Investigating Teachers' Views of the Importance and Use of Critical Thinking in Dubai

استقصاء آراء المعلمين حول أهمية واستخدام التفكير النقديفي دبي

by

SALAH AHMAD SHAITO

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Abstract

Critical thinking is needed more than ever to handle various challenges accompanied with the rapid technological development. This study investigated mathematics and science teachers' views about the importance and use of critical thinking. A sample of twenty-five middle and high school teachers from two private schools in UAE participated in the research. The participants attended a critical thinking professional development and shared their views about eight strategies to develop students' critical thinking dispositions. The results show thatteachers acknowledge the importance of various methodsto promote students' critical thinking, yet they still prefer using traditional teaching methods over student centered learning. Science teachers saw more value in project-based learning and debate while math teachers prioritized questioning and problem based learning for the purpose of fostering their students' critical thinking. Teachers found a great value in the professional development that they have attended as part of the research. The study recommends further teacher trainings to effectivelyimplement enhanced teaching methods and promote their studentsto the level of master critical thinkers.

ملخص

هناك حاجة إلى التفكير النقدي أكثر من أي وقت مضى للتعامل مع مختلف التحديات المرتبطة بالتطور التكنولوجي السريع. تحققت هذه الدراسة في وجهات نظر معلمي الرياضيات والعلوم حول أهمية واستخدام التفكير الناقد. شارك في البحث عينة مكونة من خمسة وعشرين مدرسًا من المرحلتين المتوسطة والثانوية في مدرستين خاصتين في الإمارات. حضر المشاركون تطوراً مهنياً للتفكير النقدي وتبادلوا آراءهم حول ثماني استراتيجيات لتطوير اتجاهات التفكير النقدي لدى الطلاب. توضح النتائج أن المدرسين يدركون أهمية الأساليب المختلفة لتعزيز التفكير النقدي لدى الطلاب ، ومع ذلك لا يزالون يفضلون استخدام طرق التدريس التقليدية على التعلم المتمحور حول الطالب. رأى معلمو العلوم قيمة أكبر في التعلم القائم على المشاريع والنقاش ، بينما أعطى معلمو الرياضيات الأولوية لطرح الأسئلة والتعلم القائم على حل المشكلات لغرض تعزيز التفكير النقدي لدى طلابهم. وجد المعلمون قيمة كبيرة في التطوير المهني الذي حضروه كجزء من البحث. توصي الدراسة بمزيد من التدريبات للمعلمين من أجل تنفيذ أساليب التدريس المحسنة بشكل سلس وترقية طلابهم إلى مستوى المفكرين النقديين المحترفين.

Dedication

I dedicate my work to all the professors and doctors of The British University in Dubai who helped me rise and ignited the love of research and knowledge acquisition within me.

Professor EmanGaad who always meets her students with a smile on her face and greatly leading the faculty of education to prosperity and success.

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Chapter One: Introduction

There is a pressing need for this generation to develop a critical thinking mindset more than ever. We are in an era where the success of the economic and market is directly linked to critical, creative and innovative ideas (Elder 2016). On the other hand, social media has really invaded the minds of our youths and every piece of information that is being circulated through such means needs to be critically assessed before adding it to their bank of knowledge(Alvermann 2017). Thus, with enough training on the implementation of critical thinking skillsthrough our everyday life activities we can induce a new mindset that is based on critical thinking which would consequently lead to better life decisions and consequently a better future (Butler, Pentoney& Bong 2017).

Through the research about critical thinking, many questions emerge out: What is critical thinking? Is critical thinking teachable? If yes, then how? What is the role of the teacher in the process of developing students' critical thinking skills? Which methods are better than others? All these questions and more would entertain the mind of any teacher trying to develop his skills to meet the 21st century requirements of a successful teacher.A well skilled dedicated teacher plans beyond just teaching the students content knowledge and information to pass exams but rather capable of guiding students to become lifelong learners and productive citizens(Darling-Hammond, Hyler& Gardner 2017).

On the other hand, we don't know how the world will be 20 years from now, giving the students only the content knowledge doesn't prepare them to be able to adapt to changes and cope with upcoming problems that could emerge in the future. Thus, there is a need to teach content knowledge and skills alike to be able to withstand global changes and to creatively find solutions to any emergent problems(Trilling &Fadel2012). Yet,further questions arise:

- How important is it to hone the future generations' thinking skills and boost their readiness to cope with future challenges?

- Can critical thinking be taught and transferred from teacher to student?

- How do teachers view the importance and use of critical thinking?

These questions and more will find their answers highlighted through the study.

1.1 Significance of the Study

Many studies have taken place in UAE investigating whether schools and their curricula foster the development of critical thinking skills or not (El Ayoubi2016;Saad2015;Boucif2014). Studies found that the critical thinking level varied widely between different curricula used in schools in UAE such as American Curriculum(NGSS and CCSS), British Curriculum, and International Baccalaureate. Not only that, it was also found that demographic variables have been accompanied with different levels of critical thinking skills in students(Boucif, M. 2014). In addition, if teachers already lack enough knowledge about critical thinking then it is trivially expected that they won't be able to transfer any critical thinking related skills to their students(Saad 2015).

As improving students' critical thinking skills has a significant effect on their academic performance (El Ayoubi 2016), then it is important to have a clearer view of the capability of teachers to transfer those skills especially that UAE has set it 2021 agenda with high expectation toward their students' academic achievements over international examsthat is to be achieved with the help of 100% of qualified teachers (Government of the UAE 2010).Therefore, the results of this study can show whether teachers implement methods that foster critical thinking skills in their teaching or not. It also provides recommendations for the future actions that can be taken to improve the level of understanding of teachers to the importance of implementing teaching methods that guide students through critical thinking. The study includes a critical thinking professional development for participating teacher providing those teachers with an opportunity to explore the explicit side of critical thinking by learning about elements of thought and intellectual standards as well as the opportunity to process a hands on project assignment for their students that is forged in a way to guide students through the elements of thought and thus train their critical thinking skills.

1.2 Statement of the Problem

Critical thinking is ranked as one of the highly valued skills developed throughout the learning process(DeWaelsche2015). It allows students to venture through life challenges and proceed with their own self learning even after they graduate. So, by the time students graduate from school and then from university, it is essential for them to have acquired those critical thinking

skills that will prove so helpful for their future career demands and self-satisfaction of the way thinking can lead them to the brighter picture of each situation(Quinn 2018).However, research studies show that schools and universities are not being effective in fostering those skills to their graduates. A combination of teachers' lack of necessary training to be able to transfer critical thinking skills to students and students being lazy to put extra effort into taking control of the learning process to improve their learning habits have both lead to the preference of traditional classes from both teachers and students(Crenshaw, Hale & Harper 2011).

Therefore, this study would help in assessing how do teachers in UAE view the importance and use of critical thinking. It also highlights the ways that teachers found as better than others in terms of students' development of critical thinking skills; Skills that are increasingly demanded day after day that it has become a must to acquire in order to stand out against today's and future's challenges(Trilling &Fadel2012).This study would provide a limited scope on how do math and science teachers value critical thinking and how well are they working into transferring those skills into their classroom activities.Forawiand Mitchell (2012) conducted a research study that included 90 pre-service teachers featuring ten critical thinking attributes instrument. They inferred that one of the best ways for teachers to improve their perceptions of critical thinking is to take a well-designed college course that would help them to greatly develop their own critical thinking skills and raise them to a much higher level.This in turn would serve them quite well in transferring those skills to their students through their better designed classroom activities.

1.3 Purpose of the Study and Research Questions

The purpose of this study is to investigate middle and high school science and mathematics teachers' views of the importance and use of critical thinking based on critical thinking professional development in Dubai. The study, through the critical thinking PD training, provided the participating teachers an opportunity to have a better overview about the importance of critical thinking and how to implement it in their teaching. It also provided them the chance to compare several methods used to foster students' critical thinking skills and plan to implement more critical thinking oriented lesson in the future.

Thus, the study addresses the following research questions:

1- How do middle and high school science and math teachers view the importance and use of critical thinking based on critical thinking professional development?
2- How do demographic variables affect middle and high school science and math teachers' views after the critical thinking professional development?

1.4 Rationale of the Study

One of the major reasons behind commencing the current study is that the researcher himself has benefitted so much from the critical thinking course that he has studied with my great professor in university. Being a high school physics teacher, he applied what he has learned from the course right away for my students' benefit. The results were so amazing in stepping up my students' critical thinking skills which were very clear in their reflection on a project based activity that implemented critical thinking standards where about half of the sixty students reflected that they have learned how to be creative and how to think differently.

In addition, such study will help in sharing what the researcher learned in the course along with my experience in implementing it to other teachers who would in turn carry that knowledge to their students. So, the greatest target was and will always be the benefit of the future generation whom we depend on to keep UAE as one of the top countries and be a role model to other people around the world.

On the other hand, the results of the study, despite being limited, will provide helpful data that can be used to improve teachers' views of the importance of critical thinking and will recommend various techniques that can be implemented to foster their students' critical thinking skills.On par with a study carried out by Arsal (2015) that involved 70 pre-service teachers through which the pre-service teachers were subjected to microteaching about critical thinking dispositions. The results point up that such training has enhanced the critical thinking dispositions of teachers as compared to a control group by implementing inquiry and group discussions as major methods in the process. The current study will compare the effectiveness of various methods used to teach critical thinking as viewed by the group of teachers participating in the study.

1.5 Structure of the Dissertation

The study includes 5 chapters that are divided as follows:

Chapter One: Introduces the topic of the research study and includes the importance of the current study and its rationale. In addition, it clearly states the problem, the purpose of the study, and the research questions.

Chapter Two: Starts off with the definitions of critical thinking and is followed by a discussion about the major theories of critical thinking. Next, the chapter also discusses the role of teachers in transferring critical thinking and how that affects education. Finally, a closer look is presented about critical thinking in math and science curricula followed by the present and future expectations about teaching critical thinking.

Chapter Three: This chapter presents the methodology used in this research study and explains the rationale of the choice. Next, it describes the design of the study and the settings and permissions, participants and samples. Furthermore, the chapter explains the choice of the instrument used, how the data are analyzed, how the pilot study is carried, and the ethics followed throughout the whole process.

Chapter Four: Discussion of the obtained results of the research study takes place in this chapter. Results are analyzed and compared to other studies in the same field. Gathered data are also presented as tables and graphs for easier comprehension and analysis. Since mixed methods research will be used in this study, this chapter will include the analysis of the quantitative and qualitative data as well.

Chapter Five: Connections are made between research questions and the results obtained in a well composed conclusion. Reflection is about the experience learned from the research study. Limitations of the study are also discussed then followed by future recommendations based on the experience learned from the study.

Chapter Two: Literature Review

Over its years of development, critical thinking has been given several definitions by Dewey, Paul, Fisher, and many others. Although each has defined critical thinking differently, all of them agree that critical thinking is a higher level of thinking that would help its carrier to take better life decisions. Guiding students to take better life decisions is a wish that every dedicated teacher wish to accomplish. Yet, do assigned curricula help teachers accomplish that? And what does the future carry for us toward implementing critical thinking in teaching? Light will be shed upon these questions and more in this chapter's subheadings.

2.1 Overview

During the search for the best definition for critical thinking, one discoversthat there is no actual best definition for it but rather subjective points of view on how each one looks at it. However, they all come around a major value that allows critical thinkers to have better formation of their beliefs and decision making. Next, a highlight of three major definitions of critical thinking will be discussed.

John Dewey has defined critical thinking in the early 90's as:

"Active persistent and careful consideration of a belief or supposed form of knowledge in the light of the grounds which support it and the further conclusions to which it tends." (Dewey 1909, p. 9)

Here Dewey defined critical thinking as active and persistent processes that a people use to compound their beliefs and build up the blocks of knowledge in a selective and careful manner then use such knowledge to form conclusions on which decision making take place by critical thinkers. With open mindedness and flexibility to reassess and recreate thoughts, a critical thinker is a versatile individual who fits perfectly in most situations. Not only critical thinkers are good at passing obstacles, but also they manipulate the situation or the obstacle to their advantage and add up the experience in a perfectly designed assumption to their higher thinking level(Howlett, Ferreira &Blomfield2016). This allows the critical thinkers to deeply assess the incoming knowledge as well as to re-assess the previous knowledge based on the overall knowledge developed. For example: when everyone was thinking that Earth is flat and are

afraid to travel far beyond the oceans thinking that they would fall off in a gigantic waterfall at the edge of Earth, Columbus doubted, reassessed, compared theories, and developed evidence that Earth is round and convinced others to travel with him in his exploration mission. The critical reflective thinking is evident in the above example where Columbus manipulated the obstacle to his own advantage which helped him greatly in his exploration adventure(Tan 2016).

Moving forward in time, a similar definition by Robert Ennis emerges:

"Critical thinking is a reflected thinking focused on what is to be believed or accomplished" (Ennis 1996, p. 180).

This is very comparable to Dewey's point of view in considering critical thinking as what to be believed and what is to be accomplished. However, a new term is used here describing critical thinking as a reflective thinking. Reflection can be identified as a process in which a person's perception on the beliefs, knowledge, and ideasis recalled and updated(Clarà2015). You may compare such reflective thinking to a process of building a puzzle. At each step you take, similarly each few blocks of a puzzle you attach, you stop and rebuild and rethink on how to carry on the next step to make the final image perfectly clear.

This has been further sophisticated by Richard Paul, third definition considered in this study, whodefined critical thinking as a process in which the thinking takes control of the framework of thinking that includes elements of thought, intellectual standards, andintellectual traits (Paul & Elder 2007). Applying the ten intellectual standards to eight steps of the elements of thought would greatly serve to develop eight intellectual traits of a critical thinker (Paul & Elder 2004). Both Ennis and Paul agree that critical thinking is revealed in what a person do or believe. However, Paul added a greater value to his definition by implementing a way to develop critical thinking. Now critical thinking is no longer just an inherited trait parents give to their children, but rather a higher order trait that can be acquired and developed with special training programs that implement teaching of intellectual traits (Paul & Elder 2007).Despite being teachable and transferrable, critical thinking remains a higher order thinking skills that teachers and students alike are not giving it the concern and attention it deserves. Thus, the development in critical thinking patterns of teachers and students remain minimal which keeps their reflection and reconstruction of solid beliefs also minimal (Quinn 2018; Forawi& Mitchell 2012).

