3.77-4.03) and standard deviations from (0.78-0.92). The Monitoring comprehension as a whole has (M=3.88, SD=0.60). Item (1) which states, “I ask myself periodically if I am meeting the goals that enable me to teach according to STEAM approach” came in the

first place with a mean (M=4.03, SD=0.81), with a high degree of appreciation. Item (21) which states, “I feel like I have control over my students' teaching, following STEAM approach” came in the last place with (M=3.77, SD=0.92), with a high level of Metacognitive Awareness in Monitoring comprehension.

4.1.8 The findings of the level of Metacognitive Awareness in debugging strategies

The values of means, standard deviations, and ranks were calculated, Table (12) shows the results of the analysis:

Table 12: ***Means, standard deviations, and rank of responses in debugging strategies sub-domain.***

Item	Mean	Standard deviation	Rank	Relative importance
I will ask others for help if I find something that does not make sense to me, and I need to teach it to my students according to STEAM approach.	2.86	1.17	2	Medium
I will change my teaching strategies when I notice that students fail to learn according to STEAM approach	2.76	1.19	4	Medium
I need to reassess my assumptions when I am confused while teaching according to STEAM approach.	2.81	1.15	3	Medium
If I teach according to STEAM approach, I need to stop and come back to new, unclear information in order to reformulate it.	2.93	1.13	1	Medium
Debugging strategies	2.84	0.94	Medium	

Low: 1-2.29, Medium: 2.3-3.59, High: 3.6 -5 or higher (oxford, 1990)

Table (12) shows that the means for debugging information ranged between (2.76-2.93), with standard deviations between (1.13-1.17). The debugging strategies as a whole were (M=2.84, SD=0.94). Item (49) which states, “If I teach according to STEAM

approach, I need to stop and come back to new, unclear information in order to reformulate it" came in the first place, with (M=2.93, SD 1.13). Item (40) which states, "I will change my teaching strategies when I notice that students fail to learn according to STEAM approach" came in the last place, with (M=2.76, SD=1.19), with a medium level of Metacognitive Awareness in Debugging Information.

4.1.9 The findings of the level of Metacognitive Awareness in Evaluation.

The values of a means, standard deviations, and ranks were calculated, and Table. (13) Shows the results of the analysis:

Table 13: ***Means, standard deviations, and ranks of responses in the evaluation domain***

Item	Mean	Standard Deviation	Rank	Relative Importance
I am able to figure out how well I performed just after I finish giving a new lesson using the Steam approach.	3.89	0.77	3	High
At the end of each lesson, I ask myself if there is an easier way to use STEAM approach in teaching students	4.01	0.90	1	High
I will make sure to summarize what I learned after he finished teaching according to STEAM approach	3.90	0.92	2	High
I will ask myself how to achieve my goals well as soon as I finish teaching according to my approach.	3.83	0.85	**4**	High
I ask myself if I have specified all the options assumed by STEAM approach after solving a problem	3.83	0.80	**5**	High
Evaluation	3.89	0.62		High

Low: 1-2.29, Medium: 2.3-3.59, High: 3.6 -5 or higher (oxford, 1990)

Table (13) shows that the means of the Evaluation domain ranged from (3.83-4.01), with standard deviations from (0.77-0.92). The field as a whole obtained (M=3.89, SD= 0.62). Item (19) which states, "At the end of each lesson, I ask myself if there is an easier way to use STEAM approach in teaching students" came first with (M=4.01, SD=0.90). Item (38) which states "I ask myself if I have specified all the options assumed by STEAM approach after solving a problem" came in last place, with (M=3.83, SD= 0.80), with a high level of Metacognitive Awareness in Evaluation.

4.2 The findings of the effect of the school type, experience, and specialization on Metacognitive Awareness among Jordanian Primary School Teachers:

To calculate the difference in determining the Metacognitive awareness about STEAM education among Jordanian Primary School Teachers, according to School type, Experience, and Specialization, the values of the means and the standard deviations of the domains of the questionnaire and the overall Metacognitive Awareness were extracted.

Means and standard deviations of the questionnaire domains and the questionnaire as a whole for the responses of the teachers according to the specialization, school type, and experience variables

Table (14) ***shows the means and the standard deviations of the level of Metacognitive Awareness according to the school type, experience, and specialization.***

School type	Experience	Specialization	N	M	s
Private	2 – 1	Science	11	3.37	0.56
		computer science	1	4.14	0.00
		Mathematics	4	3.24	0.41
		Social and human sciences	26	3.70	0.46
		Total	42	3.58	0.51
	5 – 3	Science	3	3.67	0.60
		computer science	9	3.46	0.21
		Mathematics	4	3.85	0.30
		Social and human sciences	10	3.30	0.42
		Total	26	3.48	0.40

School type	Experience	Specialization	N	M	s
	More than 5	Science	15	3.65	0.33
		computer science	20	3.59	0.51
		Mathematics	36	3.87	0.57
		Social and human sciences	44	3.69	0.37
		Total	115	3.72	0.47
	Total	Science	29	3.55	0.46
		computer science	30	3.57	0.44
		Mathematics	44	3.81	0.56
		social and human sciences	80	3.65	0.42
		Total	183	3.66	0.47
Public	2 – 1	Science	5	3.39	0.54
		computer science	2	2.97	0.82
		Mathematics	5	3.99	0.28
		social and human sciences	10	3.46	0.44
		Total	22	3.52	0.52
	5 – 3	Science	11	3.74	0.33
		computer science	5	3.13	0.46
		Mathematics	2	3.07	0.07
		social and human sciences	9	3.37	0.51
		Total	27	3.46	0.47
	More than **5**	Science	15	3.60	0.75
		computer science	25	3.67	0.51
		Mathematics	10	3.85	0.40
		Social and human sciences	88	3.54	0.53
		Total	138	3.59	0.55
	Total	Science	31	3.62	0.59
		computer science	32	3.54	0.56
		Mathematics	17	3.81	0.43
		Social and human sciences	107	3.52	0.52
		Total	187	3.56	0.53
Total	2 – 1	Science	16	3.38	0.53
		computer science	3	3.36	0.89
		Mathematics	9	3.66	0.51
		social and human sciences	36	3.63	0.46
		Total	64	3.56	0.51
	5 – 3	Science	14	3.73	0.38
		computer science	14	3.34	0.34
		Mathematics	6	3.58	0.46
		social and human sciences	19	3.34	0.45
		Total	53	3.47	0.43

