Assessment of Computational Thinking Skills of IT Students: Case Study of EMU-IT

Maren Omer Said Zaghdoud

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Assoc. Prof. Dr. Ali Hakan Ulusoy
Acting Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science in Information and Communication Technologies in Education.

Assoc. Prof. Dr. Ersun Iscioglu
Chair, Department of Computer Education and Instructional Technologies

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as a thesis for the degree of Master of Science in Information and Communication Technologies in Education.

Prof. Dr. Mustafa Ilkan
Supervisor

Examining Committee

1. Prof. Dr. Mustafa Ilkan
2. Prof. Dr. Oguz Serin
3. Assoc. Prof. Dr. Ersun Iscioglu

ABSTRACT

Computational theories and perspectives are important components of modern day skills that are omnipresent and may be used across a variety of industries. Individuals in the digital age are anticipated to have computational thinking skills in different disciplines, but there is still no evidence as to what extent they have these skills and if they are at a sufficient level. This study focuses on exploring the level of computational thinking skills, and differences according to gender, age and years of study. The study was conducted on Information Technology undergraduate students who were studying in the 2017-2018 academic year spring semester at Eastern Mediterranean University. In this study a mixed method (convergent parallel design) is used to obtain the result in a more consistent manner. The data was collected from 197 participants by means of a questionnaire "Computational Thinking Skills Scale" in addition to conducting semi-interviews with 23 students to explore the attitudes and skills that they used to solve problem. The findings of the study indicate that EMU undergraduate IT students at sufficient level of computational thinking skills, however, student's skills of algorithmic thinking and problem solving were a slightly low level of compared with creativity, cooperativity and critical skills which are the construct of computational thinking skills. In addition, the findings showed that, there were no significant differences in their computational thinking skills based on gender and age variables. However, significant differences exist in years of study variable. This is possibly due to the nature of course being studied in the school. So a future study could explore the emergence of computational thinking process in a non-problem based learning environment such as lecture-based courses where computational thinking activities are

occasionally provided to the students after their lectures have been completed during the course period.

Keywords: computational thinking skills, assessment methodologies, students' attitudes.

ÖZ

Sayısal teoriler ve perspektifler, günümüz dünyasının her alanında varolan ve birçok farklı sektörde kullanılabilen günlük yaşam becerileri için oldukça önemlidir. Dijital çağda yaşayan bireylerin farklı alanlarda sayısal düşünme becerilerine sahip olması beklenirken, bu becerilerin düzeyleri ve yeterlilikleriyle ilgili herhangi bir kanıt bulunmamaktadır. Bu çalışmada, cinsiyet, yaş ve eğitim süresine göre bireylerin sayısal düşünme beceri düzeyleri araştırılmıştır. Araştırmanın örneklemini, 2017-2018 akademik yılının bahar döneminde Doğu Akdeniz Üniversitesi'nin Bilgi Teknolojileri (BT) lisans programında eğitim gören öğrenciler oluşturmaktadır. Daha tutarlı sonuçlar elde etmek için araştırmada karma yöntem (yakınsayan paralel desen) kullanılmıştır. Veriler, 197 katılımcıdan toplanan "Sayısal Düşünme Becerileri Ölçeği"ne ek olarak, problem çözme konusundaki tutum ve becerileri incelemek amacıyla 23 katılımcıyla gerçekleştirilen yarı yapılandırılmış görüşmeler aracılığıyla toplanmıştır. Elde edilen bulgulara göre, DAÜ BT lisans programı öğrencilerinde iyi derecede sayısal düşünme becerileri gözlemlenmiştir; ancak algoritmik düşünme ve problem çözme becerilerinin, sayısal düşünme becerilerini oluşturan yaratıcılık, pekişme ve eleştirel düşünme becerilerine kıyasla az oranda daha düşük olduğu ortaya çıkmıştır. Buna ek olarak, cinsiyet ve yaş değişkenlerine göre sayısal düşünme becerileri konusunda anlamlı bir fark bulunamamıştır. Ancak, eğitim süresi değişkeni ile sayısal düşünme becerilerinin düzeyi arasında belirgin farklar gözlemlenmiştir. Bu fark, okul eğitimi içerisinde verilen derslerin yapısıyla ilişkili olabilir. Bu nedenle, gelecekte, problem temelli olmayan, ağırlık olarak anlatım temelli olan ve sayısal düşünme becerilerinin bazen ders sonralarında sağlandığı eğitim ortamlarındaki sayısal düşünme sürecinin gelişimiyle ilgili bir araştırma gerçekleştirilebilir.

Anahtar Kelimeler: sayısal düşünme becerileri, değerlendirme metodolojileri, öğrenci tutumları.

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INTRODUCTION

1.1 Background to the Study

At present, computer sciences have significant influence on development of technology, therefore, people who are fortunate enough to live in a technology enriched society with the opportunity to make potential use of computers and other digital technologies are at an advantage when compared with people who do not possess sufficient skills to utilize and comprehend the application of technology to solve the problems (Yadav et al., 2014). So, the ability to use computers or other technologies to solve problems has become the essential skill of daily life and work, so all citizens should be able to recognize how, when, and where to utilize computers and other technologies to solve their problems, and how to work collaboratively with others (Barr, Harrison, & Conery, 2011). These mental skills are called Computational Thinking (CT) – a term which was coined by Jeannette Wing (2006) in an article stating that "it represents a universally applicable attitude and skill" for all, which is considered as a seminal article of CT concept. Denning (2009) indicated that the idea of CT has been present since the 1950s and 1960s as 'algorithmic thinking'. CT has been referred as a type of analytical thinking which differs from other types of thinking, but at the same time it has some common elements with other types like algorithmic thinking, engineering thinking, design thinking, and mathematical thinking (Lee et al., 2011; Wing, 2008).

The term CT is defined by Cuny, Snyder, and Wing (2010) "as thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent" (p.1). CT from this point of view is a problem solving approach which includes dividing a complex problem into parts that could be solved easily, employing set of logical steps to get solutions, and generalizing those solutions to stand for many. Therefore, CT involves adopting the thinking habits and reasoning methods of computer scientists to solve well-structured problems (mathematical problem) and also ill-structured problems (problems of daily life).

Although the concept of CT, Computer Literacy- Fluency with Information Technology- are different, there is public misunderstanding between these concepts. In general, CT is boarder than fluency with IT. While Computer Literacy considers the side of ability to use applications; understand general ideas and principles of computer, and network; apply technology in complex situations, use a specific menu of facts, concepts, and thinking habits of computer scientists like algorithmic thinking, CT considers the side of conceptual understanding (National Research Council [NRC], 2010). CT comprises a set of skills including:

> "1- Decomposition (formulating problems) 2- Pattern Recognition (logically organizing and analysing data) 3-Representing data through abstractions 4- Automating solutions through algorithmic thinking 5- Identifying, analysing, and implementing possible solutions with the goal of achieving the most efficient and effective combination of steps and resources 6- Generalizing and transferring this problem-solving process to a wide variety of problems (Computer Science Teacher Association [CSTA] & International Society for Technology in Education [ISTE], 2011, p.13)."

Recently, in 2015, ISTE indicated that CT covers a range of skills, that are taken into consideration as together, including: creativity, algorithmic thinking, critical thinking, problem-solving, and cooperativity (Korkmaz et al., 2017). Along with Korkmaz et al.

(2017), in this study, CT has been defined as consisting of these skills which are primarily reviewed in the literature.