2.2 Conceptual Framework

Throughout the 20thand 21stcentury, several theories have emerged to support the implementation of more critical thinking aspects especially for teaching and learning. Scholars were striving to bridge the gap between critical thinking theories and its practical application in education and many other fields. From Bloom's taxonomy to Richard Paul's eight elements theories, social scientists have taken a giant step into exploring various methods to apply critical thinking into many aspects of our life(Cartwright 2001).

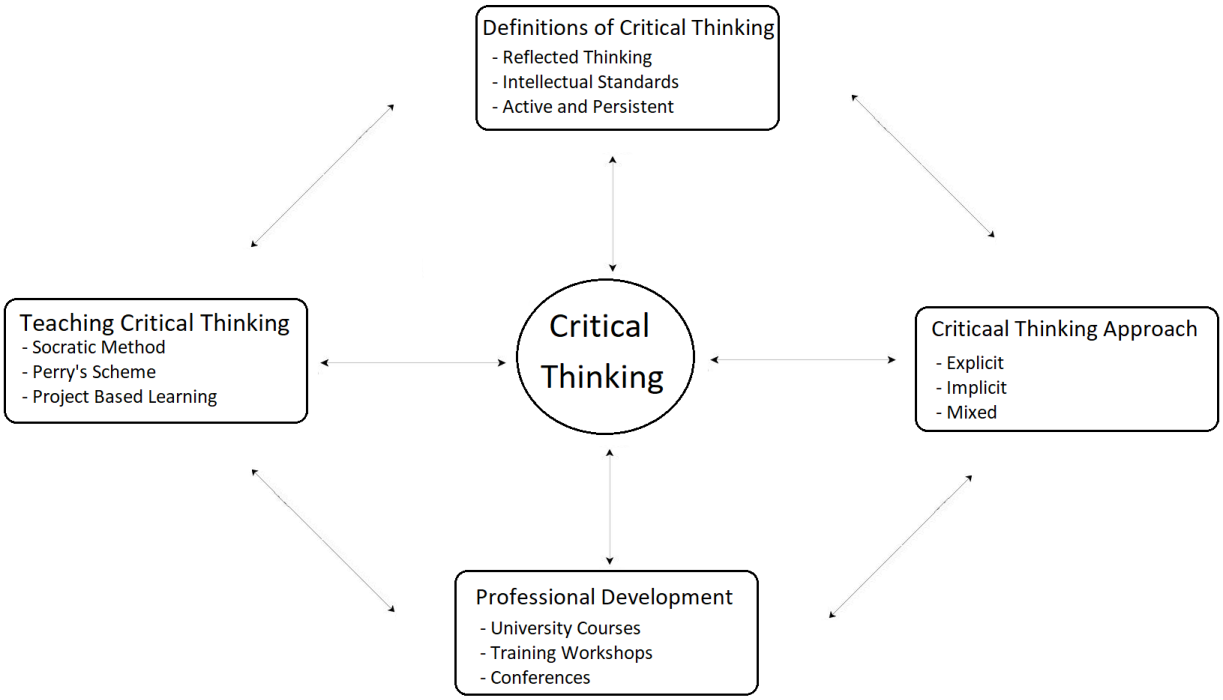


Figure 1: Critical Thinking Conceptual Framework

One of the major theories found is Bloom's taxonomy which had a great influence on teachers' critical thinking and teaching. In his taxonomy, Bloom arranged cognitive domains in order as knowledge, comprehension,application, analysis, synthesis, and evaluation where evaluation stands on the top level of the pyramid. Bloom was looking further into using this tool not only as a measuring tool but also as a skeletal foundation based on which curricula can be developed aligning the objectives and standards to level and intentionally target a certain level in each objective(Adams 2015).This is supported through a research study done by Morton and Colbert-Getz (2017) where the flipped classroom technique was used for students whom were

given a Bloom's taxonomy based assessment. Results of the study reveal that 104 students in the flipped classroom who were given the chance to reach higher cognitive level of Bloom's taxonomy while learning the anatomy class outperformed 101 students who were taught in a lecturing traditional way as per the results obtained from their exams.

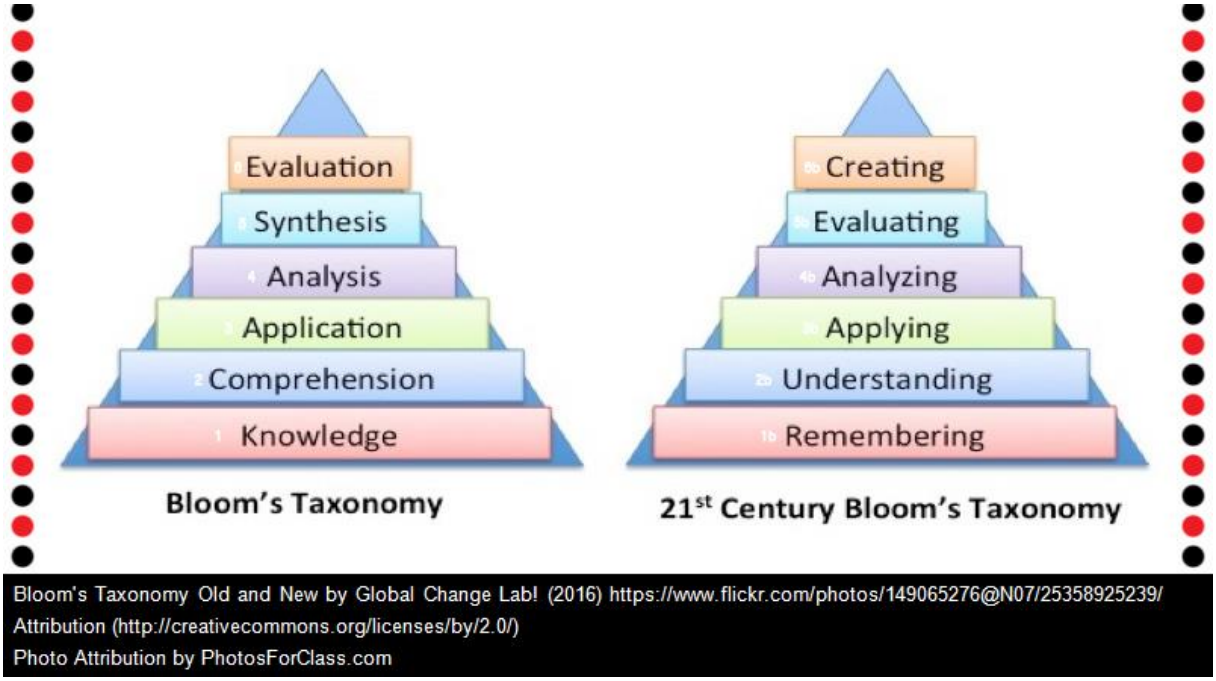


Figure 2: Bloom's Taxonomy and its revised version

Source: Adopted from Ferlazzo (2016).

Bloom's taxonomy was revised recently and had its categories updated in 2001 by Anderson and Krathwohl (2001). Now, the new version includes remembering, understanding, analyzing, applying, evaluating and creating where creating is at the top of the pyramid. Although the revised version looks completely different, yet the old and new versions of Bloom's taxonomy still carry the usage of critical thinking in every level in increasing order and contribute greatly in forming the basic foundations of curricula(Ching& Da Silva 2017).

Another great theory is Richard Paul's eight elements of thought. Richard believes that a critical thinker passes through a process that consists of eight stages as critical thinking is being implemented. The process is initiated with a clear purpose or objective(s) of thinking and is followed with a question or set of questions about the issue at hand. Data and information about

the questions are then gathered from several sources including personal experience. The next step in the process is analyzing and processing the data and drawing out conclusions that are further sent to higher phase of theories and assumptions. Finally, reflections about the thinking experience are made and a decision on whether to add to the personal bank of thoughts or not is taken (Paul, & Elder, 2004). This leads to question whether critical thinking is teachable or not.Many researches supported that it is possible to teach critical thinking through various techniques.Smith, Rama and Helms(2018) concluded that using flipped classroom and mixed model provide an implicit way to teach and improve critical thinking skills of students in classrooms. Similarly, a three-year study by Kong (2015) inducing flipped digital classrooms for 124 high school students revealed great improvement in students' deduction, evaluation and critical thinking skills.

2.3 Literature Review

2.3.1 Critical Thinking Reforms

The history of critical thinking in education trace back to one of the oldest methods used to foster critical thinking in education: The Socratic Method. Socrates developed this method in which he showers his students with questions the paves the path into depth and breadth of knowledge as well as the ignition of constructive debates between students. Until this day, Socratic Method is still considered by many professors as an efficient way to develop critical thinking skills across most subjects. Socratic Method has found its supports through many researchers(Clark & Egan 2015).

A study by Hong and Jacob (2012) implemented the use of Socratic Method through an online discussion featuring sixty undergraduate participants. Students are taking part in the discussion for a total of two weeks (in two separated periods) through which the instructor provided the necessary questions featuring the Socratic Method. Qualitative and quantitative analysis have shown the efficiency of Socratic Method in enhancing the critical thinking skills of the participants. Those results confirm what an earlier study by Yang, Newby, and Bill(2005) came up with where students under study demonstrated a higher level of critical thinking after being subjected to modelling and teaching Socratic Method.

Perry's scheme is another worthy method used in educational fields to foster students' critical thinking and push them toward thinking out of the box. In this method students are engaged in four stages that ensure the cognitive development of students: Dualism, multiplicity, relativism, and commitment (Perry 1970).

The first and minimum stage of thinking is dualism. In this stage, students look at the world in a dual view that everything around them is just right or wrong. They leave little room for negotiating knowledge or questioning it since they think that knowledge is absolute and the teacher is the carrier of all knowledge. They believe that learning is just about the truths and facts that the teacher lectures to them. To students with dualism thinking, learning is just about memorizing and getting an "A" or simply just passing a certain test. In addition, a dualist would frequently ask: will this come in the test! Are you going to help us during the exam! Will there be tricky or hard questions! Students at this stage of thinking can hardly develop their critical thinking abilities and must advance to a higher level of cognitive abilities to adequately achieve further development in their critical thinking skills (Zhu & Cox 2015).

The second stage of Perry's scheme is multiplicity. At this level, a student starts to believe that there could be some uncertainty in some of the knowledge acquired. Knowledge is no longer absolute but rather subjective and may change with time. The teacher, despite being an authority, simply represents another opinion and all opinions are evenly accepted. Students in this stage start to think that the teacher's evaluation is biased and depends on his point of view with the preference of some students over others (Zhu & Cox 2015). Although this stage is more open into improving a student's cognitive abilities than dualism, this stage is still not the best stage to keep the student at because it creates a lot of suspicion without critically assessing the reasons behind such suspicion.Students at the level of multiplicity are encouraged and guided to have better thinking practices through analyzing, comparing, and assessing. Group discussions are also promoted at this stage allowing students to learn from each other and practice listening to others' point of views. Such practice is very similar to collaborative learning that is considered as one of the most successful methods at fostering critical thinking skills of students (Meslec&Curşeu 2015).

Relativism is the third stage of Perry's scheme. Knowledge is still looked at as suspicious in this stage by students however some knowledge may be supported reason and evidence. The

teacher is guide who facilitates learning for the students to discover and assemble the knowledge. In this stage students may be divided into groups to have some internal discussion within the group then move into external discussion or a debate with other groups after they have gathered enough evidences to support their point of view. Indeed, debate was found to provide great support to foster critical thinking skills of students in a study that implemented a 38 minutes debate in classroom divided to 4 intervals of constructive 7 minutes each then followed by 2 intervals of positive and negative rebuttals 5 minutes each (Chikeleze, Johnson & Gibson 2018).

Moving along, we reach the highest stage of Perry's scheme which is represented by commitment. At this stage, a student's course of actions and decisions inside and outside the classroom is affected by the knowledge gained. A good example of this stage where one student, who were asked to explain the importance of the seatbelt in a car through inertia, wrote on her exam paper that she now always uses the seatbelt and asks her family members do the same while convincing them through scientific reasoning. In addition, students at the commitment stage of Perry's scheme are more responsible for their actions and choices they make through the course of their lifetime. They consider the teacher as one of the many available resources they can learn from to acquire facts, develop feelings and perspectives, and take actions upon them. This is the ultimate goal of every educational system that aims to prepare their students to become lifelong learners and productive citizens(Dole, Bloom &Kowalske2015).

2.3.2 Teaching Critical Thinking

There have been a lot of calls to implement critical thinking skills in 21st century. But, if critical thinking is teachable, then which way is better to teach it? Is it the implicit, explicit, or a combination of both ways? Can anyone learn critical thinking skills?

Whether trying use explicit or implicit method, a teacher must have full knowledge of explicit critical thinking theories and methods. This will prove very helpful when trying to implement a classroom activity that fosters critical thinking skills. It is even more recommended to take a full critical thinking course at university to perform better in transferring critical thinking skills to students. Having a solid foundation and depth in knowledge in critical thinking teaching methods would serve greatly in the process of teaching those skills to students as well as

creating problem-based and project-based activities that is well designed to encourage students to flawlessly think critically while solving the problems or designing the projects (Forawi2012).

There are several approaches that can be utilized to foster critical thinking skills for students. For instance, collaborative learning and group discussions allows students to learn from each other not only the subject taught but also ways of thinking as they watch each other's methods of thinking about problems (Kim et al., 2012). The effect would even be greater when groups subject to this method are frequently changed which allows students to explore various ways of thinking and develop theirs into a higher level(Meslec&Curşeu 2015). In addition, collaborative learning would serve as an efficient way to crack the barriers of communication between students thatmake them more supportive toward each other thus improving empathy which is an essential trait of a critical thinker (Van Vliet, Winnips&Brouwer2015).