School type	Experience	Specialization	N	M	s
	More than 5	Science	30	3.62	0.57
		computer science	45	3.63	0.50
		Mathematics	46	3.87	0.53
		social and human sciences	132	3.59	0.49
		Total	253	3.65	0.52
	Total	Science	60	3.58	0.53
		computer science	62	3.56	0.50
		Mathematics	61	3.81	0.52
		social and human sciences	187	3.57	0.48
		Total	370	3.61	0.51

It is noted from Table (14) that there are differences in the means for the responses of the study sample in the light of the variable of school type, and experience, and there were no differences in the mean in the light of the specialization variable.

Before using the multi-Anova test, the researcher verified the assumption of variance homogeneity, and Table (15) shows the results of Levene's Test of Equality:

Table 15: ***Levene's Test of Equality***

Metacognitive Awareness	Levene Statistic	Df1	Df2	Sig.
	1.455	22	346	0.087

Table (15) results show no statistically significant differences in variances between subgroups (at α=.05), with Levene's test value (1.455) at sig level (0.087)

These findings indicate that the homogeneity requirement in the study data, which is equal to the variation in the Metacognitive Awareness variable, has been achieved in the subgroups under study.

Table (16) shows the results of the three-way –ANOVA test to measure the effect of the school type, Experience, and specialization on Metacognitive Awareness level among primary school teachers.

Table 16: Results of the three-way –ANOVA test

Source of variance	Sum of Squares	Degree of freedom Df	Mean Square	value of F	Significance indication.	Eta Squared
Work place	0.673	1	0.673	2.798	0.095	0.008
Experience	1.938	2	0.969	4.027	0.019**	0.023
Specialization	0.471	3	0.157	0.653	0.582	0.006
School type * Experience	0.372	2	0.186	0.772	0.463	0.004
School type * Specialization	0.827	3	0.276	1.145	0.331	0.010
Experience * Specialization	1.692	6	0.282	1.172	0.321	0.020
School type * Experience * Specialization	3.581	6	0.597	2.480	0.023**	0.041
Error	83.254	346	0.241			
Total	92.808	369				

** It means statistically significant at the significance level (α = 0.05).

The following results are noted from the previous table (16):

The statistical difference (α =0.05) in Metacognitive awareness level about STEAM education among Jordanian Primary School Teachers was attributed to the school type variable (F =2.798, sig=0.095), and this value was not statistically significant at the indication level (0.05 = α).

Statistically significant differences (α= 0.05) in Metacognitive awareness about STEAM education among Jordanian Primary School Teachers were attributed to the experience variable (F=4.027, sig=0.019) which was in favour of teachers with more than 5 years of experience.

There are no statistically significant differences (α= 0.05) in Metacognitive awareness level about STEAM education among Jordanian Primary School Teachers attributed to the Specialization variable (f =0.653, sig =0.582).

There are no statistically significant differences (α= 0.05) in Metacognitive awareness level about STEAM education among Jordanian Primary School Teachers attributed to the bilateral interaction between School type and Experience, where the value (F) (0.772) was at an indicative level (0.463) and this value was not statistically significant at the indication level (0.05 = α).

There are no statistically significant differences (α = 0.05) in Metacognitive awareness about STEAM education among Jordanian Primary School Teachers attributed to the interaction between the school type and the Specialization (F=1.145, sig=0.331)

There are no statistically significant differences (α=0.05) in Metacognitive awareness level about STEAM education among Jordanian Primary School Teachers due to the bilateral interaction between Experience and Specialization (F=1.172, sig=0.321)

There are statistically significant differences (α= 0.05) in Metacognitive awareness about STEAM education among Jordanian teachers attributed to the triple interaction between Work place, Experience, and Specialization, where (F=2.480, sig= 0.023).

To detect the reasons for the different results in the light of the experience variable, LSD comparisons test were used for teachers' responses to Metacognitive Awareness level depending on the experience variable, and table (17) shows the results of the analysis:

Table 17: Post HOC comparisons of responses about Metacognitive Awareness in the light of the experience variable

Study tool	Experience levels	average	1 - 2	3 – 5	More than 5
Metacognitive Awareness	1 – 2	3.56	-	0.090	0.090
	3 – 5	3.47		-	0.18**
	More than 5	3.65			-

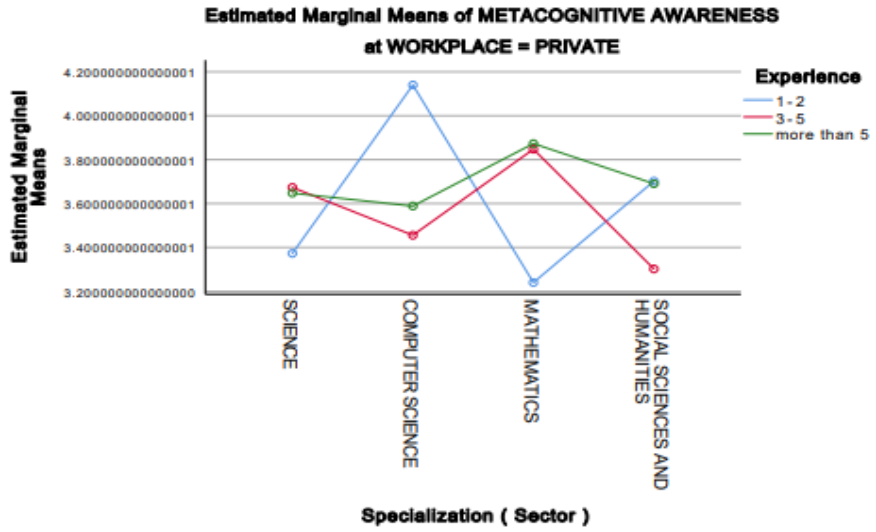
** Significant at (α = 0.05)