The importance of CT has been widely recognized. It is widely accepted as "a lens for looking at the world" (Denning, 2009). Moreover, it is considered as a key to enhance individuals in both poor and rich technological environment; both vocational and educational career. It is believed that CT would facilitate individuals to: firstly, increase success in a digital society -citizen will be able to use daily technology effectively, and evaluate sufficiently the sources of information from the Internet, social media, online-education; assist in taking the right decision of appropriate technology to use. Second, it could enhance individuals' empowerment and increase motivation for doing their important things. Third, it would support non-computer specialists to using and adopting computational tools in these disciplines (NCR, 2010). In addition, introducing CT into educational area will lead to the enhancement of students and teachers' thinking skills to problem solving, and enable students to build up a foundational comprehension of computing and create skills that may move them from being clients to makers of information technology (Yadav et al., 2014).

The possibility of implementation of CT in a wide range of disciplines, not just Computer Sciences is realized. In a variety of discipline the concepts of CT have been used by applying problem solving strategy and abstraction (ibid). These professions, furthermore, which use algorithmic thinking are disciplines such as biology, chemistry, physics, computational social science, digital arts…. etc- and areas where data analytics is used, such as training army recruits (Wing, 2010). Therefore, "CT is not just or all about computing. The educational benefits of being able to think computationally transfer to any domain by enhancing and reinforcing intellectual skills” (ibid).

The need for the integration of CT into the educational environment was recognized due the importance of CT skills for all people - 21st century literacy. Thus offering CT to all disciplines is the responsibility of educators and experts of educational technology (Guzdial, 2008). One of the efforts was made in 2010 by The National Science Foundation (NSF), (ISTE), and (CSTA) which provided an operational definition of CT that will facilitate educators to use CT skills in their curriculum (Barr et al., 2011).

In addition, in higher education, many campuses are revising their curriculum of computer science and changing it to include the essential elements and concepts of CT (Wing, 2017). However, there is still need to conduct research in higher education about curriculum, quality of learning and teaching and assessment tools (Czerkawski & Lyman, 2015). But for the most part assessment and measurement of CT skills should be more focused due to the fact that developing assessment tools is an essential way of integrating CT successfully in a curriculum (González et al., 2017).

1.2 Problem Statement

During the industrial period, classification of professions depended on the ability to develop, allocate and utilize products. During the information age categorizing professions is highlighted on the production, allocation and usage of information. This has consequences for the results of education. People are continuously required to expand their skills for innovative ways of work processing, living, learning and thinking. New skills are required to continuously update new information to operate work tools (Griffin et al., 2012).

People need to think computationally because it is expected to be an essential skill for all individuals in the 21st century, not only for computer professors (Wing, 2010). “To reading, writing, and arithmetic, we should add CT to every child’s analytical thinking” (Wing, 2006). As global economies are further inclined to the commerce in information and communications, the requirements for instructing new skills will adapt to include an educational revolution of a similar respect to that which supplemented the transition from the agricultural to the industrial revolution(Griffin et al., 2012). Therefore, the term CT has been of great concern in educational research area in the recent decade (Brnnan & Resnik, 2012).

Individuals in the digital age are anticipated to have CT skills in different disciplines, but still there is no evidence to what extent they have these skills and if they are at the sufficient level (Korkmaz et al., 2017). Throughout the years of progress in the CT research area, no study has been done in this regard in North Cyprus (NC). This issue led to carrying out this study to bridge the gap of knowledge in this area.

1.3 Purpose of Study

The purpose of this study is the investigation of the computational thinking skills of Information Technology (IT) students at Eastern Mediterranean University (EMU), according to their gender, age and years.

1.4 Research Questions

With the framework of this study, the comprehensive questions that the study seeks to answer are:

1. What is the level of CT skills of IT students and what degree of these skills do they have?
    1.1. Do levels of CT skills of students differ in terms of their gender?
    1.2. Do levels of CT skills of students differ in terms of their age?
    1.3. Do levels of CT skills of students differ in terms of their years?

1.5 Significance of the Study

The development of technology has led to a significant influence on society, whether professional or novice, so academic and career achievements in many disciplines are based on the skills and ability of the effective application of technology. Students should be prepared for their future careers, the employees that these students need to be familiar with new tools and master 21st skills (creativity, critical thinking, collaboratively, problem-solving) (Griffin & Care, 2014). “A digital literacy is now an essential skill to succeed in our complex, digital 21st century world” (Shute et al., 2017).

Assessment is a vital by product of the current significance in higher education on accountability and learning conclusions. Assessment tasks can influence activity in dialogue between different education departments, librarians, and administrators on important academic issues, such as distinguishing learning outcomes for student achievement, exploring paths to enhance academic curriculums, and authenticating change and development over time in student learning environments (Dunn, 2002).

Since there have not been any studies conducted in the assessment of CT skill in IT students at EMU as whole, it may be thought that this study possibly contributes to the literature. This study could provide insight into CT skills of participations; highlighting the intensity of CT and the size of the gap of CT skills.

The outcomes of this study might raise the awareness of policy makers and instructors of computing of the importance of developing the well though-out pedagogical use of CT skills, and develop curriculum that addresses these skills. In addition, it could assist instructors to enhance tools and develop activities of CT idea and practices with subject area to increase CT functioning and solve issues where students experiences weakness in CT.

1.6 Limitations

The collected data was limited only to students in the IT department at EMU during the 2017-2018 spring semester. Interviews will be carried out and analysed by a single researcher. This may limit result in a limitation in the comprehension of the data in the sense of the researcher being influenced by his or her own idea.

1.7 Definition of Key Terms

CSTA: (Computer Science Teacher Association) is a membership organization, which assists the computer science instructors and instructors of other computing professions. They provide opportunities for K-12 teachers to better comprehend the computing field and how it relates (Computer Science Teacher Association. n.d.).

ISTE: (International Society for Technology in Education) is a non-profit organization Providing support for its members of teachers and instructors in technologies, connections and ideas for interconnected learning (International Society for Technology in Education. n.d.).

FIT: is the word used by the committee meaning, teach the IT needed to today and how find out how to learn more information technology in the future(National Research Council, 1999).

Chapter 2

LITERATURE REVIEW

This section will focus on written scholarly research that identifying with previous studies related to CT skills, this chapter briefly discusses the CT concept in different perspectives, with special significance to CT skills identified by Korkmaz et al. (2017). In the CT spectrum, the benefits and relationship between CT skills and other thinking skills will be presented. Finally, various studies in assessing and integrating CT will be discussed.

2.1 Background of CT

It is the notion that information and communication technologies (ICT) will bring about phenomenal changes resulting in a sustainable society. However, in order to fulfil this expectation, it is equally important to alter our mind frames (Easterbrook, 2014). Most industries, such as; automotive, finance, healthcare, journalism, law and manufacturing, are continuously being enhanced with improved computer science. In order to progress and maintain careers in these industries people must change their mind sets towards thinking more computationally (Wing , 2017). For this reason, it is necessary for scientists in the future generations to be immensely involved with computing. Future scientists must exert as much attention to learning how computer science can improve their work, equally important to exploring comprehending how mathematics already improves their work (Hambrusch et al., 2009).

Computational ideas and perspectives enable a new way of communicating hypotheses and theories (Bundy, 2007). Therefore, in attempting to comprehend the digital humanities, it is vital to transform the problem to be solved in a computerized manner. This enables one to think critically about how knowledge in the 21st Century is processed through computational techniques, especially software (Berry, 2011). How to developing learners skills in the 21st century skills applying creativity, critical thinking, and problem solving, has been a predominant issue in our interconnected world-wide society. In order for students of today to contribute to transformations and future discoveries, it is vital for them to take an active role in hands-on practical work rather than simply consuming information in a passive style and manner (Gretter & Yadav, 2016). Furthermore they must be able to understand and apply skills related with programming and problem solving (Selby, 2015).