Teaching critical thinking is not instant, but rather a gradual process that requires a lot of practice and dedication(Florea&Hurjui2015). With proper practice, a person can level up from being an unreflective thinker, who is not systematic in thinking and just randomly deals with different problems, tochallenged thinker, beginner thinker, practicing thinker, advanced thinker, and finally to a master thinker where good habits of thinking are achieved and thinking critically is just a second nature (Paul, & Elder 2004).

Therefore, teaching critical thinking only implicitly students will be using skills that they don't know about and will be developing skills that they don't know about. Similarly, teaching critical thinking only explicitly to students will give the students minimal guidance on applying the skills to real life situations. Consequently, a combination of both will serve best toward a great learning experience and developing critical thinking skills. This is yet to be highlighted upon in future studies.

2.3.3 Critical Thinking in Math and Science Curricula

The math curriculum in which the study took place follows the Common Core State Standards (CCSS). On the other hand, the science curriculum follows the Next Generation Science Standards (NGSS). Both standards provide a solid basis on which future oriented curricula can be built upon(Drew & Thomas 2017).

In an interconnected world with easy access to internet and most content knowledge, it is no longer a main target of education to just deliver the knowledge to the students but rather to develop the skills and abilities analyze, process, and evaluate the knowledge to earn the greatest benefit out of it. Thus, the main focus of CCSS is to develop better thinking skills that allow students to make better decisions and judgments while dealing with mathematical problems that are directly or indirectly related to real life situations. CCSS provides the shift from traditional learning that is based on memorizing and reciting information to modern learning that is student centered and skill based (Drew & Thomas 2017).

In CCSS based curricula, the teacher is no longer a lecturer who stands in front of the students all session long modeling and solving exercises and problems. The teacher is rather now a facilitator, who prepares written instructions to students, gives a brief description of how the session will flow and then allow the students to drive through the session and be the center of attention. Students following this strategy will develop better communication skills, better thinking routines as they start to learn from multiple minds of their friends rather than the one mind of the teacher(Meslec&Curşeu 2015).

This looks so great, but there is one main obstacle: How to develop a curriculum that exactly matches with CCSS? And most importantly will teachers be able to perfectly prepare their classes to match the instruction of CCSS? Many schools actually struggled to achieve 100% alignment with CCSS in their curriculum as shifting to it requires a new mindset. A new mindset that is built upon training and professional development to direct teacher's thinking into a futuristic plan of building a generation of critical thinkers, self-directed learners, college ready, and future proof against upcoming struggles. Many have found that those standards are too high to be achieved or require immense efforts to be implemented. Consequently, many states dropped the standard or suited a fusion between the standards and other standards to create a curriculum that they can eventually deliver to their students (McGuinn 2015).

Comparably, NGSS have made a breakthrough in the shift toward improving 21st century skills implemented in science teaching. Critical thinking in solving problems in addition to using technology in project development are two main aspects that NGSS have brought to science pedagogy. However, just like every education reformation it all starts from the people in the front lines delivering the core of those standards to the students: The teachers. Without

appropriate professional development to teachers post this paradigm shift from traditional teaching to a much more sophisticated standards that combine interconnectedscientific and engineering practices, crosscutting concepts, and disciplinary core ideas, the teachers will find it a daunting task to create a suitable way to implement NGSS with ease(Pruitt 2014).

Therefore, although curriculums have undergone a great shift to further enhance critical thinking skills of students, its applications remain limited to the capabilities of the teachers and the resources they are provided(Pruitt 2014). Further professional development and workshops that include real class practices and hands on activities training sessions would definitely serve a better outcome in terms of fostering students' critical thinking skills imbedded in math and science curricula (Forawi 2016; Zuber-Skerritt 2013)

2.3.4 The Present and Future of Teaching Critical Thinking

Critical thinking is a great asset for today's generation and definitely a must have for future challenges. Various efforts must be compiled together to support the development of critical thinking skills of students. Starting from standards reformation and updating, then compile a well-designed curriculum based on the standards. Next should be teacher training and professional development in implementation of the standards and curriculum as well as critical thinking explicit courses at university level. To complete the picture, students must be aware of how important it is to put the necessary efforts onto developing their critical thinking skills for their better future (Forawi 2016; Forawi& Mitchell2012).

Furthermore, classroom organization to be student centered through the flow of the lesson must be commenced. This would allow students to learn from each other's ways of thinking while developing their own. Such classroom setup enhances collaborative learning and constructive debates and inquiry when combined with problem-based or project-based learning will lead to immense improvements in students' critical thinking skills (Forawi 2016; Kim et al., 2012).

Technology is in rapid development and with it the challenges we face. Challenges of the future will need more than a regular level of thinking to be solved. So, if we are to prepare the generation of the future to be ready for future challenges, then we must train them well to develop good mind habits and systematic ways of thinking. Thus, teachers are greatly

encouraged to implement those good thinking habits in students while they can so that their children and their country live a bright and prosperous future.

Chapter Three: Methodology

This chapter describes how the study took place explaining all the processes taken throughout the course of the research. The chapter starts with the approach followed after which the methods used in the research study are discussed and supported for their convenience to the current study. Next, the settings and the participants are shed light on. This chapter also includes detailed explanation of the instruments used for the study and how the data are gathered and analyzed. Finally, the consents used and the ethical considerations followed are elaborated.

3.1 Approach

The current study follows sequential exploratory mixed approach which is composed of two phases: The first phase is gathering quantitative data that investigates the importance and use of critical thinking through different categories. On the other hand, the second phase is composed of questions to gather qualitative data and investigate specific point of views in questions that would enrich the overall value of the research study and support its conclusion. Mixed methods approach is gaining more and more acceptance from various social sciences fields such as sociology, health, and education (Bryman2016). Although it is not fit for every kind of research, mixed method proves to be useful in researches that include pragmatism where philosophical assumptions or various points of views are valid (Creswell 2014). The use of the mixed methods requires the assortment of both quantitative and qualitative data. Such method is generally implemented in researches where using the quantitative method or the qualitative method alone would provide less understanding of the research questions that are being investigated(Creswell 2014).

The use of theexplanatory sequential mixed method approach offers a key advantage in a way that if some of the quantitative data gathered fails to have adequate explanation, then it is referred to the qualitative data to support, give a better explanation, and provide a clearer view(Creswell 2014). This provides a two parts structure where the second part provides an orientation for the first. Thus, in the first part, the survey data is used to investigate the methods used by teachers to implement critical thinking into their teaching. In the second part, data is gathered through a questionnaire about how teachers view the importance of critical thinking as well as to confirm and clarify the results obtained from the survey of the first part.

This study complies with the post-positivist constructivist philosophy that emphasizes the external reality independent of the researcher values although the theories, background, knowledge and values of the researcher play an important role in constr1ucting the foundation of the research study. The study also explores multiple realities and no absolute truth exists because each person constructs his own reality based on their experiences (Creswell 2014).

3.2 Methods

This study follows the mixed methods design. Mixed methods research blends both quantitative and qualitative methods into one giving a better perspective of the topic under study. Furthermore, using mixed methods allows combining the strengths of both methods and overcoming some of their limitations (Johnson &Onwuegbuzie2004).Using the mixed methods for the current study is most appropriate for several reasons. First, results that can't find appropriate explanation from the quantitative data can find its further explanation through the gathered qualitative data. Second, the topic being about critical thinking could carry several explanations and different points of views that can only be made aware of through open ended questions of qualitative data collection. Third, points that need to be stressed upon in the results of the quantitative method can extend its support from the qualitative data. Moreover, the extension to using both quantitative and qualitative could open the doors to interesting results that could not have been made aware of through quantitative survey only (Creswell 2014).

3.2.1 Site

The study took place at two private schools in the United Arab Emirates – Dubai. Both schools follow the American curriculum with NGSS for science standards and CCSS for math standards. A critical thinking professional development workshop was held in both schools. Seventeen participants attended the first workshop in the first school and 8 participants attended the workshop in the second school. Both workshops took around two and a half hours each and included an introduction, followed by the quantitative survey, the discussion and activities, and finally the qualitative survey with open ended questions. Further data is also collected via e-mail by contacting the participants of the workshop who carried what is discussed in the workshop and put them into activities in their classroom.

3.2.2 Participants and Sample

A total population of 25 science and math teachers participated in the study out of which 14 are math teachers while 11 are science teachers. Teachers' nationalities varied between majority of Arab in addition to Canadian, Turkish, Indian, and Pakistani. On the other hand, the participants are 44% males and 56% females from both middle and high school. When it comes to sampling, systematic sampling accompanied with stratification, so that only science and math teachers are included in the study, was used to obtain useful data from experienced people to enrich the results of the study.

3.2.3 Instruments

The instrument used for the dissertation is adopted from a dissertation by Barnhill (2010) at university of Arkansas. The items are adjusted, filtered, and upgraded to meet the needs of the current study: First, the level of the statements has also been altered to make it easier to understand while at the same time some phrases have been given extra explanation for the same purpose. Second, the items are tabulated and formatted nicely with two extra columns added to fit the data usage sections. Third, questions that belong to the same variable have been linked together under the same set. The instrument includes 50 itemsfollowing Likert scale ranging from 1 to 5 where 1 represent strongly disagree and 5 represents strongly agree (Esterman, 2003). The items are divided into 8 categories: debate and argument, group work, project-based learning, questioning, discussion, modeling and demonstration, comparing and contrasting, analyzing and interpreting. Each of the mentioned categories is represented through 5 to 8 items that belong to the same variable. Each question serves to determine the level of agreement by teachers that the mentioned technique fosters critical thinking skills, whether the teacher currently uses it in class or not, and the willingness to implement the suggested method in the future. Additionally, a set of 10 open-ended questions are featured to provide further information and confirmation of the obtained results from the 50 items survey (see appendix 1).

3.2.4 Analysis of Data

Data are organized in tables and charts which are divided into several areas. Some tables are arranged to compare the most common methods identified by teacher as methods that promote critical thinking skills of students while other tables are arranged to compare the frequency of usage of each method in the teaching-learning process. Meanwhile, the qualitative data are also analyzed and summarized into tables to support the data collected from the quantitative survey. The qualitative data will be analyzed supported by several references in addition to the researcher's 9 years of experience in teaching. Most used and most effective categories will be highlighted and compared in regards of their importance with the findings of other researches that fall into the same category. Findings will then be discussed, compared and contrasted, and recommendations upon the findings will be given. Furthermore, data will be tested for their reliability and correlation using IBM Statistical Package for the Social Sciences (SPSS).

3.2.5 Ethics Considerations

Consent letters addressing both schools were sent to the administration of each school to grant the researchers the access to do the professional development and collect surveyed data. Teachers participating in the professional development session were informed clearly in written and verbal form about the anonymity of the research study results and data collected. Participants were also notified that the survey gathered data will solely be used for the study purpose only. All attendees of the critical thinking professional development session were given freedom of choice to participate or not participate in the survey. Such guidelines were respected as being the basic foundation of every professionally compounded research (Creswell 2014).

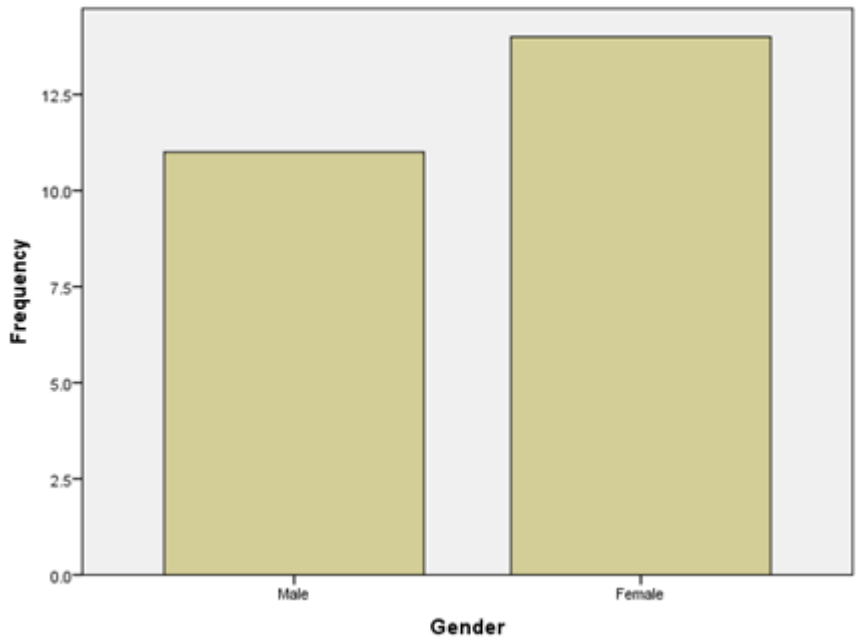
Chapter Four: Data analysis and Findings

The aim of this study was to investigate the views of math and science teachers, in Middle and high school, about the importance and use of critical thinking in their teaching based on a critical thinking professional development. For this purpose, a survey of 50 items, that include eight general strategies that possibly can foster critical thinking skills, was used to investigate which strategies are mostly used by teachers and which strategies are considered as most effective in their point of view. The second part of the survey includes a set of 10 open ended questions that are analyzed by the researcher and their values are added to the results of the research study. This chapter analyzes the results from both parts of the survey and presents the findings in tables and graphs as necessary.