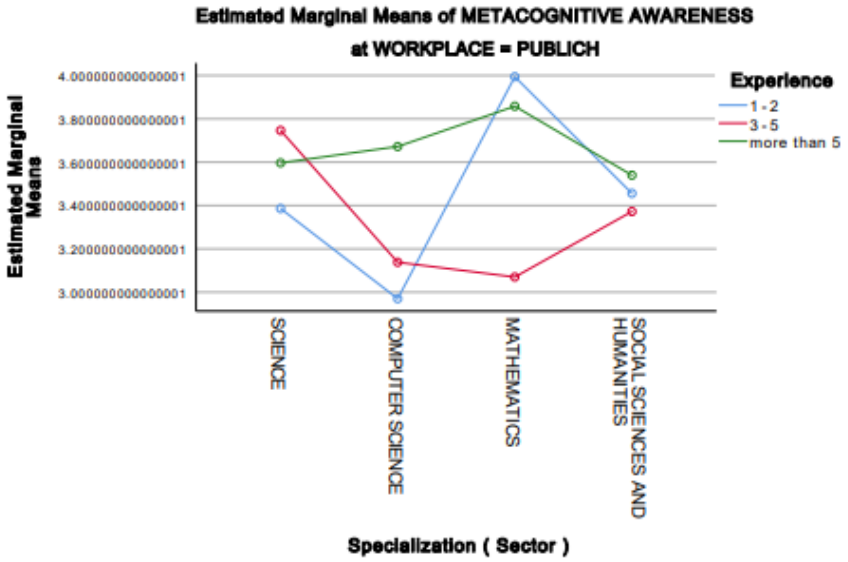
Table (17) shows that:

-There is only a difference in Metacognitive Awareness between those whose experience was 3-5 years, and for those whose experience was more than (5) years, where the value of the mean was higher.

-There is no difference in Metacognitive Awareness level in the rest of the binary comparisons.

Figure 4 shows the three-way interaction between the study variables (Specialization, Experience, and School type)





School type: 1: Private 2: Public

Experience 1 :(1-2) 2: (3-5) 3-(more than 5)

Specialization: 1: Science 2: Computer science

3: Mathematics 4: Social Studies and Humanities

Figure 4*: shows the three-way interaction between the study variables (Specialization, Experience, and School type)*

Chapter five:
Discussion and Conclusions

During this chapter, the researcher will clarify the answers to the questions of the study and try to link them to what was presented in previous studies and theories. In addition, the researcher discusses the extent of the compatibility of those studies with the results reached. From the results, the researcher will also clarify the shortcomings of this study to encourage researchers to address those aspects that the researcher could not address.

5.1 The Metacognitive level of Awareness about STEAM education among primary school teachers in Jordan in the knowledge about cognition was medium. While the level of Awareness about STEAM education in the regulation of cognition was high.

This result is attributed to the urgent need for teachers to cope with the rapid growth in all aspects of life including the field of education. It reflects the importance of Metacognitive awareness in education as it gives a better method to understand the aim of education. It is difficult to enhance the teaching process if we do not have a moderate level of Metacognitive awareness about the methods we are using. If one of the goals of education is to prepare students to be lifelong learners, it is critical to assist students in being aware of themselves as learners and taking charge of their actions. This movement has attracted teachers' interests and pushed them to progress in their teaching methods. This finding is in line with the study, which was conducted by (Dori et al., 2018). They showed in their study that over the last few years, research regarding STEM education has viewed increasing improvement, attracting considerable interest among students and teachers.

The researcher found that the Metacognitive level of awareness has a great role in cognition as teachers can finally be aware of what they teach and be able to cognize and

understand the whole teaching process. This result agrees with the result that (Guven, 2011) reached in his study. Primary school teacher trainees utilized "self-control," "cognitive strategy," "self-evaluation," and "self-awareness" the most among the metacognitive strategies they used. *(Boice et al. 2021)*

The level of Metacognitive Awareness about the STEAM approach in the regulation of cognition among primary school Teachers was high. This result is attributed to the fact that teachers were forced to online their lessons and organize their work in a few months during the Corona epidemic. The results showed the effect of the Metacognitive level of awareness on the regulation of cognition as the metacognitive level of awareness does not stop on clarifying the cognition and increasing the student's self-awareness, it helps with using this awareness and organizing it to enrich the teaching process. This result agrees with (Rowsome, 2014) in which the researcher focused on the importance of self-regulation among teachers and encouraged other researchers to search deep in detail in this field.

5.1.1 The level of Metacognitive Awareness about the STEAM approach among teachers in declarative knowledge was medium.

This result indicates that teachers can identify the most proper information that must be given to the students in the class. In addition, they are somewhat aware of the level of awareness of their strong and weak points in using STEAM education, and this is considered as a first step to classifying strengths to depend on them and then improving their weaknesses.

The fact that the ministry of education has been trying hard to cope with the recent improvements concerning education can be another reason for this result. Their efforts are beneficial and lead to well-trained teachers who know quite well the importance of

declarative knowledge and care about their methods in teaching classes. This is quite clear in (Sangster, P et al., 2013) as they showed how declarative knowledge made a difference among students who wanted to learn the language more effectively

The declarative knowledge of teachers is as important as the students' declarative knowledge because teachers cannot help students unless they are aware of their abilities. Learners' knowledge and opinions about themselves have an impact on their ability to learn and solve problems and (Akyol and Garrison, 2011) quite agree with this.