Applying advanced computing capabilities to understand and solve complex problems can be improved with computational science, expanding our ability to achieve greater inventions previously never comprehended, by using techniques previously unavailable to us. In order to achieve such great advances, modern day students need to acquire and develop computer technology skills in order to keep up with the rapidly changing developments in the world (CSTA & ISTE, 2011).

Computational theories and perspectives are important components of modern day skills that are omnipresent and may be used across a variety of industries. Wing (2006) debated that all children should be equipped with computational skills applied analytically at school in subjects equally as applied in statistics, biology, chemistry, and physics. Barr and Stephenson (2011) supplemented this claim, highlighting that computing is a large part of students' lives, influencing their choice of career in computing fields. For this reason, they argue that it is vital that students' are introduced to algorithmic problem-solving and computing equipment at a young age.

2.2 CT Conception

The term CT has been made more prevalent by Wing (2006). In her inspiring article on CT, she states CT as "solving problems, designing systems, and comprehending human behaviour, by drawing on the theories important to computer science" (p.33); CT is consisted of a variety of cognitive skills, which reveal the vast scope of the industry of computer science. Conversely, her article did not reveal the definition or explanation of what CT means for everyone. Since then many scholars have attempted to define the notion of CT (Barr & Stephenson, 2011;NRC, 2010;Denning, 2007), resulting in various different significances. Denning (2009) highlighted that the notion of CT has existed since the 1950s, discovered by Papert. He defined the idea as 'algorithmic thinking', meaning using a cognitive pathway to solve problems as a transformation of an input to an output and finally searching for algorithms to perform the conversions. The term has further evolved by perceiving in many stages of thoughts and ideas. These abstracts are more diverse and complex as to those used in the mathematical and physical sciences(Wing, 2008). Wing went on to further develop the notion of CT in 2010, as "thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent"(p.1).

Scholars have not only been occupied with defining CT, they have also been involved in distinguishing the main features and characteristics. Recently, the functional meaning has been confirmed by the CSTA, in partnership with the (ISTE) and leaders in education and industry. This definition refers to computational thinking as a problem-solving procedure which consists of the subsequent features, such as; expressing problems and solving them using a computer and other technological devices, rationally arranging and analysing information, illustrating data through abstractions, such as replicas and simulations, using an automated sequence of stages to process, using algorithmic thinking to identify, analyse, and apply achievable results with the aim of accomplishing the most competent and effective amalgamation of stages and resources, simplifying and applying the problem-solving process to a wide variety of different problems (CSTA & ISTE, 2011).

Furthermore, in a recently published article which explores and assesses CT Brennan & Resnick (2012) have expanded on a definition of CT which involves three vital components; computational concepts, computational practices and computational perspectives. Computational concepts consist of seven notions, which are extremely useful in a variety of Scratch projects which transfer to other programming contexts such as: sequences, loops, parallelism, events, conditionals, operators, and data. Computational practices concentrate on the procedure of thought and acquiring information, transforming from what one is learning to how one is learning. They maintained four main stages of practices: being incremental and iterative, testing and debugging, reusing and remixing, and abstracting and modularizing. Computational perspectives secure how programmers' perspectives are affected and influences during CT in three different ways: expressing, connecting, and questioning.

Nevertheless, there is still disagreement on the formal definition of CT(Shute et al., (2017) . Weintrop et al., (2016) proposes that it will be necessary to dissect CT into a group of distinct and assessable skills, ideas, and practices. Therefore, along with Korkmaz et al. (2017), in this study, CT has been defined as consisting of abilities such as: creativity, algorithmic thinking, critical thinking, cooperativity, and problem solving.

2.2.1 Creativity

CT has the potential to promote creativity in the classroom by allowing students the freedom to progress from simply consumers of technology to constructing programs used in modern day that also benefit society (Voskoglou & Buckley, 2012; Mishra, Henriksen, & the Deep-Play Reaerch Group, 2013). Likewise, imaginative innovations boost the expansion of CT (Shell et al., 2014). Creativity may be described as cognitive processes including the collection of new ideas or concepts, or new relations between current ideas or notions (Jackson et al., 2012).

Furthermore, Mishra et al. (2013) describe a creative idea as original, introducing something new into the universe. These unique notions, or novels are sometimes defined as being innovative and original. 'Novelty' must be associated with 'purpose' or simply how useful and productive something is. However, just because it may be novel, its novelty does not pledge to be effective. Some words, which may be used to describe this notion are: useful, rational and understandable are some words that are used in connection with this aspect. 'Wholeness**',** referring to the visual aspects within the scope of the work is regarded as a third dimension of discovering creative replicas. Different ways of describing this dimension are organic, well crafted, and elegant.

Korkmaz et al. (2017) claim that creative thinking is not a separate and individual entity. Other features such as critical thinking are also intertwined within it. If one possesses the ability to think critically, they will also likely have the ability to think creatively and in addition be able to solve problems. The origin of thinking creatively begins in recognition of oneself. Possessing the skills to Imagine and create new ideas, not ever created before is at the heart of being able to problem solving. Overall, programming is the series of activities that transforms the problem into a numerical format and therefore solving it in a computerized manner. Within this scope, the learner discovers his own innovations and seeks techniques for solutions. Therefore, it may be claimed that creative skills are one of the most significant divisions of CT.

2.2.2 Algorithmic Thinking:

CT processing has been a significant topic since the 1950's, also known as algorithmic thinking (Denning, 2009). Algorithmic thinking is a set of skills that are interlinked to construct and understand algorithms. And also it may be defined as the capability to comprehend, implement, assess, and invent computational procedures. It is the ability to analyse and solve specified problems; the ability to state a problem accurately; the ability to find the simple steps that are sufficient to solve the presented problem; to enable the construction of a correct algorithm to the presented problem using the basic techniques; to enable thinking processes about all possible outcomes to a problem, both special and normal and finally enable the ability to improve the efficiency of an algorithm (Futschek, 2006; Futschek & Moschitz, 2010).

First and foremost, an algorithmic thinker needs to have the competence to comprehend a computational procedure in its individual stages. It is also necessary for Algorithmic thinker to assess processes for both accuracy and effectiveness. In order to become an algorithmic thinker, one must also be able to invent new algorithms(Futschek & Moschitz, 2010). Algorithmic thinking is vital in an information-based society, which all humans consume. Almost all of our modern day industries consist of following a sequence of rules, applying. Many fields of modern life involve the processes of following procedures, applying rules or executing methods. Therefore it may be argued that these are perceived as human-processed algorithms (Katai, 2015; Futschek & Moschitz, 2010). Algorithmic thinking processes are thought of as one of the most important features to be able to be separate in line with the age of informatics (National Research Council, 1999). Thus, algorithmic thinking is not only required by computer scientists, but also for students in our modern day (Lamagna, 2015). Therefore, Algorithms are key to both computer science and CT (Yadav et al., 2017).

2.2.3 Cooperativity

CT and programming are social and creative processes. They enable a platform for implementing tasks of importance for others in areas of society in which design sharing and cooperation with others are absolutely necessary. It may be argued that CT may also be referred to as computational participation (Kafai, 2016). Cooperative problem solving may be perceived as one of the principle features, described by the Irish National Council for Curriculum and Assessment (NCCA) in the requirement of Coding where teamwork is a skill necessary for students to acquire knowledge by pooling resources together, in a way that will mirror their work (Doleck et al., 2017).