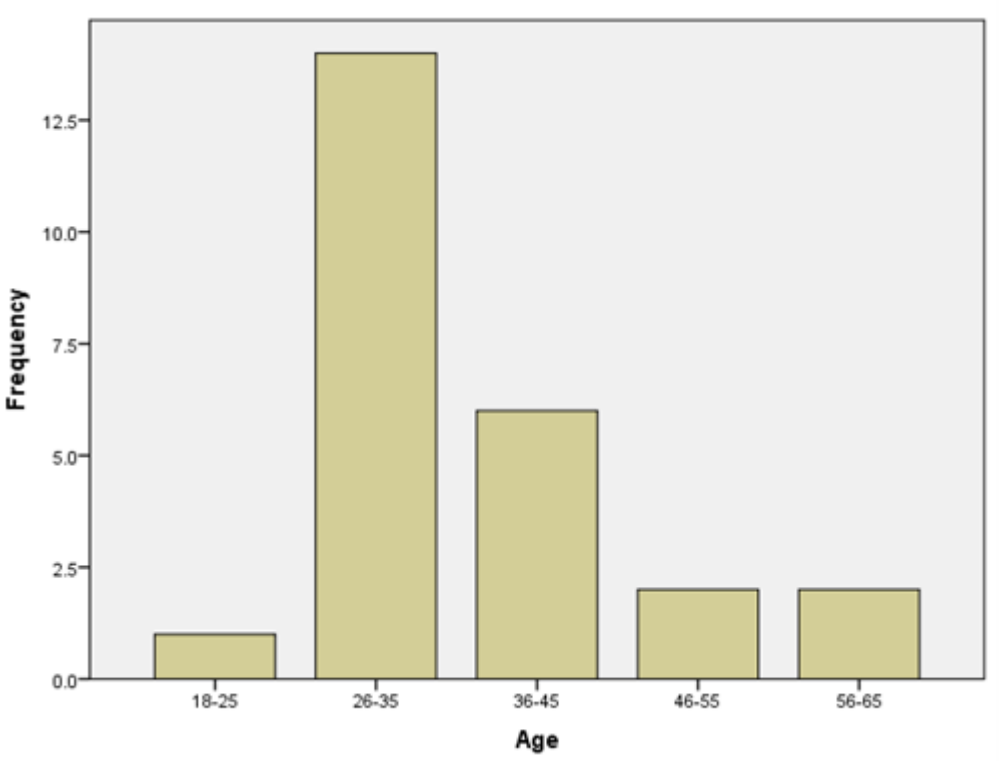
4.1 Demographics

The results were comprised of 44% male and 56% female and similarly 56% were math teachers and 44% were science teachers. The majority of teachers were between 26 and 35 years old while when combined with the age group range 36 to 45 years old will form 80% of the participating sample. Majority of participants (68%) held a Bachelor's degree in their respective teaching field while 32% held a Master's degree or above. The nationality of the participants was mostly Arab (Lebanese, Jordanian, Egyptian, etc...) who formed 80% of the participating group while 20% were non-Arab (Canadian, Turkish, Indian, and Pakistani). A link between demographics and other data variables will be made further on in the next chapter to answer the second research question "How do demographic variables affect middle and high school science and math teachers' views after the critical thinking professional development?"

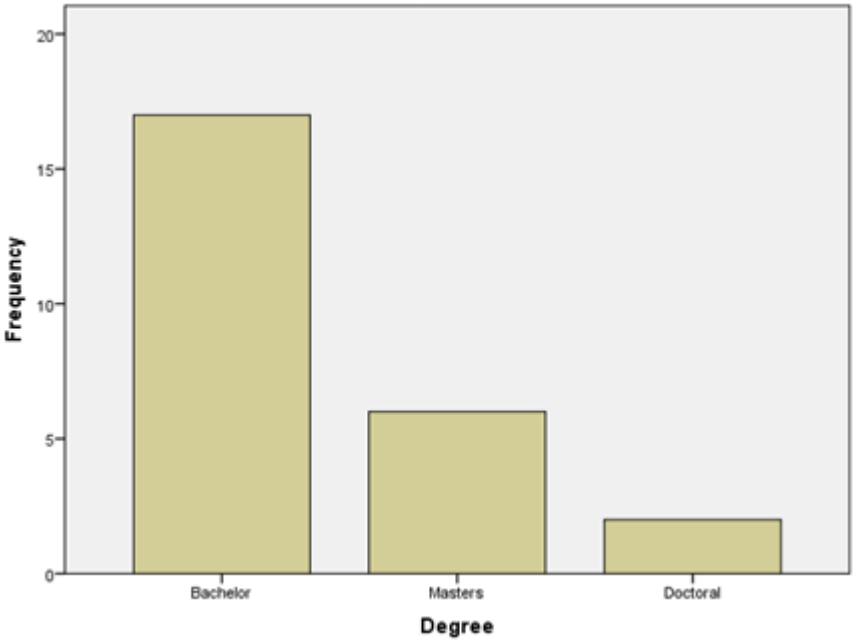
Below are the bar graphs representing the demographic data obtained through the research study:



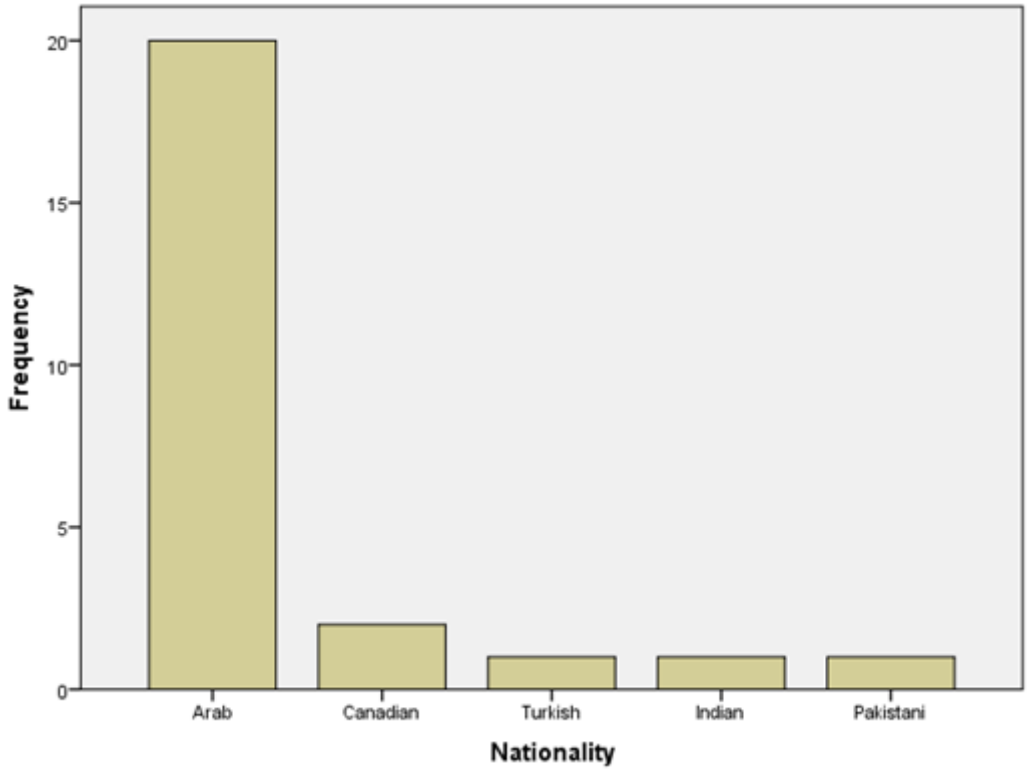
Graph 1: Gender Statistics



Graph 2: Age range of participants



Graph 3: Degrees carried by participants



Graph 4: Nationalities of Participants

4.2 Optimal Critical Thinking Strategies

The effectiveness of eight strategies in promoting critical thinking skills was surveyed:Debate and argument, group work, project-based learning, questioning, discussion, modeling and demonstration, comparing and contrasting, analyzing and interpreting. Three categories are checked in each strategy: First, the level of agreement of each mentioned method in improving students' ability to think critically is checked. Second, the current usage of each method in the teaching-learning process by the teacher is identified. Third, the teachers' interest in applying each of the methods in the future is verified.

The initial test to start with is the reliability test. This is used to measure the internal consistency of the data obtained. Cronbach's Alpha is found to be 0.919 which means the general internal consistency of the data is excellent. The SPSS results are shown in the table below:

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.919	.930	150

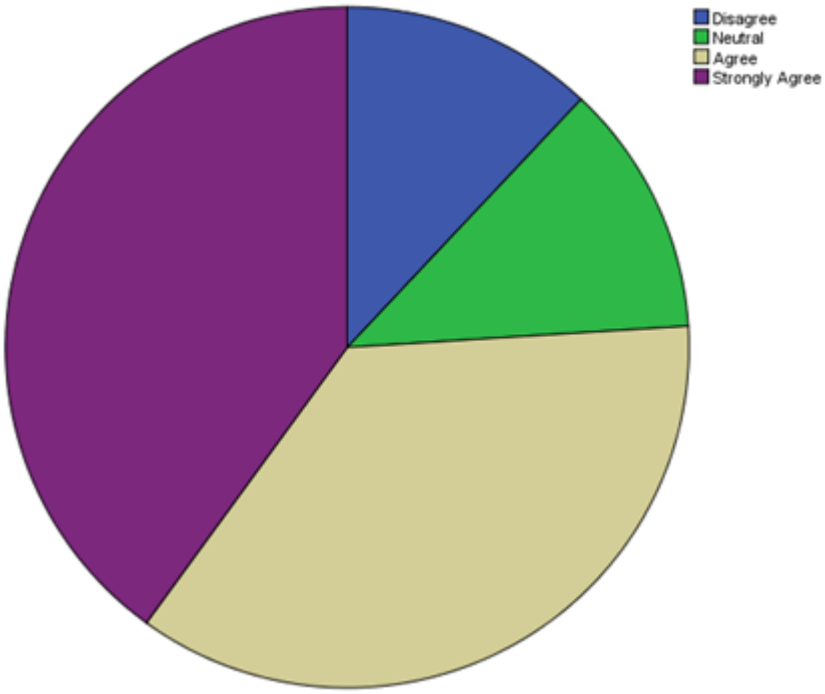
Table 1: Reliability Statistics

This is followed by finding Cronbach's alpha for each of the three questions separately (level of agreement, usage in class, and future usage). Cronbach's alpha for the three tests ranged were: Cronbach's alpha = 0.984 for level of agreement,Cronbach's alpha = 0.911 for usage in class, and Cronbach's alpha = 0.89 for future usage. This indicates that all three categories are reliable to measure(Tavakol&Dennick 2011).

4.2.1 Great Strategies to Promote Critical Thinking

The first category of the 50 questions survey is represented by 8 sets of techniques that use debate and arguments to foster critical thinking of students. As reviewed in the literature, Socratic Method is one of the successful methods the uses questioning and debates lead by the instructor(Hong & Jacob 2012; Clark & Egan 2015). This was also the view, to some extent, of math and science teachers who participated in the study where 76% of them agree or strongly

agree that Socratic Method can foster critical thinking skills of students. Such results are also affirmed by a study done in Malaysia about developing critical thinking through Socratic Method by Sahamid(2016). The action research involves 24 students and concluded that upon repetitive application of Socratic Method students were able more reasoned and proficient responses indicating an improvement in their critical thinking skills. On the other hand, the study noted few reasons that could hinder the progress achieved through Socratic Method including but not limited to language proficiency and students' anxiety toward questioning featured through Socratic Method. This may explain why few teachers of the current study see that Socratic Method would not lead to progress in critical thinking abilities of students.



Graph 5: Socratic Method (Level of Agreement)

Data of the table below reveal that structured controversy or debate has been mostly recognized by teachers out of the 8 other items to have a positive impact onto improving critical thinking skills for students. Examples of structured debates could be dividing students into two groups, allowing them some time to build up defending statements, and then each group would try to stand out for their point of view about the same topic that the other group would see it in another

way. On par with British Parliamentary Debate, a study by Zare and Othman (2015)where a class of 16 students is divided into government group and opposition group. Each group is given 20-30 minutes per session to build uptheir statements before the start of the debate. The practice continued over 9 sessions and constructive outcome. Students, who participated in the study and according to the gathered data analysis, have been found to develop greater critical thinking skills, better speaking abilities, and higher self confidence. Conversely, presenting and discussion the dynamics of academic argumentation in writing is considered a weaker approach in the debate than its friends Socratic Method and structured controversy.

Statistics

		(Level of Agreement) Socratic Method	(Level of Agreement) Structured controversy (argument) or debate	(Level of Agreement) Requiring students to justify their positions with examples and evidence, both in verbal and written analysis	(Level of Agreement) Convincing others of the truth of a claim based on supporting facts and evidence using persuasive techniques	(Level of Agreement) Presenting and discussing the dynamics of academic argumentation, especially in writing	(Level of Agreement) Asking students to analyze ethical choices in small group discussions and in written summaries	(Level of Agreement) Creating a continuum of perspectives on an issue, with students asked to place their own views along the continuum and to articulate why they have chosen their stance and not that of another	(Level of Agreement) Asking a student to articulate an argument that would come from a point of view other than the student's own
N	Valid	25	25	25	25	25	25	25	25
	Missing	0	0	0	0	0	0	0	0
Mean		4.04	4.20	4.12	4.04	3.52	3.68	3.88	3.76
Median		4.00	4.00	4.00	4.00	3.00	4.00	4.00	4.00
Mode		5	4	5	5	3	4	4	4
Std. Deviation		1.020	.645	.927	1.060	.714	.945	.726	.879

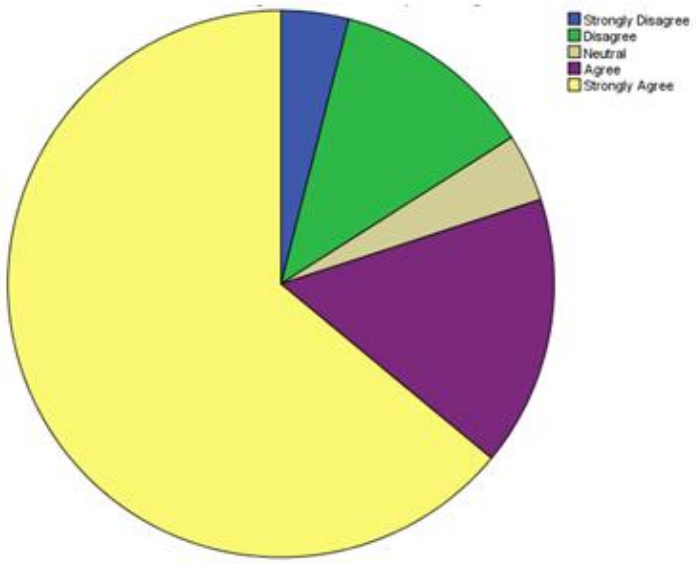
Table 2: Debate and Argument (Level of Agreement)

Moving along, group work is accompanied with 5 techniques to be evaluated through the study. It is interesting to see the cooperative learning has won the most agreement among other techniques. Indeed, cooperative learning is one of the successful methods used widely around the world and serves pretty well in improving critical thinking skills of students(Garcha& Kumar2015).In their study in an Indian school, Garcha and Kumar conducted a research study that involved 116 students from grade 9. Results back up the effectiveness of cooperative learning as the group under study achieved significantly higher critical thinking dispositions than the control group.