5.1.2 The level of Metacognitive Awareness about the STEAM approach among teachers in procedural knowledge was low.

This result indicates that teachers are still using the familiar teaching processes that they are comfortable with and avoid getting away from their comfort zone. They still follow the traditional methods of teaching their students and do not pay much to the process they should prepare and follow according to modern education. Procedural knowledge relates to knowing how to do things as it helps with applying knowledge to the completion of a procedure or process. Thus, it is knowledge about how to implement the teaching. For instance, they do not prepare for the science lesson. They do not as well prepare methods to apply the lesson that suit the STEAM approach.

This requires them to know the process and the time to apply the process in various situations. Nevertheless, if they work harder their metacognitive awareness helps them to choose the methods that match the new approaches such as the STEAM approach.

5.1.3 The level of Metacognitive Awareness about the STEAM approach among teachers in conditional knowledge was high.

This result is attributed to the fact that teachers' performance increases according to their Awareness of providing the suitable conditions for the students and asking themselves why their methods will work. This is what helps them in making the best

decisions about the class and makes them modify and improve what they have missed from the procedural knowledge, as they understand the best conditions and seek for achieving them. The determination of when and why specific processes or skills should transfer; knowledge of when and why to use learning procedures; application of declarative and procedural knowledge with specific conditions presented; and students can obtain knowledge through simulation. These results go in line with (Nagro & Monnin, 2022) through which the importance of conditional knowledge and its effects were focused.

5.1.4 The level of Metacognitive Awareness about the STEAM approach among teachers in planning was high

The result is attributed to the nature of teachers' role in school and inside the classroom. It emphasizes the fact that the teachers' awareness of time and goals is high as they organize the whole class before it starts. They prepare the lesson and the way they will apply it to suit the STEAM approach. Metacognitive awareness in planning is not restricted to timing only; it includes planning for each step in the class (the class time, the class content, and how the content will be applied to match the scientific theories with the experimental approach). Planning entails selecting metacognitive strategies and allocating resources appropriately. In addition, setting goals, activating relevant prior knowledge, and allocating learning resources through practices such as time management are all part of it. These facts go in line with (Dolgopolovas and Dagienė. 2021).

5.1.5 The Level of Metacognitive Awareness in Information management strategies was high.

From the results, we can see that the responsibilities of teachers to manage the classes are high as they control and choose each suitable detail that could help and fit the students and this is how Metacognitive Awareness controls their choices to help them to manage

the teaching process effectively. It also helps them with finding the best information, teaching techniques, how they control the lessons, and what they are teaching the students. This increases their awareness of the content of the lessons much better than letting the classes go by the traditional methods. According to the Regulation of cognition, Metacognitive skills are the voluntary control that individuals exert over their cognitive processes (Desoete, 2009) and the purposeful application of cognitive behaviours at a specific moment (Stel and Veenman, 2014). Metacognitive skillfulness manifests itself in information management, planning, monitoring, and evaluation (Stel and Veenman, 2014). As a result, it refers to information management that is as efficient as possible (Kohen and Kramarski, 2012).

5.1.6 The Level of Metacognitive Awareness in comprehension Monitoring was high.

The result indicates that teachers were able to measure their abilities in meeting the STEAM approach in teaching if they are taking the right path. It also indicates that they think about several alternatives when it comes to change or if they need to examine the benefits of their approaches. Therefore, this provides a cautious following system for the teaching approach that helps with providing the best teaching method for the STEAM approach. The current knowledge and skill levels are monitored by reflecting on one's thought processes. What was mentioned previously goes in line with (Engel, 2021) (Kohen and Kramarski, 2012). Monitoring strategies, for example, self-testing can help to check one's own comprehension and performance.

5.1.7 The Level of Metacognitive Awareness in debugging strategies was medium

According to the results, we can see that Metacognitive Awareness is also working as a reference for the teachers to rethink what they cannot do or what to ask about efficiently. Therefore, they do not only give the students the information they need to be

aware of, and they need to understand each word they are saying to match the STEAM approach. This helps them to ask each other and always find new solutions for classes and make them always ready for new methods in teaching to match students' needs, Debugging strategies are used to correct comprehension and performance errors (Schraw and Dennison, 1994). It includes students correcting their mistakes and enhancing their understanding of their work (Kohen & Kramarski, 2012). In mathematics, for instance, students may reread something they do not understand or correct mathematical errors (Schraw et al., 2006) so, the same is for teachers who find what they do not understand and search for a solution.

5.1.8 The Level of Metacognitive Awareness in the evaluation was high.

We can see that Metacognitive Awareness is almost creating a chain of connected series that leads eventually to evaluating all of the previous stages that teachers have been through starting with increasing their awareness of the information and what they are teaching the students and ending with how they could improve their methods and evaluate this improvement. This opens up their minds to seek to choose the easiest and the most efficient ways to teach STEAM students to achieve the main goals of the curriculum, such as following a learning experience, evaluating including analyzing the effectiveness of performance or strategy (Schraw and Dennison, 1994). This entails assessing the progress and effectiveness of one's learning and, as a result, re-evaluating one's goals and conclusions in response (Schraw, 1998), as well as reflecting on performance concerning required standards and goals (Kohen and Kramarski, 2012). In mathematics, for example, students may assess the appropriateness of a solution and decide to debug or find an alternative solution. Re-evaluating goals and conclusions, as well as revising predictions, are examples of this (Schraw, 1998).

In the end, we can say that the level of Metacognitive Awareness is a whole teaching approach as it helps the teachers to improve themselves from zero and then to improve their methods in information delivery. It also helps with improving the information itself and choosing the best words and techniques that help their students.