A key feature of solving problems collectively is the freedom to propose one idea correlated with another person. Collaborative problem solving consists of an instantaneous combination of a variety of behavioural and social-cognitive skills (Warneken et al., 2014). The significance of collaboration in a competent manner in solving coding problems is highlighted (Standl, 2016). Farris & Sengupta, (2014) examined the progression of CT in students working together using agent-based modelling. It was discovered that cooperation together with having a mediator outlook assisted in comprehending the related scientific ideas. In the future, social collaboration is proposed to have an accelerated significance in CT skills since new computational problems are increasingly directed toward larger-scale networking and complex data-intensive applications, where solutions result from collaboration and collective problem solving.

Collaborative problem solving has been hypothesized as containing five distinctive threads, the ability of a person to acknowledge the viewpoint of other people in a collective; contribute as a associate of the group by adding their information, experience and expertise in a productive way; acknowledge the requirement for input and how to operate them; distinguish structure and process included in solving an issue, constructing, understanding and developing information. During the process of experimenting and testing collaborative problem situations, comprehensive types of situations and tasks are being trialled and tested(Griffin et al., 2012).

2.2.4 Critical Thinking

CT assists critical thinking by analysing in order to solve problems, make decisions and communicate in the universe (Kules, 2016). The intensity of the problem needs thorough evaluation and production, determining the most appropriate technique giving importance to accuracy. These all come under the umbrella of critical thinking skills (Voskoglou & Buckley, 2012).In addition, Voskoglou & Buckley (2012) state that critical thinking also influences the comprehending and learning of knowledge. Due to knowledge being the result of thinking about theories and amalgamating them with rules. Concepts are learned via thoughts and principles connecting the concepts and resulting in creating a network. When a theory has been discovered it needs to be implemented into the current cognitive arrangement. A complex procedure such as this would not be possible without critical thought processes. When a problem occurs, it must be critically evaluated before being solved. The problem must be identified with the available data. Thus, it can be argued that critical thinking is also plays a role in applying the data in order to solve the problem.

Critical thinking may be represented both as a cognitive situation and as a capability (Williams, 2005).Critical thinking is considered to be a more advanced, non-algorithmic, multifaceted kind of thinking that often results in a series of solutions. It is a platform for higher-level processes such as analysis, creation and assessment in a combination making a path for other skills such as deducing, predicting, approximating, simplifying, creative thinking and problem solving. Thus, we can make the assumption that problem solving is followed by critical thinking (Kules, 2016; Voskoglou & Buckley, 2012).

2.2.5 Problem Solving

The promise of CT is that it can enhance problem solving and critical thinking by connecting the strength of computing (CSTA & ISTE, 2011). Being involved in problem solving suggests both conscious and subconscious thinking. The kind of thinking processes necessary will be determined by the kind of problem. So, it is claimed that the more difficult the problem, the more advanced the level of thinking needs to be (Voskoglou & Buckley, 2012; Mueller et al., 2017).

It may be suggested that CT may be geared towards a particular kind of problem solving, with a particular mind set. Computer programming may be defined as the determination of a problem and the formation of a solution using a language and reason that orders a computer to carry out instructions leading to a solution (Mueller et al., 2017). When the programming process is perceived as a major problem solving process, problem solving skills could not be disregarded in a macro thinking skills like CT (Korkmaz et al., 2017).

2.3 Benefits of CT

Although there is still uncertainty regarding CT, the field has a huge amount of positive support. CT has brought about into society a wide variety of advantages and still strives to improve practices in all fields. Gouws, Bradshaw, & Wentworth (2013) indicate that as a school of thought emerging from computer science, CT has undisputable advantages in the industry of computing. CT delivers an opportunity to establish a trial and error platform, where learners are given awards and encouragement for the level of their thinking skills rather than simply based on their experience with former technology. Furthermore, Wing (2010) argue that by CT students will be able to comprehend components of a problem, which are agreeable to computation. They would be able to assess the connection between computational devices and practices and a problem. Learners would be able to comprehend the weaknesses and strength of computational devices and techniques. They will also be able to implement or change a computational device or technique for a new purpose. They would be able to acknowledge a situation of where and how to use computation in a new way as well as implement computational techniques such divide and conquer in any domain. In addition, Proficiency in CT, which is known as computer science, assists us to methodically accurately and effectively process data and tasks (Lu & Fletcher, 2009). Reinforcing these aspects, workshop participants offered a number of reasons for declaring CT skills more broadly; Succeeding in a technological society, increasing attention in the information technology careers; Supporting investigations in various other areas, enabling personal development (NRC, 2010).

In addition, CSTE & ISTE have identified a number of perceptions that are both necessary for and a result of CT. These consist of: Confidence in handling with complexity, Persistence in working with complex problems, Tolerance for uncertainty, The skills to handle open-ended problems, The skills to interact and collaborate with others to attain a shared result or solution (Barr et al., 2011). These abilities and outlooks do not normally require technology, however, they are assisted by and encouraged in a digital environment. CT and problem-solving are connected with higher-order thinking skills that are established as key to success in a digital age (Mueller et al., 2017).

Yadav et al. (2011) have shown that a learner's perception of computing becomes highly positive the more information on computing they are exposed to. In addition to theories in science and mathematics are formed upon instinctive computational instruments, increasing understanding in both fields (Rodrigues et al., 2016; Orton et al., 2016).

Furthermore, it is claimed that by CT, gender discrimination is reduced in this field, engaging more and more females in computer science, improving female confidence with CT and interest in STEM professions (Orton et al., 2016; Yadav et al., 2014; Grover & Pea, 2013). In addition, introducing CT into educational area will lead to the enhancement of students and teachers' thinking skills to problem solving, and enable students to build up a foundational comprehension of computing and create skills that may move them from being clients to makers of information technology (Yadav et al., 2014).

2.4 Relationship between CT Skills and Other Thinking Skills

Wing (2008) argues that CT is a type of systematic thinking; it shares common ground to mathematical thinking when attempting to solve a problem. It also shares similar thinking processes, which engineers use, in terms of how a project is planned for and assessed working with complex systems, which are used within the limits of the real world. It shares with scientific thinking in the general ways in which we might approach understanding computability, intelligence, the cognitive processes and human behaviour. On the contrary, CT has differenced to critical thinking and mathematical thinking. This is due to CT being an exclusive collection of thinking techniques that, when joined together; establish the foundation of a new and strong kind of problem solving. For example, CT focuses on tools, it uses familiar problem-solving skills such as trial and error, repetition, and predicting by deducing in contexts where they were formally impractical but which are now achievable because they may be automated and applied at faster speeds (Barr et al., 2011). Moreover, the core of CT is the abstraction that tends to be more intense and more complex than those in the mathematical and physical sciences. The abstraction process entails determining which parts of data are required and what is not underlies CT (Wing, 2008; Kramer, 2007). In problem solving, abstraction may take the form of breaking down a problem to its most simplest form. Abstraction may also be perceived as securing of shared traits or actions into a set that may be used to portray all other situations (Lee et al., 2011).