Statistics

		(Level of Agreement) Discussion of case studies in both large and small groups	(Level of Agreement) Instructing students about informal fallacies of reasoning, with groups of students subsequently asked to identify the fallacies as they occur in advertising, letters to the editor, etc.	(Level of Agreement) Peer reviews of writing	(Level of Agreement) Cooperative learning - sharing in groups and working together to accomplish a goal	(Level of Agreement) Having students sitting in groups in class all the time and assigning different parts of the lesson to different groups
N	Valid	25	25	25	25	25
	Missing	0	0	0	0	0
Mean		3.80	3.72	3.44	4.24	3.68
Median		4.00	4.00	3.00	5.00	4.00
Mode		4	4	3	5	4

Table 3: Group Work (Level of Agreement)



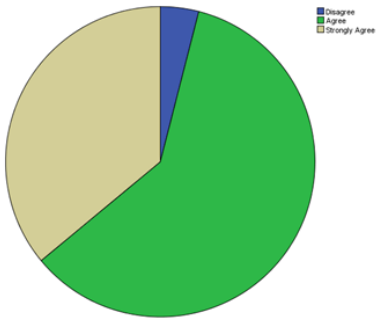
Graph 6: Cooperative Learning-sharing in groups and working together to accomplish agoal (Level of Agreement)

Furthermore, project-based learning has got a very high rate of approval in regards of its ability to foster critical thinking skills however it was not the highest.Most of the teachers (96%), who participated in the study, agree and strongly agree that in-class creative projects with a variety of tools for students to choose from would greatly enhance their ability to think critically. Many applications include more materials than the students need to spark their creativity and critical thinking to come up with ideas the teachers themselves could never think of. Researches around the globe have approved the effectiveness of such method in promoting critical thinking, creativity, and confidence (Widyaningsih& Yusuf 2018;Dimmitt 2017;Rochmahwati2015). Besides the project itself, students learning through project-based learning acquire different ways of thinking from their classmates as they progress through the project which adds to their own bank of thoughts and thus enhances their ability to think critically (Mutakinati, Anwari & Kumano 2018).

Statistics

		(Level of Agreement) In-class, creative projects involving a variety of materials	(Level of Agreement) Mentoring student projects. Students work together to provide feedback and suggestions for major projects.	(Level of Agreement) Asking students to reflect on their decision-making processes during development of a project	(Level of Agreement) Asking students to compare their project to other groups and identify why their project is better or not	(Level of Agreement) Embedding lesson materials as much as possible through the process of project making	(Level of Agreement) Allowing students to enhance the rubrics to be used for project assessing prior to the start of their projects
N	Valid	25	25	25	25	25	25
	Missing	0	0	0	0	0	0
Mean		4.28	3.88	4.12	3.96	3.72	3.52
Median		4.00	4.00	4.00	4.00	4.00	4.00
Mode		4	4	4	4	4	4
Std. Deviation		.678	1.054	.881	.841	.737	1.085

Table 4: Project Based Learning (Level of Agreement)

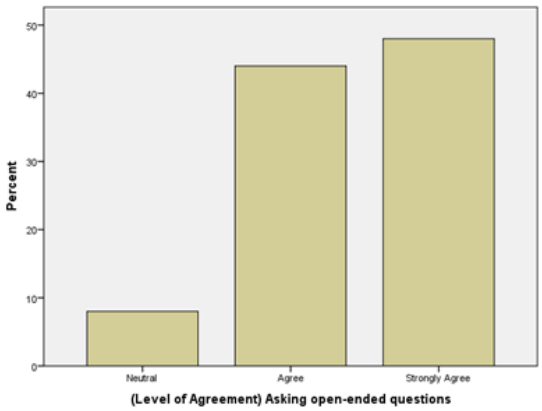


Graph 7: In class, creative projects involving a variety of materials (Level of Agreement)

While majority agree that questioning could foster critical thinking in a way or another, this section have seen some neutrality and disagreement in comparison to others. The winner of this questioning section is the technique of asking open-ended questions where 92% agree and strongly agree that asking open-ended questions could improve critical thinking skills of students. The effectiveness of asking open-ended questions can vary significantly with the topic being discussed, the curiosity of the students to the topic at hand, and the way the question is presented by the teacher(Çakır&Cengiz2016).

		(Level of Agreement) Asking students to consider how course material relates to them personally	(Level of Agreement) Asking students to consider ethical and technical issues of material presented	(Level of Agreement) Asking open-ended questions	(Level of Agreement) Asking questions that provide opportunities for students to respond by applying critical thinking skills to assess the question	(Level of Agreement) Asking students if insight from other disciplines can be incorporated in an analysis	(Level of Agreement) Creating an environment in which students may ask questions that exceed the instructor's immediate familiarity	(Level of Agreement) Asking students to create their own questions in response to a text where these questions are designed to test the limits of the text's applicability, raise possible applications, and address inconsistencies or silences.	(Level of Agreement) Minute papers (Reflection papers at the end of the lesson)
N	Valid	25	25	25	25	25	25	25	25
	Missing	0	0	0	0	0	0	0	0
Mean		3.96	3.72	4.40	4.32	3.32	4.28	3.88	4.00
Median		4.00	4.00	4.00	4.00	3.00	5.00	4.00	4.00
Mode		4	4	5	5	3	5	4	4
Std. Deviation		.889	1.061	.645	.900	.900	1.021	.881	.866

Table 5: Questioning (Level of Agreement)



Graph 8: Asking open-ended questions (Level of Agreement)

In the same way, discussion category had its share of disagreement and neutrality toward its ability to improve critical thinking skills. Yet, discussion can prove to be efficient in increasing critical thinking dispositions for students if it is well designed and rounded up to serve this purpose(Ordem2017). Teachers have shown their agreement to the previous statement when the topic of discussion was about the abilities of the students themselves while discussing their strengths and weaknesses. Similar views were present when the discussion is mixed with metacognition and the students are invited to reflect on their own statements and ideas.

		(Level of Agreement) Discussing with students to about the strengths and weaknesses of their own arguments	(Level of Agreement) Discussion oriented, seminar style instruction	(Level of Agreement) Student directed discussion, assessed by both the teacher and peers	(Level of Agreement) Introducing topics and discussion on levels of complexity and system Interrelations hips	(Level of Agreement) Inviting students to abstract from their observations, to think about the implications of their ideas, and to share the findings with their peers
N	Valid	25	25	25	25	25
	Missing	0	0	0	0	0
Mean		4.00	3.68	3.64	3.80	4.24
Median		4.00	4.00	4.00	4.00	4.00
Mode		4	4	4	4	4
Std. Deviation		.816	.748	1.186	.913	.926

Table 6: Discussion (Level of Agreement)

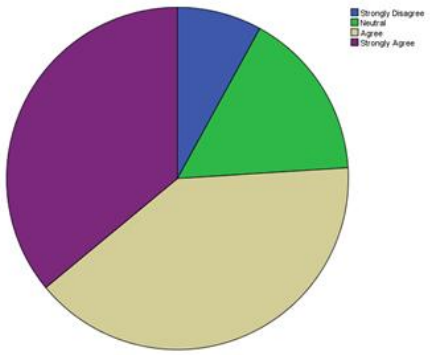
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	4.0	4.0	4.0
	Neutral	2	8.0	8.0	12.0
	Agree	17	68.0	68.0	80.0
	Strongly Agree	5	20.0	20.0	100.0
	Total	25	100.0	100.0	

Table 7: Discussing with students about the strengths and weaknesses of their own arguments (Level of Agreement)

Modeling and demonstrating are closely related to traditional teaching practices. Such practices could barely increase if any critical thinking skills for students. Yet, some teachers have shown their disagreement to the statements (around 25%) while others (around 75%) see that modeling and demonstrating can be an important factor in fostering critical thinking skills. Modeling and demonstration of lesson concepts and on how to solve problems would leave the students as passive learners taking in only what the teacher visibly show while as active learners such inquiry based learning and project based learning students would have a better chance to use their knowledge and develop through thinking the techniques that would serve them forging creative solutions and train their minds to think critically to reach the best solutions(Dimmitt 2017;Duran &Dökme2016).

		(Level of Agreement) Modeling appropriate use of the concepts	(Level of Agreement) Modeling habits of continuous investigation	(Level of Agreement) Modeling a wide variety of examples of critical thinking	(Level of Agreement) Demonstrating how approaches can vary, and the value of searching multiple media and multiple examples	(Level of Agreement) Talking about decision-making processes during demonstrations	(Level of Agreement) Demonstrating mathematical problem solving
N	Valid	25	25	25	25	25	25
	Missing	0	0	0	0	0	0
Mean		3.96	3.72	4.36	3.76	3.88	4.16
Median		4.00	4.00	5.00	4.00	4.00	5.00
Mode		4	4	5	4	4	5
Std. Deviation		1.136	1.208	.907	1.012	.666	1.248

Table 8: Modelling and Demonstrating(Level of Agreement)

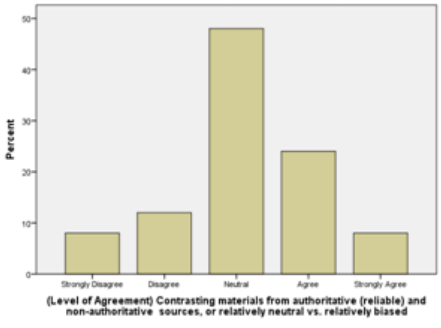


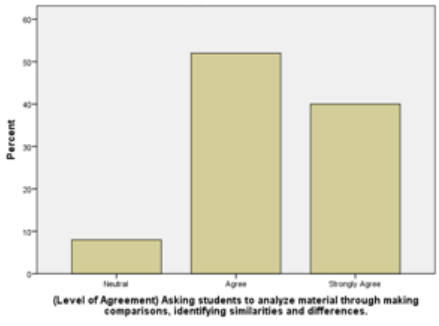
Graph 9: Modelling appropriate use of content (Level of Agreement)

By analyzing the data gathered about the effectiveness of comparing and contrasting model in promoting critical thinking, one can clearly see the most teachers agree that little benefit exist from simply using the comparing and contrasting method without integrating it with another model in regards of improving critical thinking skills. Data show that only 32% agree with the aim of improving critical thinking through contrasting materials from reliable and non-reliable sources. On the other hand, 92% agree and strongly agree that asking students to compare and contrast accompanied with analysis and interpreting would see its way through on the path of improving critical thinking skills of students.

		(Level of Agreement) Asking students to evaluate the different sources from which they draw information, e.g., online peer-reviewed journals vs. Wikipedia vs. a website advocating for a particular point of view	(Level of Agreement) Asking students to define the perspective that is revealed in a text and evaluate the impact of that perspective on the way the text is	(Level of Agreement) Asking students to apply what they have learned previously to new situations	(Level of Agreement) Contrasting materials from authoritative (reliable) and non-authoritative sources, or relatively neutral vs. relatively biased	(Level of Agreement) Asking students to analyze material through making comparisons, identifying similarities and differences.
N	Valid	25	25	25	25	25
	Missing	0	0	0	0	0
Mean		4.08	3.72	3.96	3.12	4.32
Median		4.00	4.00	4.00	3.00	4.00
Mode		4	4	4	3	4
Std. Deviation		.812	.614	1.136	1.013	.627

Table 9: Comparing and Contrasting (Level of Agreement)





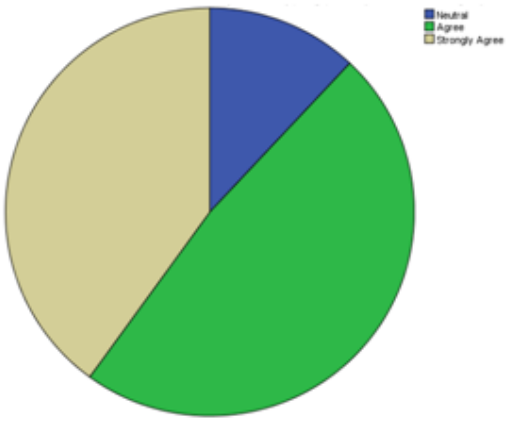
Graph 10(left): Contrasting materials from authoritative (reliable) and non-authoritative sources, or relatively neutral vs. relatively biased (Level of Agreement)

Graph 11(right): Asking students to analyze material through making comparisons, identifying similarities and differences (Level of Agreement)

The last category, which is analyzing and interpreting model, has received a high level of agreement in its efficiency to boost critical thinking skills of students. Analyzing a real world problem and fetching solutions to address the issues and interpreting graphs have received the greatest level of agreement in this section. Similarly, results of studies in this field have shown analogous results where analyzing and interpreting in its different forms has been found valuable in raising the level of critical thinking disposition of students (Abrami et al. 2015).

		(Level of Agreement) Asking students to identify a real-world problem along with possible solutions and evaluate how each addresses key issues, and how each perhaps falls short	(Level of Agreement) Asking students to take evidence and apply it to a problem in order to produce a theory or use it to evaluate an existing theory or solution to the problem	(Level of Agreement) Asking students to describe orally or in written form data that are shown to them figuratively, e. g., interpretation s of graphs	(Level of Agreement) Analyzing Statistics	(Level of Agreement) Reviewing and analyzing an area of research	(Level of Agreement) Asking students to evaluate evidences.	(Level of Agreement) Providing writing assignment prompts for students to engage in textual analysis of literature
N	Valid	25	25	25	25	25	25	25
	Missing	0	0	0	0	0	0	0
Mean		4.36	3.76	4.28	3.88	4.00	3.92	3.52
Median		5.00	4.00	4.00	4.00	4.00	4.00	4.00
Mode		5	4	4	4	4	4	4
Std. Deviation		.907	1.052	.678	.881	.816	.759	.918

Table 12: Analyzing and Interpreting (Level of Agreement)



Graph 12:Asking students describe orally or in written form data that are shown to them figuratively, e.g. interpretations of graphs (Level of Agreement)

Overall, most of the categories that the research tackles have received some level of agreement at different rates. While group work is still viewed a good mean to foster critical thinking, yet it has received the least mean (mean = 3.77) on likert scale where strongly disagree is represented by 1 and strongly agree by 5. Conversely, Questioning has received the highest average (mean = 3.98) and in between lies comparing and contrasting (mean = 3.84), discussion (mean = 3.87), debate and argument (mean = 3.90), project-based learning (mean = 3.91), analyzing and interpreting (mean = 3.96), and modeling (mean = 3.97). While project-based learning and debate were expected to get a higher rate than others, several factors could have led to such results that put questioning at the top and group work at the bottom of the list. More light will be shed on these results and reasons will be argued in the discussion section of chapter 5.