5.2 The significant difference in deciding the Metacognitive Awareness about STEAM education among Jordanian Primary School Teachers, according to School type, Experience, and specialization:

5.2.1 There are no statistically significant differences between the means of Metacognitive Awareness of the STEAM approach among primary school teachers in Jordan, attributed to specialization, and in favour of teachers working in the private sector with more than five years of experience

This result indicates that though each specialization has its methods and ways of adapting the Metacognitive Awareness, it all depends mainly on the teacher and his ability to mix the academic content and the way he could apply it. We can see that some specializations provide a space for the teachers to apply the STEAM approach in an easier way such as computer science as it mainly depends on practice. Mathematics for example depends on theories, which puts the teacher in a challenging position to create a proper approach. Science results in between, as science is a mixture between experiments and scientific theories that make the mission easier for the teacher. *Z.turan Sarl et al.* (2020) investigated the cognitive Awareness levels of education faculty students in terms of various variables. . The specialization of the participants in the study with Science, Elementary Mathematics, Classroom, and Social Studies, teachers were found to have a high level of knowledge, which agrees with what the current study concluded .Academic achievement and cognitive Awareness had a positive relationship, and the Specialization variable made a significant difference in cognitive Awareness. However, contrary to expectations, the findings revealed a significant negative relationship between the

participants' logical thinking scores and their cognitive knowledge dimensions. Furthermore, according to the study's findings, the teachers' cognitive Awareness levels did not differ based on the specialization they studied.

5.2.2 There is a statistically significant difference between the means of Metacognitive Awareness of the STEAM approach among primary school teachers in Jordan, attributed to the school type.

From the results, we can see that experience plays the main role in the variation of the results, as experience enriches the teachers' knowledge and their methods to adapt to new conditions. As we mentioned before, the academic specialization affects how hard it would be for the teacher to adopt the STEAM approach so the experience would solve this problem and gives the teacher the courage to find solutions and apply new methods in teaching. We can see from the results that experience is the main factor when it comes to Metacognitive Awareness. According to the overall findings, teachers with a higher level of Metacognitive Awareness can produce students with high academic achievement (Palantis et al. 2018).

5.2.3 There is a statistically significant difference between the means of Metacognitive Awareness of the STEAM approach among primary school teachers in Jordan, attributed to the school type.

The results indicate that the school type plays an important role in the level of Metacognitive Awareness among teachers. Teachers who work in the private sector get better chances to improve (Hong, O, and Song, J. 2016). Private schools pay special attention to activities, and most of them teach the international curricula, which justifies their high level of awareness about STEAM education. There is much yet to understand about how teachers' effectiveness with students depends on the characteristics and quality of the school as a school type

It is clear that the school type can enable or constrain good teaching. Teachers must have a school type that promotes their efforts in a variety of ways and this agrees with (Bryk and Schneider, 2002). They discussed in their study the qualities of a school type that positively affects the level of metacognitive awareness of teachers. They focused on the school type that supplies the teachers with everything they need to promote and so produce good beneficial teaching.

Many studies have shown clearly that the school type can either enable or constrain good teaching (Bryk and Schneider 2002). Thus, improving the conditions of the school as a school type can increase the capacity of schools to serve all students. The school as a school type can be understood as having many features that together create the context for individual teachers' work. All of these aspects of the school type can mediate the effectiveness of teachers within their classrooms and influence their decisions during the teaching process.

So finally, we can say that the main factor in this process is measuring the teachers' metacognitive awareness of the STEAM approach. If they were aware of it, they would make use of their experiences and apply them to their subject whatever it is.

5.3 Recommendations

STEAM integration is nevertheless a controversial problem with long records of debate; however, most researchers agree that STEAM integration would have a wonderful effect on education. Through the previous conclusions, this study recommends the following:

1. A successful education reform process should be adopted to control the barriers like (the complexity of the interdisciplinary approach, teacher readiness, and school culture).

2. The necessity of a unified reform plan with clear educational goals and outcomes.
3. All stakeholders who value and appreciate the impact of the new approach must be involved in the reform process.
4. The need to be followed up on the educational reform process by testing and evaluating at different phases.
5. The necessity to provide needed resources, such as qualified human capital, specialized curriculum, and all the required material.

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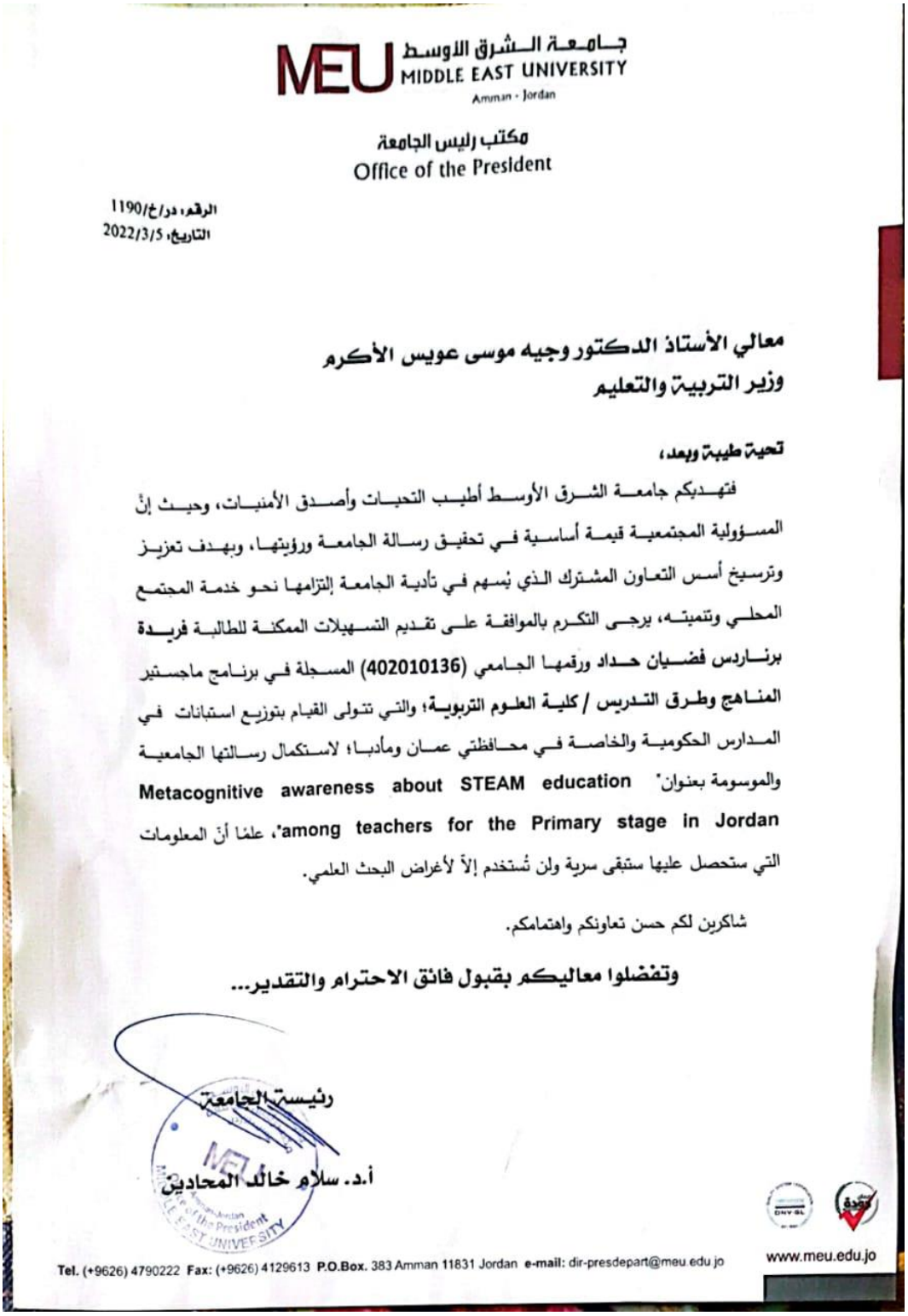
Appendices