According to CSTA & ISTE (2011) CT does not substitute focusing on creativity, reasoning and critical thinking, however reiterates those skills while stressing ways to manage a problem in a way that a computer can assist. It expands and transfers human creativity and critical thinking by enabling CT to provide support in all fields to improve the learner's skills to resolve problems and be occupied with higher-order thinking. Students are involved in CT when they use algorithms to solve problems and strengthen problem solving with computing. They participate in CT when they analyse text and create complex communications. They are absorbed in CT when they analyse huge amounts of data and discover patterns as they carry out scientific investigations.

Larry Snyder claimed that CT could not be compared with fluency with information technology (FIT) although they share common ground. For example, many of the aspects sometimes assigned to CT are also a component of a fluency curriculum which consists of both theories and capabilities (NRC, 2010). IT Problem Solving which develops equivalent CT capabilities consists of: logical thinking, planning, abstract thoughts, procedural thoughts, optimizing, and iterative refinement (Heureux et al., 2012). On the contrary, the perception of the difference between computational thinking and fluency portrays computational thinking as highlighting conceptual understanding. Many participants, thinking about the scope and type of CT, argued that the capability to progress facility with new technologies is a component within itself of CT. CT in this light consists of discovering the most suitable technology for an issue and utilizing the technology to solve the problem. In order to achieve this, learning how to properly operate the technology, debugging the solution, and exhibiting the result by ease as highlighting applications among a comprehensive variety of topics and problem domains such as creating Word document (NRC, 2010).

2.5 Assessment and Integration of CT (Related Study)

There have been copious efforts to classify and assessment of CT. The following segment of this research reflects on the assimilation and analysis of CT, which have been previously examined by scholars.

Due to the diversity of CT meanings and interpretations, there is no doubt that scholars have not found a complete procedure for precisely assessing CT (Shute et al., 2017). Consequently, assessing CT maintains to be an on going issue (Weese & Feldhausen, 2017).

As students from a diverse variety of backgrounds are capable of using concept extraction, mechanization, and examination to construct genuine and unique artefacts providing they have the opportunity of a knowledgeable setting consisting of qualified instructors, the scope to advance and the latest technological devices. However, consistent and regular assessment is required to enhance previous experimental procedures in order to explain the development of these three CT constructions(extraction, mechanization, and examination) (Lee et al., 2011). Buffum et al. (2015) states that consistently assessing students at intervals is a vital requirement for students in our new era of technology, as with more advanced subjects such as physics who have already established and have been using systematic testing procedures for a long time.

In addition, the process needed to increase the exposure of students to CT in K-12 is complex, and requires development of substantial resources, teacher engagement and systematize change and for this to happen, it is to collaborate with computer science education community, hence a research was carried out by Barr and Stephenson (2011) to understand what it entails as well as the role of computer science education in computational thinking. Respondents from their research seem to focus on the importance of computer and had several ideas about what CT entails and how it should be used in the classrooms. Participants in their research was also of the opinion that CT is manifested in classrooms via operational problem solving. They also discovered that key concepts such as outputs, inputs, sequence, etc. were used among students and the students also mentioned the key concepts in the context of dispositions, capabilities, pre-dispositions and classroom culture. The capacities include use of vocabulary, group problem solving, design solutions to problems, etc.

The authors also identified strategies that should be beneficial for any learning experience which includes teachers and students increasing their use CT to enhance their computational vocabulary, there should be team work among students and teachers and students should come to acceptance when they have failed solution attempts knowing that having early failure is a path to having a successful outcome.

To develop systematic CT assessment, some researchers have utilized Scratch project. Brennan & Resnick (2012) state that Scratch-based projects would be beneficial for the future by adding context to learning to help apply the knowledge in a more comprehending manner. They also contested for an active evaluation procedure to examine Scratch users' (8-17 years old) CT capabilities over time, unravelling the evolution of acquiring knowledge and evaluating theoretical comprehension and implementation of CT skills. The CT assessment consisted of formative analysis, questioning and design projects. The formative analysis consisted of assessing users' portfolios in order to see the on going expansion of CT with the help of projects completed over time. Interviews enabled the researchers to explore thinking processes of users in a richer context. In addition, there were three sets of design projects, in different levels of difficulty, which were implemented to evaluate and record the performance. Each set consisted of two tasks of the same difficulty level but with different image. Users were required to choose one task from each set to describe and debug.

Zhong et al., (2016) stated that the fundamental skill which student must possess is CT, and CT is a crucial assessment factor in education but due to the deficiency of effect approaches to which CT can be evaluated, the authors in their research designed a Three-Dimensional Integrated Assessment (TDIA) framework. The aim of the framework was to integrate process, openness and directionality dimension and also to comprehensively evaluate the three CT dimensions in terms of computational perspectives, practices and concepts. Through the direction of the framework, three pairs of tasks was designed by the authors: open tasks with creative design report and open tasks without creative design report was the first pair, semi-open forward tasks and semi-open reverse tasks was the second pair while close forward tasks and close reversed tasks was the last pair.

In order to confirm the advantages and disadvantages as well as the applicability of the tasks. The authors carried out an experiment in primary school in 2014 towards the end of the autumn semester. Their findings revealed that the three pairs of tasks' discrimination and difficulty were all suitable; the semi-open tasks also had a higher level of discrimination and difficulty than others. Moreover, their findings showed that forward tasks were less superior to the reverse tasks, the close task were not as effective as the open tasks, there was no substantial difference in the scores of both the girls and the boys in all tasks and self-reports offered useful function for guidance and learning diagnosis. The authors suggested that teacher should give different types of task in assessment, motivate students' enthusiasm and interest, incorporate semi-finished artifacts and include guidance and learning diagnosis when designing computational tasks for effective CT.

Other researchers have proposed to assess CT through game-based assessment and via programming assessment. Werner et al., (2012) in their attempt to engage k-12 students in CT highlighted lack of assessment tool as a limiting factor, thus, their study was geared towards creating and testing performance assessment tool for measuring CT in the middle school. Specifically, Werner et al. (2012) described the context for measuring game-programming course in the middle through the examination of a total of 311 students for a period of 2 years in central California's public schools. The students were asked to engage in CT in 3-stage progression of Use-Modify-Create (Lee et al., 2011) in self-paced instructional exercises for minimum of 20 hours in a semester. The outcome of these exercises CT can be enhanced via pair-programming as student's assessment improved with increasing number of hours spent together with colleague.

The interesting findings of this study however is that CT can be taught and assessed through challenges, self-paced instructional material. As it is in the fairy tale case, students were able to solve comprehension, design and programming as well as comprehension and programming challenges. Importantly, this study suggests similarity between fairy tale assessment method and the scratch assessment method which may be a pointer to the direction CT assessment module may be taking.

In furtherance to publication regarding computational thinking, Basogain, Olabe, Olabe and Rico (2018) carried out a research on how the different elements of the CT can be implemented in pre-university settings in Latin America and USA. Two different courses: ECE 130 and PC-01 courses were designed for this research. The ECE 130 and PC- 01 courses are introductory courses to computational thinking and programming was designed for both senior and junior high school students to introduce them to the CT concept and programming foundation using Alice and Scratch visual programming environments. Three different tools were implemented for weekly assessment, which included the Peer-to-Peer (P2P) assessment, test and self-assessment. These weekly assessment helped the students to read, interpret and assess the quality and complexity of the code; it also helps the students to review new vocabulary, core ideas and programming rules that should be mastered before going further and also certify that the students have achieved the requirement to successfully complete the course. Also, in these assessment, student transit from passive role to actively evaluating the work of others which gives them the implicit belief that they are experts.