Statistics

		Analyze_Interpret_Mean	Comparing_Contrasting_Mean	Modeling_Demonstrating_Mean	Discussion_Mean	Questioning_Mean	Project_Based_learning_Mean	Group_Work_Mean	Debate_Argument_Mean
N	Valid	25	25	25	25	25	25	25	25
	Missing	0	0	0	0	0	0	0	0
Mean		3.9600	3.8400	3.9733	3.8720	3.9850	3.9133	3.7760	3.9050
Median		4.0000	3.8000	4.0000	3.8000	4.0000	4.0000	3.6000	4.0000
Mode		4.00	4.20	3.83	3.60	4.00	4.00	3.60	3.38
Minimum		2.71	3.00	2.00	2.20	2.25	2.50	2.00	3.00
Maximum		4.71	4.80	5.00	5.00	4.75	4.83	4.80	4.75

Table 12: Mean of the eight tested categories (Level of Agreement)

4.2.2 Most Used Strategies

Moving along to the use of strategies in the teaching-learning process, the most two used strategies by teachers (96%) are asking open-ended questions and the use of cooperative learning where students work together to accomplish a certain goal. In addition, the following methods are very commonly used by teachers: asking students to analyze material through making comparisons (84%), asking students to apply what they have learned previously to new situations (88%), asking students to identify real world problem along with possible solutions (84%), in class creative projects involving variety of materials (80%), and modelling appropriate use of concepts (84%). Meanwhile, the least used strategies (used only by 40% or less) are: Presenting and discussing the dynamics of academic argumentation (32%), creating a continuum of perspectives on an issue with students asked to place their own views (32%), asking students if insight from other disciplines can be incorporated in an analysis (36%), contrasting materials from authoritative and non-authoritative sources (36%), and allowing students to enhance the rubrics to be used for the project assessing prior to the start of their project (40%).

Generally speaking, most techniques that are valuable in terms of raising the critical thinking abilities of students are already being used by more than 70% of the teachers as shown from the data. Yet, how often these techniques are used raises the research into a new level and could be an area of research for future studies. In addition, class observations can be valuable for similar researches in the future.

4.2.3 To Be Used Strategies

Teachers were given the opportunity to indicate which techniques they find valuable and wish to try in the future if they have not used them yet. Despite being used by 40% of the teachers, another 28% have shown their interest in trying the technique that enables students to enhance the rubrics to be used for the project assessing prior to the start of their project. Also, the technique, where a teacher asks students to create their own questions in response to a text where these questions are designed to test the limits of the text's applicability, raise possible applications, and address inconsistencies or silences, is being used by just 48% of teacher and an extra 20% showed their interest in trying this in the future. Additionally, asking students to

reflect on their decision-making processes during development of a project is being used by 68% and another 16% would like to apply it in their future practices.

It has been noticed through the analysis of the data that the points with high rates of agreement to their effectiveness in promoting critical thinking skill have also received a higher rate of willingness to be applied for future use. This could show some acknowledgment of the importance of critical thinking by teachers. Yet, there is a grave need for appropriate knowledge on best practices that inspire students to think critically and become master thinkers in order to prepare students to cope with future challenges.

4.3 The Value within Qualitative Data

The qualitative data that was collected post the critical thinking workshop is a set of 10 open-ended questions that added great value for this research study. In this section, a summary of the answers from the qualitative part of the survey will be provided along with their respective analysis. Data will be analyzed according to the researcher's experience backed up with related studies to provide fruitful conclusions that benefit the education field.

The opening question inquired about how teachers define critical thinking in their own words. Answers included that it is a way of thinking that allows a person to deal with challenges appropriately and the ability to think differently using intellectual standards which were brought up in the professional development prior to the qualitative survey. Other answers include that critical thinking is to question what is said or seen before adding it up to the bank of thoughts. Furthermore, more than 70% of teachers defined it as reflective thinking that helps in deciding what to do or believe. The last definition matches the definition by Norris and Ennis (1989) where they defined critical thinking as reasonable, reflective thinking that is focused about deciding on what to believe and what to do.

When asked about their most preferred method they use to teach critical thinking, majority of science teachers we identified project based learning as an optimal method together with few math teacher pointing out STEAM projects as an effective method to raise students' critical thinking. Unlike science teachers, the majority of math teachers referred to questioning and problem-based learning as a preferred method for them to teach critical thinking skills. Such

difference explains the results from the quantitative survey that teachers gave more credit to questioning and open-ended questions than to debate and project-based learning. To support this, most science and math teachers added that they use questioning techniques and real life inquiries to foster students' critical thinking skills when asked to provide further examples.

Around 80% of teachers have never participated in critical thinking professional development workshops or courses with 50% of them pointing out that this workshop "The Art of Critical Thinking", which is accompanied with the study, is their first critical thinking workshop. Yet, everyone agreed about the great importance of such professional developments that would be extremely helpful in providing them with enough experience to transfer critical thinking dispositions to their students.

Moving along, results show that 88% of math and science teachers use the book in addition to other online resources, videos, pictures, and worksheets in order to provide critical thinking rich instructions. While 12% rely entirely on the textbook. One teacher mentioned that if the book is good enough and resourceful enough then he just uses what he finds in that book, else he seeks external resources. In addition, 68% of the teachers focused regularly on the critical thinking set of questions at the end of every chapter in the book, 20% did so if they had enough time for it, and 12% skipped those questions for various reasons. These two points can be argued and discussed further in such a way that seeking multiple resources may mix things up and leads to an unorganized structure of the lesson while a well structured book might provide all what it needs to cover the content and skills, including critical thinking skills, in an organized manner. Conversely, a poor structured book may just provide the content of the lesson and in this case the teacher will have to surf through other resources in order to achieve critical thinking rich instruction(Avargil, Herscovitz&Dori2012).

When asked to identify the characteristics of critical thinkers, 60% of teachers view critical thinking as a very important asset that helps prepare students for the future and become lifelong learners. While 32% see its major importance in problem solving, 8% of teachers believe that critical thinking empowers their intellectual abilities and it is important to keep training these abilities until it turns into a habit to think critically to be active master thinkers. Critical thinkers are identified by teachers as those who think out of the box, ask a lot, ready to debate and defend their ideas, independent and self driven, and can fit into a leading position quite well. Such

students can be identified through assessment (60%), from the way they participate in class and the curiosity to know the rationale behind any topic they learn (40%). Although it may be possible to perceive critical thinking, it is much harder to measure the level of critical thinking and the progress in that field through the given course(Buckley et al. 2015). Thus, appropriate level of experience and knowledge is required to successfully follow up the progress in critical thinking skills of students which recalls back the need to undertake a full course in critical thinking by teachers in order to run the evaluation and progress processes smoothly(Zein2016).

Despite that technology can be a great assistant in the process of teaching critical thinking, quantitative data reveals that more than 80% of the teachers actually just use it as either a visual aid through watching a video or explaining a picture or a bank of resources for extra exercises. Technology can definitely do much more in enriching the learning process to enhance critical thinking skills of students especially when blended properly with problem-based learning and project based learning (Yu et al. 2015).

4.4 The Professional Development Workshop

The professional development took place conference rooms within the schools. Math and Science teachers were seated in groups with up to 4 teachers per group. The workshop opened up with an introduction to the expectations and objections of the critical thinking professional development. Next, pictures of students' achievements post a well structured, critical thinking oriented project based learning experience is presented. Afterwards, teachers are handed A3 papers that include famous 4 definitions of critical thinking. Instead of just lecturing the 4 definitions to the teachers, the teachers found themselves working on identifying which is the "best" definition in their opinion while at the same time they need to defend their choice. Thus, teachers carefully scanned every definition before pointing one. This is followed by the groups presenting their opinions to other groups and discussing their choices. Teachers' opinion varied among the 4 definitions presented however each group succeeded in giving a reasonable explanation for its choice. After all, the 4 definitions still have a common ground that can hold them all together that is critical thinking as an active process that helps the person to shape his beliefs and guide his doings(Kuhn 1999).

In the next part, the quantitative survey was filled up by teachers. Upon completion, the workshop is resumed and this time there were an active discussion about the 8 elements of thought, intellectual standards, and intellectual traits (Paul & Elder 2007). Teachers linked what is being discussed to their own experiences and provided examples from real life situations to assimilate the concepts behind the fusion of the elements of thought into the structure of the lesson.

In the final part, teachers grouped up to create a real life problem based activity for their students with the 8 elements of thought fused into it. In this problem-based activity, students are expected to guided implicitly into falling off to every step starting with purpose and questions and ending up with building perceptions. It is noted here that science teachers did much brighter activities than their colleagues in the math department. For example: One science group prepared an activity in which students are to imagine themselves as astronauts and would have a mission to identify an unknown living organism that they discovered through their mission. Through this activity, students would identify the purpose, ask questions, design methods to help them with the identification process, come up with theories, and lastly reflect on the whole process and decide on what conclusions to add into their perception. Finally, teachers filled up the qualitative part of the survey and the workshop is concluded.

Chapter Five: Discussion, Conclusions, Recommendations, and Limitations

This chapter provides a thorough discussion about the findings of the study to answer the two research questions raised. Data that are analyzed in the previous chapter will be brought closer together, connected, and argued in order to set proper conclusions, future recommendations, implications, and limitations.

5.1 Discussions

This study aimed to investigate how middle and high school teachers view the importance and use of critical thinking and how demographic factors affect that. A professional development that is especially catered for the purpose of this research study has also been a great asset and was very enriching to the participants. Science teachers recognize the importance of open-ended questions and cooperative learning as routines to foster critical thinking skills of students and would gladly attend further professional development to improve their efficiency in applying those learning routines(Haag &Megowan2015). This is found to be also consistent to their views about the effectiveness that open-ended questions and cooperative learning hold as successfulmethods to promote critical thinking of students. However, about 20% of the participants didn't approve having students sitting in groups all the time with tasks assigned to each group to partake a fraction of the lesson for discussion as an effective method to foster critical thinking. They reasoned that students turn to be dependent on each other to get their tasks accomplish when they sit in groups all the time and they turn to be distracted easily.In a similar manner, a study by Simmons et al. (2015) concluded that cluster seating, despite its positive impact on the social interactions, has increased the off-task behaviors of students.

Although demographics tell that none of the teachers is a fresh graduate and data show that teachers are aware of many methods to improve critical thinking skills of students, yet majority of teachers seem to need further practice and training on how to implement each method professionally and get the best out of it. To achieve such target, one could think of a college course as recommended by Forawi and Mitchell (2012) as well as further practical professional development (Girvan, Conneely& Tangney 2016). This would provide the core of the knowledge to understand critical thinking and the practical experience to implement it into their lesson plans.

Regarding the three categories that were viewed as most important, there seems to be some connection between questioning, analyzing and interpreting, and discussing. Data also showed that they are most commonly used as well. While techniques from these categories promote critical thinking skills to a certain level, yet when used solely for the teaching-learning process would put us at the traditional level of teaching where any increase in critical thinking perceptions gained would just be minimal (Ordem2017). Furthermore, science teachers showed more agreement with analyzing and discussing than math teachers while math teachers gave more value to questioning. This brings us yet again back to traditional teaching where science teachers are discussing scientific knowledge with students and analyzing graphs while math teachers are asking students to solve mathematical questions. Yet, it is too early to draw conclusions before making further research and doing some class observations regarding this matter(Ma 2016).

The ability to integrate the 8 suggested methods skillfully into the lesson plan and in a more frequent manner is the real challenge. Data has revealed that teachers are familiar with most of the methods mentioned and have used most of the at least once through their teaching career. Curriculum designing requires a lot of efforts and strategic revolution and the contribution of every academic person counts toward transforming the teaching process from teacher centered more into student centered process with the teacher facilitating that process(Alismail& McGuire 2015). Teachers will have to shift from teaching for the test only and start setting higher goals that ensures the readiness of the students to cope with future challenges. To achieve such purpose, teachers will have to focus on more practical methods of teaching to enhance students' critical thinking as well other 21st century skills such as: inquiry-based learning, project-based learning, and structural debates (Rochmahwati2015). While it is true that we need make the change, we will have to change a very important factor first: The teacher's views and pedagogy(Dole, Bloom &Kowalske2015). As long as teachers, as in this research study, value questioning and modeling more than group work, project based learning, and debate then we will continue to see more teacher centered learning in the future. Whence, in order to make a breakthrough and achieve the evolvement of learning into a higher level teacher interactive training should be commenced to introduce them into a new pedagogy. One of the best ways to convince teachers to the new methods of teaching is to expose them to these methods through workshops and training so that they experience its great results themselves(Kennedy 2016).