Appendix *A*: Panel of Referees Committee

Number	Name	Rank	Specialization	University
1	**Prof. Elham Shalaby**	**Professor Dr.**	**Curricula and Teaching Methods**	**Middle East University**
2	**Prof. Adnan Al.Jabery**	**Professor Dr.**	**Curricula and Teaching Methods**	**Amman Arab University**
3	**Prof. Khaled abu Loum.**	**Professor Dr.**	**Curricula and Teaching Methods**	**University of Jordan**
4	**Dr.Ayat Al.Mughraby**	**Assisstant Professor**	**Curricula and Teaching Methods**	**Middle East University**

Appendix B: Research Agreement



جـامـعـة الـشـرق الاوسـط
MEU MIDDLE EAST UNIVERSITY
Amman - Jordan

مكتب رئيس الجامعة
Office of the President

الرقم، د ر/1190
التاريخ، 2022/3/5

معالي الأستاذ الدكتور وجيه موسى عويس الأكرم
وزير التربية والتعليم

تحية طيبة وبعد،

فتهـديكم جامعـة الشـرق الأوسـط أطيـب التحيـات وأصـدق الأمنيـات، وحيـث إنّ المسـؤولية المجتمعيـة قيمـة أساسـية فـي تحقيـق رسـالة الجامعـة ورؤيتهـا، وبهـدف تعزيـز وترسـيخ أسـس التعـاون المشـترك الـذي يُسـهم فـي تأديـة الجامعـة إلتزامهـا نحـو خدمـة المجتمـع المحلـي وتنميتـه، يرجـى التكـرم بالموافقـة علـى تقـديم التسـهيلات الممكنـة للطالبـة **فريـدة برنـاردس فضـيان حـداد** ورقمهـا الجـامعي (**402010136**) المسـجلة فـي برنـامج ماجسـتير **المنـاهج وطـرق التـدريس / كليـة العلـوم التربويـة**؛ والتـي تتـولى القيـام بتوزيـع استبانات فـي المـدارس الحكوميـة والخاصـة فـي محـافظتي عمـان ومأدبـا؛ لاسـتكمال رسـالتها الجامعيـة والموسومة بعنوان" **Metacognitive awareness about STEAM education among teachers for the Primary stage in Jordan**"، علمًا أنّ المعلومات التي ستحصل عليها ستبقى سرية ولن تُستخدم إلاّ لأغراض البحث العلمي.

شاكرين لكم حسن تعاونكم واهتمامكم.

وتفضلوا معاليكم بقبول فائق الاحترام والتقدير...

رئيسة الجامعة

أ.د. سلام خالد المحادين

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Appendix C: Research survey

Part I: Demographic Data

1. Gender:

☐ **Female** ☐ **Male**

2. School type:

☐ **Private** ☐ **Public**

3. Experience:

☐ **1-2** ☐ **3-5** ☐ **More than 5**

4. Specialization (Sector) :

☐ **Science** ☐ **Computer science** ☐ **Mathematics** ☐ **Social Studies and Humanities**

Part II: STEAM approach Card

○ **Goals according to STEAM approach**
• **Problem-solving** • **Analysis skills** • **Scientific Research Skill** • **Brainstorming and idea organizing** • **Cooperation Skills** • **Creativity and alternative solutions** • **Practical and literary writing skills** • **Presentation and speaking skills** • **Technological skill**
○ **Content according to STEAM approach**
○ **•Content is built to cover all practical، humanitarian، engineering ،and technical domains ،which are not related to a single domain and there are no separate books**
○ **Activities and methods according to the STEAM approach**

• **Integrative projects and positions based on previous knowledge that include life problems from all practice areas, humanitarian, technical, and engineering areas** o **Need to create new knowledge that can be good solutions to these problems**
o **Evaluation according to STEAM approach**
• **Evaluation based on the performance of the learner in situations similar to the real situations** • **Continuous Evaluation (formative)** • **Assessment tools should be: self-evaluation observation/peer evaluation**
• **Teaching according to STEAM approach**
• **Participatory social interaction** • **Interaction between teacher and student** • **Survey-based learning** • **Project-based learning** • **Problem-solving learning**

Part III: Metacognitive Awareness Inventory (MAI) for teachers

Read the following statements carefully then select the choice that best represents the degree of your metacognitive awareness.