Findings from their study show that in the US, especially in high schools, the courses have been implemented in classes which has been continuously evaluated from 2009 till 2016 academic years. They also found out that when the courses were still unknown and new to the students, they practiced for a longer time and these courses also boosted the students' confidence on their knowledge and skills. In terms of the grades, throughout the course, it was observed that the students had better grades on tests than on self-assessment. In line of this, students may be able to adapt more quickly to new technologies as well as methods of evaluating computers.

Basawapatna et al., (2011) study mainly focused on using game designs or video games to teach CT across Colorado's middle age schools. To achieve the aim of their study, the researchers exposed students and teachers to several CT patterns for a period of two weeks in a summer institute. Thereafter, participants are then required to solve 8-question quiz designed to understand the participant's computational thinking patterns. Four specific patterns are expected to be discovered by the participants based on the researchers' criteria for completing the projects. The responses of the participants were evaluated using categorization and coding. Mean score of each participant in all the given questions demonstrated that they were able to identify computational patterns in varying scenarios. Essentially, the study supported that, pattern quiz such as employed in this research can be used in evaluating CT however, with foundational understanding that the method possess some inherent limitations like ambiguity of video in relation to CT or the "implication bias" that often makes students to overlook the obvious patterns in a bit to discover the implied complex patterns.

The outcomes of their study however may be deemed very valuable considering that participants were only exposed to CT for two weeks period. Therefore, if this method is incorporated into the educational system wherein games are designed in ways to stimulate CT may yield more results. Conclusively, students can tangibly gain CT competences through the application of game design in classrooms.

Weese and Feldhausen (2017) in a bit to improve confidence in CT and problem solving skills created a STEM outreach program in which 5th to 9th grades are exposed to hands-on activities relating to several STEM career subjects and programs. Problem-based learning and inquiry learning approaches as recommended by Weese, Feldhausen and Bean (2016) was used to encourage verbal persuasiveness, improved self-efficacy and enactive attainment among students. Specifically, a systematic learning approach was used to ensure that students were introduced to CT from the basis through different incremental stages till they get to the final stage. For instance, the 5th and 6th grade were introduced to "Saving the Martian" in four stages that culminated in understanding specific artificial intelligence concepts like neural networking. Similar approach was used for students from other grades in the "Mighty Micro controller" experiment.

To assessment the contribution of their study, a pre and post survey format was adopted in which researchers administered pre-experiment surveys to the participants and then after the experiment, they also administered another survey. The analysis of results revealed that majority of the students has been previously exposed to a visual-based programing activity suggesting that outreach efforts have been in place. Further, prior experience in STEM program was not deemed to be an added advantage as students with no prior experience in STEM program did equally well in the assigned tasks. The study was concluded with the assertion that the use of micro controller in CT teaching was not as effective as using pure computer science. However, curricula with active-media design better foster improved CT skills and enhances student's self-efficacy.

Atmatzidou and Demetriadis (2016) in their research examined how students' CT skills are developed using the learning activities in educational robotics (ER). A suitable CT model was employed for exploring and operationalizing the CT skill development in students across gender and age group between 15 and 18. The total number of respondents used was 164 and were from a public school in Thessaloniki, Greece. Of the 164, 75 of the, attended high vocational school and 89 in Junior high. Every week, two hours was used to engage the students in ER learning activities and during the different phases of the activities, the students were evaluated using both oral and assessment tools.

The result of their research revealed that comparing genders, girls seem to need more training time in all the situations presented for them the attain the same level of skill as the boys; also, irrespective of their gender or age, the CT skill development of students will reach the same level. Furthermore, their findings showed that students' performance is also affected by the type of skill assessment used; also, using the different CT skills model dimensions, there showed some pertinent differences in gender and age. Finally, they discovered that as students reached the end of the activity, their scores improved which implies that in most cases, CT skills need time to develop fully.

Chen et al. (2017) in a recent research assess the CT of elementary students in robotic programming and in daily reasoning. Using a CT framework that was modified from the Computer Science Teacher Association's standards, the authors developed an instrument to assess the CT of students in the fifth grade. With two types of CT application which includes reasoning of daily events and coding in robotics, the items were conceptualized; the instruments were used in elementary school as a pre and post-measure where their fifth grade just adopted the new humanoid robotics curriculum. Their result indicated that the instrument possessed suitable psychometric properties and has the ability to expose students' learning growth and challenges in regard to CT.

However, the aforementioned assessment tools of CT were purposed for particular study. Recently, some researchers have developed CT scales for generic use. In Moreno-León, et at. (2017) study on validating the assessment tool for aiding CT learners and teachers, the researchers utilized experimental simulations to compare expert's manual opinion with the assessment tool's outputs. The findings of their study was based on 53 valid projects received from encouraging youngsters to build a game-like project of real-life situations with the assessment tool named "scratch". The selected projects were later evaluated by group of experts with ample experience on the use of the tools. In evaluation the outcome of the research, output from scratch was compared with the expert result. The result showed reasonable correlations which provide the initial validation that scratch tool parameter is adequate for aiding CT among learners and teachers alike. Overall, Moreno-León et al. (2017) revealed that the area of automatic assessment of CT is a viable field of exploration.

Although their finding provided initial validation for the adoption of scratch for assisting learners of CT, they also suggested that scratch does not take into consideration some fundamental aspects of programming like remixing skills, and debugging which may also be a huge limitation to the use of scratch without human educator as those aspects of programming are integral for CT.

González et al. (2017)in their research in an attempted to address the issue of how CT can be incorporated into the curricula of the educational system (Lye & Koh, 2014) through psychometric approach. The authors also aimed at proposing new instruments that can be used to measure CT and providing correlation evidence that exist between CT and other renowned psychological contract. They identified only two instruments, which are designed for middle and high school students and these instruments are undergoing validation. The instruments included commutative assessment (Weintrop & Wilensky, 2015) and test for measuring basic programming abilities (Mühling, Ruf, & Hubwieser, 2015). The commutative assessment is created for high-school students between 9th and 12th grade with the purpose of measuring how they understand the various computational concepts dependent on if they either occur as textual programming languages or through scripts composed in block-based (visual) languages. It is an important progress in attaining a higher level of code-literacy while the test for evaluating their elementary programming skills is designed to evaluate students' capability to implement a specific program in light of "flow control structure" and was created for Bavarian students who are from 7th to 10th grade.

A multiple-choice assessment was given to Spanish students who were from 5th to 10th grade students and findings which were 1,251 in total. In addition to the CT test, RP30 problem solving and Primary Mental Abilities (PMA) tests were administered. Finding revealed that as the level of grade increases, CT test also increases while in terms of gender differences in CT varies with respect to the type of problems in which the ability is projected. In addition, they discovered that there is a positive but moderate correlations between the four PMSs and CT while there high correlation between problem-solving ability and CT.

Similar attempt have been carried out by Korkmaz, Çakir and Özden (2017). In their study of CT evaluated the validity and reliability of the Computational Thinking scales (CTS) developed a scale to help in determining the students' computational skills. Their respondents where students who had their undergraduate and associate degree from Amasya University in Turkey and 580 students who through distance education in the same university was educated in pedagogical formation education. The authors developed the CTS scale by first exploring past literature review and forming item pool. The scale developed was a five-point Likert scale which consisted of 29 items collected under five factors.

The five factors included creativity, algorithmic thinking, cooperativity, critical thinking and problem solving. According to CSTA and ISTE (2011), computational thinking covers the five factors as well as establishing communication making it six factors. However, during analysis in Korkmaz et al. (2017) research, they discovered that communication skills loaded on the problem solving, critical thinking and cooperative thinking factors, hence the five factors for computational thinking scales. Their findings concluded that the five-factor scale is reliable and valid as a measurement tool to measure students' CT skills.