The completion of the survey has opened the eye of the participants from math and science teachers into effective methods of teaching that they have shown interest to try in the future. This is apparent in the results of strategies that teachers shown interest to use in the future such as allowing students to participate in setting the rubrics of their project prior to start which was used only by 40% of the teachers but another 28% showed their interest in applying such strategy.Similarly, 68% of teachers used to ask students to reflect on their decision making during the development of a project while another 16% are willing to use this strategy in the future. Therefore, teachers gained the benefit of participating in the professional development workshop and the survey itself as well. This also indicates that teachers see great importance in implementing techniques that would help foster students' critical thinking skills. Methods that include involving students in reforming the rubrics of the project they will be doing as well as asking them to reflect on their decision making during the progress of the project have been seen high rates of agreement on their capabilities to promote critical thinking dispositions and at the same time many teachers who were not using such methods have shown their great interest to put it into action in the future. Comparably, many researchers especially who maintain constructivist principles believe that project-based learning is far more superior to traditional ways of teaching (Machumu& Zhu 2017;Rochmahwati2015). Project based learning naturally induces with it cooperative learning allowing students to sharpen two future proof skills: social communication and teamwork skills. In the current study cooperative learning has received the highest agreement level in its category and have been acknowledged by many other researches that it plays an important role in promoting critical thinking skills of students(Garcha& Kumar2015). Similarly, a study by Loes and Pascarella (2017), that involved 1,455 freshmen students at 19 institutions throughout the United States and investigated the development of critical thinking skills of those students through cooperative learning, has concluded that cooperative learning is associated with development in critical thinking students given that they have been prepared well to be college ready in high school.

Project based learning is greatly based on the philosophy of constructivism. Such philosophy encourages students to build their knowledge and skills through into a greater level especially if it is ill structured and little instructions on how to complete the task. Students in this experience find themselves obliged to push their skills further, including critical thinking skills, in order to provide brighter solutions and better outcomes(Anazifa&Djukri2017).Not only this

helps students to become better thinkers and learners, but also prepares them to the job market where they have to communicate with others frequently to come up with innovative solutions and ideas to boost the productivity in the job position they fill(Habok& Nagy 2016).

In light of discussion of the qualitative data, many participants have never attended a critical thinking workshop before. Untrained science and math teachers would still struggle to implement critical thinking assets into their teaching even if they know what promotes critical thinking(Farah, Fauzee&Daud2016).When teachers are asked to impose critical thinking in their lesson plans and still not trained enough to do it fluently, they will struggle to accomplish such task and may just give it up all together and roll back into traditional teaching once again(Forawi 2016). Thus, the need to educate teachers about the perceptions of critical thinking is not the only obstacle facing education development, but also the ways to implement it into their lessons and activities (Forawi& Mitchell2012). Teachers who participated in the professional development have shown so much interest in the activities presented in the workshop and commended that this is one of the greatest workshops that we truly benefitted from. Another challenge emerges herewhich is the quality of the workshops to make a difference and convince teachers for the need to change their mindset from traditional teaching strategies to 21st century skills' teaching strategies(Seaton 2018; Patton, Parker & Tannehill 2015).

Assuming that teachers are convinced of the importance of fostering students' critical thinking skills and are well trained to implement it in their teaching, then they would fall into a new obstacle of how to measure the progress of students' critical thinking skills. Indeed, while majority (60%) of surveyed teachers think that they can measure the progress of critical thinking through subject tests, yet researchers argue that is much harder to accurately measure critical thinking perceptions progress merely through a subject test (Buckley et al. 2015). On the other hand, Forawi and Mitchell (2012) have developed a popular tool called critical thinking attributes skills (CTAS) which is further implemented in a study by Forawi (2016) to investigate pre-service teachers' perceptions and utilization of critical thinking.

As we proceed in the qualitative data, Teachers have shown some concerns regarding the application of these methods. For example, students may become so dependent on others in the same group to do the work for them and after all they are evaluated as a whole group. So, this

requires, just like any newly implemented method, a good policy that governs the evaluation of group work as individual effort in addition to the group effort as a whole(Xu, Du & Fan 2015). Therefore, teachers should be supervising that each has divided the responsibilities among every student in the group so that each of the students have enough tasks to remain occupied throughout the whole duration of the group work activity.Roskosa and Rupniece (2016) agrees that the success of the group work can be tuned greatly if the lecturer assures the presence of some preconditions such as the groups being heterogeneous, motivation and support to all students in the group, and promoting the sense of responsibility between all members of each group.

A review of the literature insists that if we are to raise teachers' perceptions of critical thinking, then teachers are to sit for a college course or multi sessions professional development workshop to become familiar with best practices to help them implement it into their teachings (Forawi& Mitchell2012). While most teachers know what methods can be used to achieve such target, only few are familiar to how to apply the processes needed professionally and fluently. Indeed, a lot of teachers complain about the absence of critical thinking oriented resources in their curriculum and that they find themselves spending long hours preparing such critical thinking rich content(Nagro, Fraser & Hooks 2019).Thus, a lot of traditional teaching will continue to be seen in classrooms and this will continue until we provide adequate tools and training for the teachers to reduce their anxiety toward such practices (Patton, Parker, & Tannehill 2015).

Conclusions

Developing critical thinking of students is an ultimate goal that has a great impact on the rise of nations. Yet, little is done to ensure that future generations are prepared to be master critical thinkers. Teachers carry a great responsibility in creating a suitable environment that fosters students' critical thinking. This study addressed the views of science and mathematics teachers in middle and high school about the importance and use of critical thinking. The main findings show while most teachers agree that debate, project-based learning, questioning, and class discussions can help improve critical thinking skills of students, yet they had different views on which method is more valuable. Science teachers valued debate and project-based learning more than mathematics teachers while mathematics teachers saw more value in questioning and class discussions.Overall, project-based learning deems to be very valuablesince it combines hands on, real life application, problem solving, and collaborative learning under one umbrella.Thus, implementing more project-based learning into school curriculums would prove very efficient in enhancing critical thinking skills of students while at the same time raising their motivation to learn.

5.2 Implications and Recommendations

Therefore, much planning and effort is required if nations are to succeed in such endeavor. It requires the combined efforts of academic researchers, curriculum developers, teachers, professors, and academic trainers to achieve such success. It is not an easy task, yet it is possible. It is not going to happen instantly, but a persistent will to make it happen will carve a will to use critical thinking in every aspect of life.More efforts have to be done to ensure that future generations are prepared to be master critical thinkers(Huber &Kuncel2016).In addition, providing teachers with critical thinking oriented resources in their curriculum can save them long hours preparing such critical thinking rich content and allow them more time to focus on developing methods to deliver such content(Nagro, Fraser & Hooks 2019). While problem-based learning has a positive effect of problem solving and critical thinking skills of students, it poses an insignificant effect on students' motivation to learn(Argaw et al. 2017). Instead, project-based learning can see its way to the hearts of students easily to improve their motivation and critical thinking skills at the same (Bilgin, Karakuyu& Ay 2015).

Despite its limitations, this research study adds up to the body of education valuable data and recommendations for future research. It is recommended that any future research would take into consideration the rate at which critical thinking oriented activities are applied by teachers and not just whether they use it or not. Also, Teachers are encouraged to participate in any available professional development especially practical oriented workshops to enhance their abilities to permeate critical thinking into the teaching-learning process(Patton, Parker, & Tannehill 2015). The goal is to prepare the future generation to face any challenges in a very innovative way and to improve their critical abilities to take the right decisions in what they do or believe. It is a great challenge indeed, but the reward is a prosperous community of master thinkers where thinking critically is autonomous.

5.3 Limitations

While the current study identified which methods are used by science and math teachers, it would have been not possible to identify how often each method is being used with the current survey model. Thus, further improvements for the survey to set a range of how often each mentioned item is being used would provide a better understanding on how teachers view the importance of the use of each method. Teachers tend to give a more informed evaluation for the importance of each method when they have used such method more frequently and assessed its effect on the critical thinking dispositions of students (Forawi 2016). Another limitation is the number of participants and number of schools in which the study took place. A larger sample would have served better at the ability to generalize the results obtained and build up stronger conclusions (Khalilzadeh&Tasci 2017). Besides, class observations could have proved very useful ininvestigating how science and math teachers apply each activity, the level of proficiency, and its direct and indirect effects on students' thinking abilities over a longer period of time (Martinez, Taut &Schaaf 2016).

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Appendix A:

Critical Thinking Survey

Critical Thinking Questionnaire

This questionnaire measures how do middle and high school science and math teachers view the importance and use of critical thinking based on critical thinking professional development. You are kindly asked to fill the three parts of the questionnaire. The participation is voluntary and all data will be treated as confidential and will be used solely for my dissertation research. Thank you very much in advance.

Part A: Demographic Information

1. What is your gender?

   a. Male b. Female

2. What is your age?

   a. 18-25 years old b. 26-35 years old c. 36-45 years old

   d. 46-55 years old e. 56-65 years old f. above 66 years old

3. What is your degree level?

   a. Bachelor level b. Master's level c. Doctoral level

   d. Other _____

4. What is your field of study?

_____

5. What subject do you teach?

_____

6. What is your nationality?

_____

7. In case the study needed little more data from a limited number of extra questions, would you like to help make the study better by answering these extra questions? If yes, please provide your email in the blank below.

_____

Questionnaire questions variables

1-8 Debate and argument

9-13 group work

14- 19 project based learning

20- 27 questioning

28-32 discussion

33- 38 modeling and demonstrating

39-43 comparing and contrasting

44-50 analyzing and interpreting

Adopted from

TEACHING STRATEGIES FOR CRITICAL THINKING: PERCEPTIONS OF LIBERAL ARTS FACULTY

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Education in Higher Education

Edith Jane Barnhill, August 2010, University of Arkansas

Part B: Questionnaire

The following strategies are utilized by teachers to enhance students' critical thinking.

1) Rate your level of agreement to each method in improving students' ability to think critically.

2) Specify whether you use the strategy or not in your class.

3) Place a (*) next to the strategy that you wish to implement in your future teaching.

#	Strategy	Level of agreement	Do you use it in class? (Y/N)	Do you wish to use it in the future? If yes, place a (*)
1	Socratic Method * Socratic method is a method in which the teacher leads a discussion with continuous questioning and debating.	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
2	Structured controversy(argument) or debate	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
3	Requiring students to justify their positions with examples and evidence, both in verbal and written analysis	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
4	Convincing others of the truth of a claim based on supporting facts and evidence using persuasive techniques	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
5	Presenting and discussing the dynamics of academic argumentation, especially in writing	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
6	Asking students to analyze ethical choices in small group discussions and in written summaries	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	

#	Strategy	Level of agreement	Do you use it in class? (Y/N)	Do you wish to use it in the future? If yes, place a (*)
7	Creating a continuum of perspectives on an issue, with students asked to place their own views along the continuum and to articulate why they have chosen their stance and not that of another	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
8	Asking a student to articulate an argument that would come from a point of view other than the student's own	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
9	Discussion of case studies in both large and small groups	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
10	Instructing students about informal fallacies of reasoning, with groups of students subsequently asked to identify the fallacies as they occur in advertising, letters to the editor, etc.	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
11	Peer reviews of writing	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
12	Cooperative learning - sharing in groups and working together to accomplish a goal	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
13	Having students sitting in groups in class all the time and assigning different parts of the lesson to different groups	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	

#	Strategy	Level of agreement	Do you use it in class? (Y/N)	Do you wish to use it in the future? If yes, place a (*)
14	In-class, creative projects involving a variety of materials	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
15	Mentoring student projects. Students work together to provide feedback and suggestions for major projects.	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
16	Asking students to reflect on their decision-making processes during development of a project	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
17	Asking students to compare their project to other groups and identify why their project is better or not	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
18	Embedding lesson materials as much as possible through the process of project making	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
19	Allowing students to enhance the rubrics to be used for project assessing prior to the start of their projects	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
20	Asking students to consider how course material relates to them personally	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
21	Asking students to consider ethical and technical issues of material presented	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	

#	Strategy	Level of agreement	Do you use it in class? (Y/N)	Do you wish to use it in the future? If yes, place a (*)
22	Asking open-ended questions	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
23	Asking questions that provide opportunities for students to respond by applying critical thinking skills to assess the question	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
24	Asking students if insight from other disciplines can be incorporated in an analysis	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
25	Creating an environment in which students may ask questions that exceed the instructor's immediate familiarity	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
26	Asking students to create their own questions in response to a text where these questions are designed to test the limits of the text's applicability, raise possible applications, and address inconsistencies or silences.	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
27	Minute papers	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
28	Discussing with students to about the strengths and weaknesses of their own arguments	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	

#	Strategy	Level of agreement	Do you use it in class? (Y/N)	Do you wish to use it in the future? If yes, place a (*)
29	Discussion oriented, seminar style instruction	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
30	Student directed discussion, assessed by both the teacher and peers	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
31	Introducing topics and discussion on levels of complexity and system Interrelationships	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
32	Inviting students to abstract from their observations, to think about the implications of their ideas, and to share the findings with their peers	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
33	Modeling appropriate use of the concepts	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
34	Modeling habits of continuous investigation	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
35	Modeling a wide variety of examples of critical thinking	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
36	Demonstrating how approaches can vary, and the value of searching multiple media and multiple examples	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	

#	Strategy	Level of agreement	Do you use it in class? (Y/N)	Do you wish to use it in the future? If yes, place a (*)
37	Talking about decision-making processes during demonstrations	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
38	Demonstrating mathematical problem solving	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
39	Asking students to evaluate the different sources from which they draw information, e.g., online peer-reviewed journals vs. Wikipedia vs. a website advocating for a particular point of view	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
40	Asking students to define the perspective that is revealed in a text and evaluate the impact of that perspective on the way the text is	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
41	Asking students to apply what they have learned previously to new situations	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
42	Contrasting materials from authoritative (reliable) and non-authoritative sources, or relatively neutral vs. relatively biased	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
43	Asking students to analyze material through making comparisons, identifying similarities and differences.	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	

#	Strategy	Level of agreement	Do you use it in class? (Y/N)	Do you wish to use it in the future? If yes, place a (*)
44	Providing writing assignment prompts for students to engage in textual analysis of literature	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
45	Asking students to evaluate evidences.	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
46	Reviewing and analyzing an area of research	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
47	Analyzing Statistics	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
48	Asking students to describe orally or in written form data that are shown to them figuratively, e.g., interpretations of graphs	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
49	Asking students to take evidence and apply it to a problem in order to produce a theory or use it to evaluate an existing theory or solution to the problem	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	
50	Asking students to identify a real-world problem along with possible solutions and evaluate how each addresses key issues, and how each perhaps falls short	☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree	☐ Yes ☐ No	

Part C: Answer briefly the following questions

1) What is critical thinking?