		Strongly disagree	disagree	Neutral	Agree	Strongly agree
1.	I ask myself periodically if I am meeting the goals that enable me to teach according to STEAM approach					
2.	I consider several alternatives to any problem I might encounter in teaching, according to STEAM approach.					
3.	. I try to employ teaching strategies that I used before and that were successful if I taught according to the STEAM approach					
4.	I need to increase the pace of teaching time to save more time to fit in with the STEAM approach.					

5.	**I realize my strengths and my weaknesses about my ability to use STEAM approach.**					
6.	**I think about what students need before any learning process starts according to the STEAM approach**					
7.	**I am able to figure out how well I performed just after I finish giving a new lesson using the STEAM approach.**					
8.	**I am able to set specific targets that correspond to the STEAM approach. before the beginning of any lesson**					
9.	**I slow down when I find important information in the lesson that does not fit the STEAM approach.**					
10.	**I can specify what kind of information could be most important for teaching my students according to STEAM approach.**					
11.	**I ask myself if I considered all the options that the STEAM approach can offer when solving a problem**					
12.	**I am good at organizing information when teaching according to STEAM approach**					
13.	**I focus my attention consciously on important information in the teaching content based on the STEAM approach.**					
14.	**I have a specific goal for every teaching strategy that can be used in teaching according to the STEAM approach.**					
15.	**I teach better, when I have more knowledge about the subject I will teach following STEAM approach.**					

16.	**I know what the student expects me to teach him, which is not against the STEAM approach.**					
17.	**I am good at remembering the information related to the use of the STEAM approach in teaching.**					
18-	**I can use different education strategies according to the situation, which suits STEAM approach.**					
19.	**I think deeply about my performance at the end of each lesson**					
20.	**I feel like I have control over my students' teaching, following. STEAM approach.**					
21.	**I periodically review the mechanism of the STEAM approach to help me understand the relationships associated with that mechanism.**					
22.	**I will ask myself questions about the scientific subject and the way in which to follow STEAM approach in teaching it, before I start the lesson.**					
23.	**I encourage my students to consider several ways to use STEAM approach to solve problems and choose the best.**					
24.	**I will make sure to summarize what I taught after I finished teaching according to STEAM approach**					
25.	**I will ask others for help if I find something that does not make sense to me, and I need to teach it to my students according to STEAM approach.**					
26.	**I can motivate my students to learn according to STEAM approach when they need it.**					

27.	**I am familiar with the strategies I use based on STEAM approach when I teach my students.**					
28.	**If I teach according to the STEAM approach, I need to analyze the benefits of the strategies used during my teaching**					
29.	**I use my intellectual strength to compensate for my weaknesses in teaching according to the STEAM approach**					
30.	**I use my intellectual power to make up for my teaching weaknesses according to the STEAM approach.**					
31.	**I create my examples to make scientific content built according to STEAM approach more useful**					
32.	**I can judge how successful what I taught according to the STEAM approach**					
33.	**I find myself using useful teaching strategies that match STEAM approach.**					
34.	**I feel like I am going to stop regularly to check students' understanding to ensure that their learning is effective according to Steam**					
35.	**I can decide when to use each strategy that is most effective according to the STEAM approach**.					
36.	**I will ask myself how to achieve my goals well as soon as I finish teaching according to my approach.**					
37.	**I need to draw pictures or diagrams to help students understand while learning according to the STEAM approach.**					

38.	**. I ask myself if I have specified all the options assumed by STEAM approach after solving a problem**					
39.	**I try to express the new information in words that are easier to match with the use of the STEAM approach**					
40.	**I will change my teaching strategies when I notice that students fail to learn according to STEAM approach**					
41.	**I will use the text organizational structure to help students learn according to the STEAM approach**					
42.	**I need to read the instructions showing the sequence of using STEAM approach in activities carefully before I start the task**					
43.	**I need to reassess my assumptions when I am confused while teaching according to STEAM approach.**					
44.	**I organize my time to achieve my goals so that they best match STEAM approach.**					
45.	**I teach better, when I pay more attention to using STEAM approach.**					
46.	**I try to divide the STEAM teaching process into smaller steps.**					
47.	**I focus more on the general meaning than the details when teaching according to STEAM approach.**					
48.	**I ask myself questions about the harmony and fluidity of my teaching process when I teach according to STEAM approach.**					

49.	**If I teach according to STEAM approach, I need to stop and come back to new, unclear information in order to reformulate it.**					

This survey and scoring guide are attributed to Schraw, G. & Dennison, R.S. (1994). Assessing metacognitive awareness.

***Contemporary Educational Psychology, 19*, 460-475.**

Metacognitive Awareness Inventory (MAI) Scoring Guide

Approaches

For each strongly disagrees, give yourself 1 point in the Score column.

For each disagreement, give yourself 2 points in the Score column.

For each Neutral, give yourself 3 points in the Score column

For each Agree, give yourself 4 points in the Score column

For each Strongly Agree, give yourself 5 points in the Score column

Total the score of each category and place it in a box. Read the descriptions relating to each section.