In this chapter, the literature reviewed shows that the term CT has been recently made more prevalent. After Wing (2006) in her inspiring article on CT many articles have been published on this topic. Although there are many working definitions for CT, term is generally understood as "a focused approach to problem solving, incorporating thinking processes that utilize abstraction, decomposition, algorithmic design, evaluation, and generalizations"(C. Selby & Woollard, 2010).

Nevertheless, there is still disagreement on the formal definition of computational thinking (Shute et al., 2017), Weintrop et al., (2016) proposes that it will be necessary to dissect computational thinking into a group of distinct and assessable skills, ideas, and practices. Therefore, along with Korkmaz et al. (2017), in this study, CT has been defined as consisting of the following skills: creativity, algorithmic thinking, cooperativity, critical thinking, and problem solving.

In higher education, many campuses are revising their curriculum of computer science and changing it to include the essential elements and concepts of CT (Wing, 2017). Thus, individuals in the digital age are anticipated to have CT skills in different disciplines, but still there is no evidence to what extent they have these skills and if they are at the sufficient level (Korkmaz et al., 2017). Furthermore, it seems from the most the available literature; no many researches have focused on assessing CT at the university level. Therefore, this study seeks to fill that gap in the literature, by seek to answer the questions: what is the level of CT skills of IT students? Do levels of CT skills of students differ in terms of their gender? Do levels of CT skills of students differ in terms of their years? In the next chapter of this study, the used methodology, to address this question, was described.

Chapter 3

METHODOLOGY

The intention of this section of the research is to discuss the methods that will be applied to examine the subject at question. This involves the evaluation of EMU-IT student‘s CT skills. A more thorough explanation will be unveiled regarding the research procedure, case study, selection of participants, data collection tools, and data analysis.

3.1 Research Method

To acknowledge the aforementioned research aim, this study uses case study method whish is a descriptive study in line with research questions (Yin, 2003b). The most prominent intention of descriptive research is an explanation of the situation, as it presently exists. A popular term in social science and business is descriptive research. It is a method of research measuring how an independent variable, existing before the experiment, affects the dependent variable. The most significant feature of this method is that the examiner has no power over the variables. The researcher can merely only write an account of the experiment. Descriptive studies are mostly used where the researcher intends to measure items such as, rate of shopping trips, choices of people, or similar information (Kothari, 2004). Case study is an effective procedure for this research study as it pursues to gain a detailed, background understanding of an investigation by supplying rigorous accounts, examinations, and clarifications of this case (Merriam, 1998). In addition to examine general situations of current discoveries within a realistic setting(Yin, 2003 b; Gay et al., 2012).

The anticipation of thoroughly detailed descriptions and background understandings of an investigation delivers a rich learning device for investigators. Flyvbjerg (2006) reiterates this by claiming that “If researchers wish to develop their own skills to a high level, then concrete, context-dependent experience is just as central for them as to professionals learning any other specific skills” (p. 223).

In this research, the mixed method was operated to conduct a case study investigation within context students in the IT department at EMU. This study makes use of the mixed method approach that may be described as a procedure used for gathering, examining, and combining both quantitative and qualitative procedures in a single study or a number of studies to comprehend a research enquiry(Creswell, 2009). A mixed method is conducted when both qualitative and quantitative are present in a new discovery to gain a better understanding of the research enquiry (Creswell, 2012).

This study examined the CT skills of EMU-IT students case study via a convergent parallel mixed method research design. This method provides a better understanding of CT skills of IT students which may have not been discovered via using only quantitative or qualitative methods and to provide stabilizer advantages and disadvantages of each one. Quantitative data is involved in prediction and strives to enhance independence, replicability, and simplification of findings. On the other hand, qualitative data supplies data regarding the context or setting (Creswell, 2012). Figure 1, convergent parallel mixed methods designs, shows the stages for conducting this type of research. The quantitative and qualitative data hold even priority and were gathered and analysed independently; the result of both quantitative and qualitative strands analysis were implemented in discussion simultaneously (integrated two databases side by side) (Creswell, 2009).

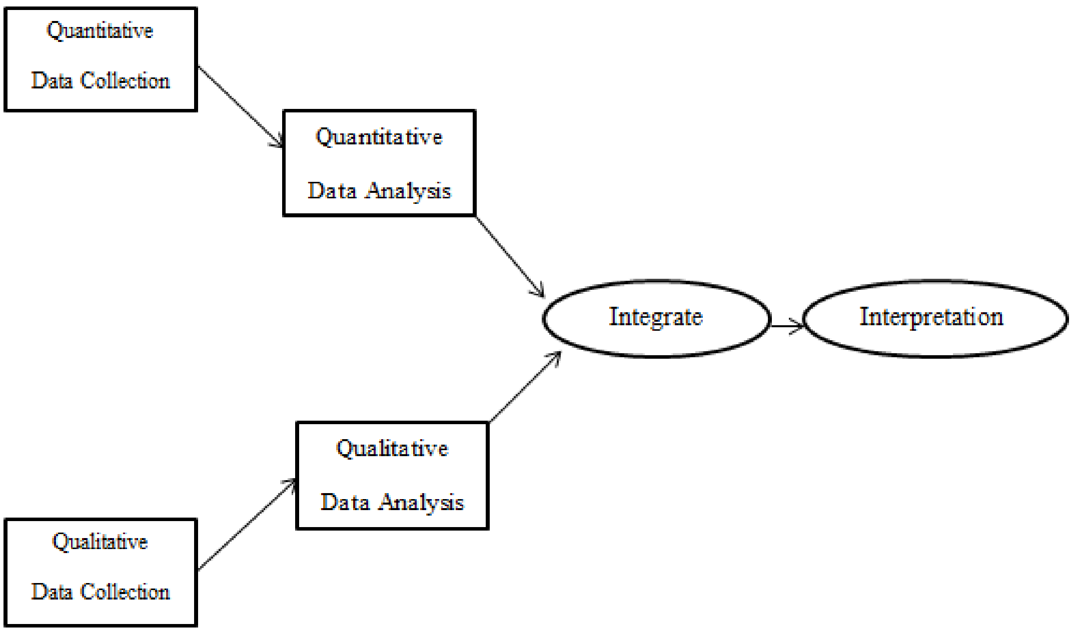

Figure 1: Convergent Parallel Mixed Methods Design

3.2 Case Study

This is a single case study. The study's case is IT students' CT skills. This case seems to be critical, because it may yield the most information, and also it should has features and meets conditions for testing theory (Yin, 2003a) which coincide with the research interests of basic CT skills. Participating in this study are students in the IT Department at school of computing and technology which seeks to gain students skills such as: allowing students to understand the operational principle of the computer, establishing the thought of solving problems, grasping the basic skill of computer application; good analytical and critical thinking skills, self-development and adaptation skills in the changing world, wide range business and real world perspective (Information Technology Undergraduate Program, n.d.).

3.3 Participants

The participators of the research were all undergraduate students registered in the IT department varied among different levels. They had appropriate level of English because the medium of instruction is English. 197 students took part in the study and were convenience sample selected across 4 years of education, to increase reliability. For interview, convenience samples were used. Where conducted with 23 interviewees depended on how many years they were enrolled on their course.