2) Is there a particular method that you prefer in how you teach critical thinking? Explain.

3) What techniques you use in you classes that foster critical thinking? Please give an example.

4) How does professional development raise teachers' awareness teaching critical thinking skills? Have you experienced any professional development that helped with that? Please describe an example.

5) Do you focus on critical thinking questions of each section in the textbook or just go solving the easier direct questions?

6) Do you rely on textbook content to provide critical thinking rich instruction? If yes, how? If no, what alternatives do you use?

7) Why is it important to design lessons that are rich in critical thinking skills?

8) What characteristics do you expect to see in a student who exhibits critical thinking?

9) How do you perceive and measure your students' progress level of critical thinking skills in the courses you teach?

10) How can technology assist in developing lessons that promote students' critical thinking? Give an example.

Appendix B:

Consent Forms

11/6/2018

To: [redacted]

This is to certify that Mr.Salah Shaito with Student ID number 2016101023 is a registered part-time student in the Master of Education from the Faculty of Education offered by The British University in Dubai since September 2016.

Mr. Shaito is currently collecting data for his dissertation (Critical Thinking)

He is required to gather data through conducting surveys that will help him in writing the final dissertation. Your permission to conduct his research by conducting a training workshop about critical thinking skills for teachers in your organisation is hereby requested. Further support provided in this regard will be highly appreciated.
Any information given will be used solely for academic purposes.

This letter is issued on Mr.Shaito's request.

Yours sincerely,

Dr. Amer Alaya
Head of Student Administration

PO Box 345015 · Block 11 Dubai International Academic City Dubai U A E · T +971 4 279 1400 · F +971 4 279 1490
FB.com/BUiD.Team BUiD_Team youtube.com/BUiDadmin @BUiD_Team BUiD

Dear administration,

I hope you are doing well. I am very thankful for you that you provide me with the chance of presenting my critical thinking workshop for the teachers of your school. I hope they will be able to benefit a lot from what I will be offering them through the workshop.

The workshop will include the following:

1- Introduction to the workshop and objectives.

2- Group work in which each group will have to select the best definition of critical thinking, out of 4 definitions, providing reasoning behind their choice.

3- Quantitative part of the survey is filled.

4- Discussion about universal intellectual standards, elements of thought, and intellectual traits

5- Group work in which each group constructs a task for their students that allows them to merge critical thinking into real life problem based activities.

6- Qualitative part of the survey is filled.

Best regards,

Salah

Appendix C:

Tables, Graphs and Demographic data

		Analyze_Interpret_Mean	Comparing_Contrasting_Mean	Modeling_Demonstrating_Mean	Discussion_Mean	Questioning_Mean	Project_Based_learning_Mean	Group_Work_Mean	Debate_Argument_Mean
N	Valid	25	25	25	25	25	25	25	25
	Missing	0	0	0	0	0	0	0	0
Mean		3.9600	3.8400	3.9733	3.8720	3.9850	3.9133	3.7760	3.9050
Median		4.0000	3.8000	4.0000	3.8000	4.0000	4.0000	3.6000	4.0000
Mode		4.00	4.20	3.83	3.60	4.00	4.00	3.60	3.38
Minimum		2.71	3.00	2.00	2.20	2.25	2.50	2.00	3.00
Maximum		4.71	4.80	5.00	5.00	4.75	4.83	4.80	4.75

Debate_Argument_Mean

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.00	1	4.0	4.0	4.0
	3.25	1	4.0	4.0	8.0
	3.38	4	16.0	16.0	24.0
	3.50	1	4.0	4.0	28.0
	3.63	2	8.0	8.0	36.0
	3.75	1	4.0	4.0	40.0
	3.88	2	8.0	8.0	48.0
	4.00	4	16.0	16.0	64.0
	4.13	2	8.0	8.0	72.0
	4.25	1	4.0	4.0	76.0
	4.38	2	8.0	8.0	84.0
	4.50	2	8.0	8.0	92.0
	4.63	1	4.0	4.0	96.0
	4.75	1	4.0	4.0	100.0
	Total	25	100.0	100.0	

Group_Work_Mean

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	1	4.0	4.0	4.0
	2.20	1	4.0	4.0	8.0
	3.20	1	4.0	4.0	12.0
	3.40	3	12.0	12.0	24.0
	3.60	7	28.0	28.0	52.0
	3.80	2	8.0	8.0	60.0
	4.00	1	4.0	4.0	64.0
	4.20	2	8.0	8.0	72.0
	4.40	4	16.0	16.0	88.0
	4.60	2	8.0	8.0	96.0
	4.80	1	4.0	4.0	100.0
	Total	25	100.0	100.0	

Project_Based_learning_Mean

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.50	2	8.0	8.0	8.0
	3.50	3	12.0	12.0	20.0
	3.67	4	16.0	16.0	36.0
	3.83	1	4.0	4.0	40.0
	4.00	5	20.0	20.0	60.0
	4.17	4	16.0	16.0	76.0
	4.33	1	4.0	4.0	80.0
	4.50	4	16.0	16.0	96.0
	4.83	1	4.0	4.0	100.0
	Total	25	100.0	100.0	

Questioning_Mean

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.25	1	4.0	4.0	4.0
	3.13	1	4.0	4.0	8.0
	3.63	1	4.0	4.0	12.0
	3.75	4	16.0	16.0	28.0
	3.88	3	12.0	12.0	40.0
	4.00	7	28.0	28.0	68.0
	4.25	1	4.0	4.0	72.0
	4.38	1	4.0	4.0	76.0
	4.50	4	16.0	16.0	92.0
	4.63	1	4.0	4.0	96.0
	4.75	1	4.0	4.0	100.0
	Total	25	100.0	100.0	

Discussion_Mean

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.20	1	4.0	4.0	4.0
	2.80	1	4.0	4.0	8.0
	3.20	1	4.0	4.0	12.0
	3.40	1	4.0	4.0	16.0
	3.60	5	20.0	20.0	36.0
	3.80	4	16.0	16.0	52.0
	4.00	3	12.0	12.0	64.0
	4.20	3	12.0	12.0	76.0
	4.40	3	12.0	12.0	88.0
	4.60	2	8.0	8.0	96.0
	5.00	1	4.0	4.0	100.0
	Total	25	100.0	100.0	

Modeling_Demonstrating_Mean

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	1	4.0	4.0	4.0
	2.50	1	4.0	4.0	8.0
	3.67	3	12.0	12.0	20.0
	3.83	7	28.0	28.0	48.0
	4.00	2	8.0	8.0	56.0
	4.17	4	16.0	16.0	72.0
	4.50	4	16.0	16.0	88.0
	4.67	2	8.0	8.0	96.0
	5.00	1	4.0	4.0	100.0
	Total	25	100.0	100.0	

Comparing_Contrasting_Mean

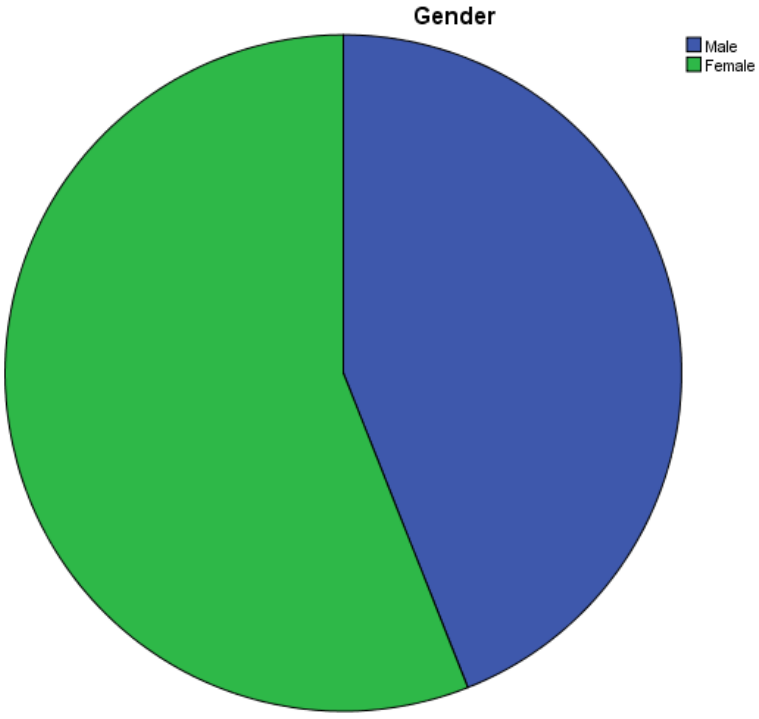
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.00	1	4.0	4.0	4.0
	3.20	1	4.0	4.0	8.0
	3.40	5	20.0	20.0	28.0
	3.60	2	8.0	8.0	36.0
	3.80	4	16.0	16.0	52.0
	4.00	4	16.0	16.0	68.0
	4.20	6	24.0	24.0	92.0
	4.40	1	4.0	4.0	96.0
	4.80	1	4.0	4.0	100.0
	Total	25	100.0	100.0	

Analyze_Interpret_Mean

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.71	2	8.0	8.0	8.0
	3.00	1	4.0	4.0	12.0
	3.43	1	4.0	4.0	16.0
	3.71	2	8.0	8.0	24.0
	3.86	1	4.0	4.0	28.0
	4.00	7	28.0	28.0	56.0
	4.14	4	16.0	16.0	72.0
	4.29	2	8.0	8.0	80.0
	4.43	3	12.0	12.0	92.0
	4.71	2	8.0	8.0	100.0
	Total	25	100.0	100.0	

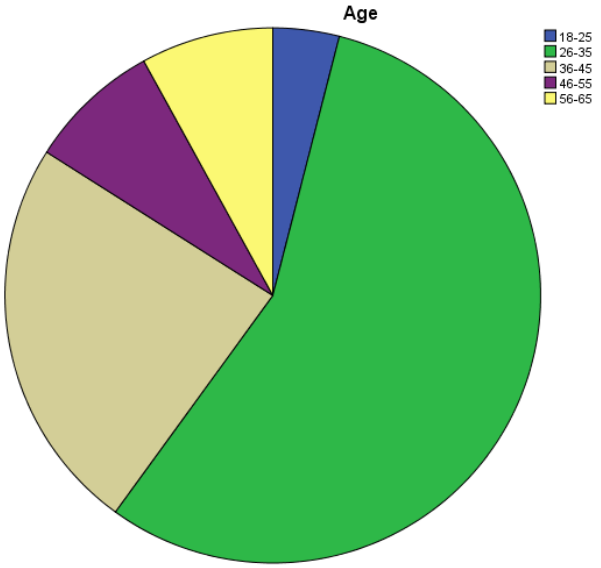
Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	11	44.0	44.0	44.0
	Female	14	56.0	56.0	100.0
	Total	25	100.0	100.0	



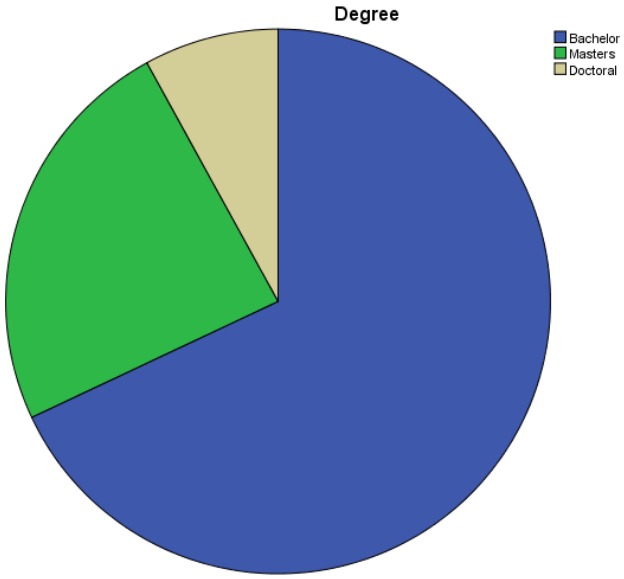
Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-25	1	4.0	4.0	4.0
	26-35	14	56.0	56.0	60.0
	36-45	6	24.0	24.0	84.0
	46-55	2	8.0	8.0	92.0
	56-65	2	8.0	8.0	100.0
	Total	25	100.0	100.0	



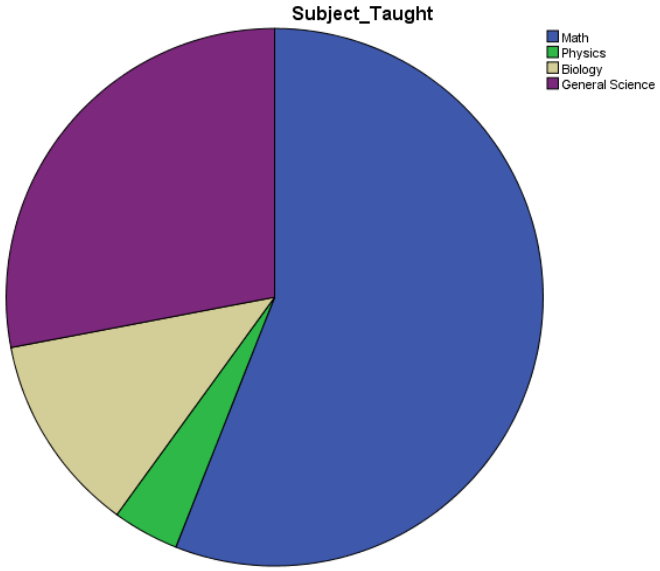
Degree

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bachelor	17	68.0	68.0	68.0
	Masters	6	24.0	24.0	92.0
	Doctoral	2	8.0	8.0	100.0
	Total	25	100.0	100.0	



Subject_Taught

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Math	14	56.0	56.0	56.0
	Physics	1	4.0	4.0	60.0
	Biology	3	12.0	12.0	72.0
	General Science	7	28.0	28.0	100.0
	Total	25	100.0	100.0	



Nationality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Arab	20	80.0	80.0	80.0
	Canadian	2	8.0	8.0	88.0
	Turkish	1	4.0	4.0	92.0
	Indian	1	4.0	4.0	96.0
	Pakistani	1	4.0	4.0	100.0
	Total	25	100.0	100.0