KNOWLEDGE ABOUT COGNITION

	DECLARATIVE KNOWLEDGE	SCORE
DECLARATIVE KNOWLEDGE **The factual knowledge the teacher needs before being able to process or use critical thinking related to the topic** • **Knowing *about, what, or that*** • **Knowledge of one's skills, intellectual resources, and abilities as a teacher** • **Teachers can obtain knowledge through presentations, demonstrations, discussions** **PROCEDURAL KNOWLEDGE** • **The application of knowledge for the purposes of completing a procedure or process** • **Knowledge about *how* to implement teaching procedures (e.g., strategies)** • **Requires teachers to know the process as well as when to apply the process in various situations** **CONDITIONAL KNOWLEDGE** • **The determination under what circumstances specific processes or skills should transfer** • **Knowledge about *when* and *why* to use teaching procedures** • **Application of declarative and procedural knowledge with certain conditions presented** • **Teachers can obtain knowledge through simulation**	**5. I realize my strengths and my weaknesses about my ability to use STEAM approach.**	
	10. I can specify what kind of information could be most important for teaching my students according to STEAM approach.	
	12. I'm good at organizing information when teaching according to STEAM approach	
	16. I know what the student expects me to teach him, which is not against the STEAM approach.	
	17. I am good at remembering the information related to the use of STEAM in teaching	
	20. I feel like I have control over my students' teaching, following. STEAM	
	32. I can judge how successful what I taught according to the STEAM approach	
	45. I teach better, when I pay more attention to using STEAM approach.	
	TOTAL	**/40**

PROCEDURAL KNOWLEDGE	SCORE	CONDITIONAL KNOWLEDGE	SCORE
3. I try to employ teaching strategies that I used before and that were successful if I taught according to the STEAM approach		**15. I teach better, when I have more knowledge about the subject I will teach following STEAM approach in education.**	
14. I have a specific goal for every teaching strategy that can be used in teaching according to the Steam approach.		**18. I use different education strategies according to the situation، which suits STEAM approach**	
27. I am familiar with the strategies I use based on STEAM approach when I teach my students.		**26. I can motivate my students to learn according to STEAM approach when they need it.**	
33. I find myself automatically using useful teaching strategies that match STEAM approach.		**29. I use my intellectual strength to compensate for my weaknesses in teaching according to STEAM approach I use my intellectual strengths**	
		35. I can decide when to use each strategy that is most effective according to the STEAM approach.	
TOTAL	**/20**	**TOTAL**	**/25**

This survey and scoring guide are attributed to Schraw, G. & Dennison, R.S. (1994). Assessing metacognitive awareness. ***Contemporary Educational Psychology****, 19,* **460-475.**

REGULATION OF COGNITION

	PLANNING	SCORE
PLANNING • **Planning, goal setting, and allocating resources *before* teaching** **INFORMATION MANAGEMENT STRATEGIES** • **Skills and strategy sequences used to process information more efficiently (e.g., organizing, elaborating, summarizing, selective focusing)** **COMPREHENSION MONITORING** • **Assessment of one's learning or strategy use** **DEBUGGING STRATEGIES** • **Strategies to correct comprehension and performance errors** **EVALUATION** • **Analysis of performance and strategy effectiveness after a teaching episode**	**4. I need to increase the frequency of teaching time to save more time to fit in with the STEAM approach.**	
	6. I think about what students need before any learning process starts according to the STEAM approach	
	8. I am able to set specific targets that correspond to the Steam approach. before the beginning of any lesson	
	22. I ask myself questions about the scientific subject and the way in which to follow STEAM approach in teaching it, before I start the lesson.	
	23. I encourage my students to consider several ways to use STEAM approach to solve problems and choose the best.	
	42. I need to read the instructions showing the sequence of using STEAM approach in activities carefully before I start the task	
	44. I organize my time to achieve my goals so that they best match STEAM approach.	
	TOTAL	**/35**

INFORMATION MANAGEMENT STRATEGIES	SCORE	COMPREHENSION MONITORING	SCORE
9. I slow down when I find important information in the lesson that does not fit the		**1. I ask myself periodically if I am meeting the goals that enable me to teach according to STEAM approach**	
13. I focus my attention consciously on important information in the teaching content based on the STEAM approach		**2. I consider several alternatives to any problem I might encounter in teaching, according to STEAM approach.**	
.30 **I focus on the meaning and the importance of new information when teaching according to STEAM approach**		**11. I ask myself if I considered all the options that STEAM can offer when solving a problem**	

31. I create my examples to make scientific content built according to STEAM approach more useful		**21. I feel like I have control over my students' teaching, following. STEAM approach.**	
37. I need to draw pictures or diagrams to help students understand while learning according to the STEAM approach.		**28. If I teach according to the STEAM approach, I need to analyze the benefits of the strategies used during my teaching.**	
39. I try to transform new information into easier words to match the use of STEAM approach.		**34. I feel like I am going to stop regularly to check students' understanding to ensure that their learning is effective according to Steam**	
41. I will use the text organizational structure to help students learn by STEAM approach		**48. I ask myself questions about the harmony and fluidity of my teaching process when I teach according to STEAM approach.**	
-I try to divide the STEAM teaching process into smaller steps.			
-I focus more on the general meaning than the details when teaching according to STEAM approach.			
TOTAL	**/50**	**TOTAL**	**/35**
DEBUGGING STRATEGIES	**SCORE**	**EVALUATION**	**SCORE**
25. I will ask others for help if I find something that does not make sense to me, and I need to teach it to my students according to		**7. I am able to figure out how well I performed just after I finish giving a new lesson using the Steam approach.**	
40. I will change my teaching strategies when I notice that students fail to learn according to STEAM approach		**19. At the end of each lesson, I ask myself if there is an easier way to use STEAM approach in teaching students**	
43. I need to reassess my assumptions when I am confused while teaching according to STEAM approach.		**24. I will make sure to summarize what I learned after he finished teaching according to STEAM approach**	
49-If I teach according to STEAM approach, I need to stop and come back to new, unclear information in order to reformulate it.		**36. I will ask myself how to achieve my goals well as soon as I finish teaching according to my approach.**	

		38. I ask myself if I have specified all the options assumed by STEAM approach after solving a problem	
TOTAL	**/25**	**TOTAL**	**/30**

This survey and scoring guide are attributed to Schraw, G. & Dennison, R.S. (1994). Assessing metacognitive awareness. ***Contemporary Educational Psychology*****,** ***19*****, 460-475**