Table 1: Demographic information of respondents

		Frequency	Percent
Gender	Male	153	77.7
	Female	44	22.3
Age	18-20	76	38.6
	21-22	67	34.0
	23 and older	54	27.4
Years of studies	1	59	29.9
	2	33	16.8
	3	53	26.9
	4 and higher	52	26.4
	Total	197	100

As indicated in Table 1 above, our sample contained total of 197 respondents. The overwhelming majority of the study's respondents are male which comprised of over 70%. With regards to age, the samples seem to be almost equally spread across all age groups with slight differences in the "23 & older" group with a total percentage of 27.4. As expected, all years of study also seem equally distributed in our sample, 29.9%, 16.8%, 26.9%,26.4% respectively.

3.4 Data Collection

To address the research questions, both quantitative and qualitative data was collected. A gathering of multiple data sources endorses enrichment to a research enquiry (Yin, 2003a). The significance of collecting qualitative data was not merely to gather more information but also to increase the dependability of the study and to reveal several different and complex understandings of the study. The operation of multiple data sources to ascertain grander credibility in findings involves establishing "converging lines of inquiry" (ibid). The operation of procedures was largely parallel, however, the priority may be given to information gathered by questionnaires.

<u>Quantitative strand:</u> This tool was field tested in the period of the spring 2018 semester at the IT department-EMU located in Northern Cyprus. The questionnaire was divided into two sections, which the first section included the demographics and the second section Computational Thinking Scale (CTS), developed by Korkmaz, Çakir, & Özden, 2017. The CTS consisted of 29 questions to measure five factors: Creativity, Algorithmic Thinking, Cooperativity, Critical Thinking and Problem Solving. It employed a 5-point Likert Scale, each of the items were scaled as: Never (1), rarely (2), sometimes (3), generally (4), always (5). The CTS had Cronbach Alpha reliability coefficient as .822. The questionnaire may be found in Appendix A.

<u>Qualitative strand</u>: The semi-structured interviews were conducted with each of the 23 participants lasting approximately 30 minutes. The instrument was developed in consultation with experts. The major purpose of conducting the interview was to develop an in-depth understanding of each participant's perceptions of CT skills. These interviews were audio-recorded and notes were taken during each interview.

The audio-recordings of the interviews were transcribed. The interview transcriptions and interview notes did not include any identifying information. The interviews were fully transcribed to enable analysis. The semi-structure interview protocol may be found in Appendix B.

3.5 Data Analysis

To assume with convergent parallel design, the quantitative and qualitative data were analysed independently; the results of both quantitative and qualitative strands analysis were implemented in discussion simultaneously (integrated two database side by side). In this research, the quantitative data was analysed using Statistical Package for the Social Science SPSS 25. To examine the data which is covered with only two variable, the t-test was used such as gender, whereas for analyse the data that is comprised with more then two variables such as age and years of study, the ANOVA has been used through SPSS v.25.0. Gathered data was organised and further assembled into a database in the Statistical Package for the Social Sciences (SPSS) and was analysed according to a descriptive statistics test or assessment. The value of significance level (P) was taken as 0.05 in this study.

The qualitative data in this research was encoded to patterns of responses that generated themes within the data.

3.6 Ethical Considerations

Any research enterprise that involves human subjects demands to take into account ethical issues that may potentially affect those individuals under study. The ethical considerations for this case study do not apply to the case itself, but more for the individuals who delivered the data for this study.

All potential participants were given a consent form (may be found in Appendix C) outlining all research procedures and activities involved in participating in this case study. Participation in this case study did not involve any predictable risks beyond those experienced in everyday life. From the informed permission, the participants were informed that they were under no obligation to participate in this research; it was entirely their choice whether to be a part in the study or not. They were also reassured that their personal information and their responses would be kept confidential and utilized only for study purpose, not breaching confidentiality. Collected data could be used for further publications. No names or other identifying information were captured in interviews and questionnaire in the field notes. The results of the research conducted will be used for to discuss and conclude the research enquiry.

3.7 Validity and Reliability

Relying on validated measuring tools is something vital and valued in any experimental subject. Reliability is the grade to which a test reliably performs a measurement. The more accurate an evaluation is, the more assurance we can have that the result gained from the test would be the same as those gained if the test was administered to the same sample at a different time or by a different person (Gay et al,. 2012). A variety of techniques was used to guarantee validity and reliability.

Triangulation is the term given to different types of techniques and data sources to offset and test one another for the purpose of reducing any foreseen bias of the consequence of one particular method of data collection tool. Triangulation assists in supporting the construction of a single conclusion together with the chance to analyse collected data from different perspectives (Creswell, 2012).

Furthermore, to assist in validity of the data collected in this research study, Computational Thinking Scale (CTS) developed by Korkmaz et al., 2017 has high Cronbach Alpha reliability coefficient as .822 In addition, the Cronbach's alpha reliability statistic was operated and used to evaluate the reliability of this study. In this study, as shown in table 2, the result of Cronbach's alpha is (n=29), (.816)

Table 2: Reliability statistics

Cronbach's Alpha	N of Item
.816	29

Moreover, to improve the reliability, the qualitative instrument was developed from the Computational Thinking Scales CTS in consultation with three college professionals in EMU.

Chapter 4

FINDINGS AND DISCUSSIONS

This section of the study focuses on analysing data collected through the tools of the study, which were consequently submitted into a database. For the purpose of data analysis, an SPSS file was used. Percentage, mean and standard deviation results were also obtained through a descriptive statistics recording the participant's responses in relation to Likert scale varieties. In addition, T-test analysis has been carried out for gender groups. ANOVA analysis has been conducted for age and years of study.

4.1 Level of Students' CT Skills

With respect to the first experimental enquiry, Table 3 below displays the mean and the standard deviation of CT results according to the five dimensions in CT framework obtained.

Table 3: Descriptive statistical of students' CT skills dimension

CT dimensions	N	Mean	Standard deviation
Creativity	197	3.9169	.56511
Algorithmic thinking	197	3.2039	.81356
Cooperativity	197	3.7284	.83329
Critical thinking	197	3.7391	.68805

Problem solving	197	3.266	.790
CT score	197	3.5796	.45125

Table 3 presents the standard deviation and mean of the dimensions construct of Computational Thinking (CT), which was represented by the mean score of all its dimensional variables, includes critical thinking, creativity, algorithmic thinking, cooperativity and problem solving. Except for problem solving and algorithmic thinking dimensions, all other dimensions have a mean value above 3.5 indicating that a good number of students possess CT skills. Even with approximately 3.2 mean value of problem solving and algorithmic thinking items, it can still be inferred that students have a good level of computational skills since 3.2 between 2.60 to 3.39, which is the mean of the anchor scale for the measurement of the items.

When considered distinctively, the CT score has the descriptive values of M = 3.57 ,SD = 0.4512. This finding affirms the previous suggestion that students have a sufficient level of CT skills. Further, it can also be concluded that students possess a higher level of creativity as evident in (M =3.9169), followed by critical thinking (M =3.7391), then cooperativity (M =3.7284) problem solving (M =3.266) and Algorithmic thinking (M =3.2039) in that particular order. IT students possess a low level of algorithmic thinking. This is not surprising, since the focus of information technology is on the application, integration and optimization of, rather than the development of software. More compressive details of each item within each dimension are demonstrated in next part.

4.1.1 Creativity Dimension

Table 4 below presents the descriptive analysis of 8 creativity items constructed the CT scale based on percentages, mean and standard deviation responses.

It can be observed from the Table 4 that, 78.7% of students responded ‘always and generally’ in their attitude to liking confident people. On the other hand, 18.8 remained ‘sometimes’. 2.5% ‘rarely’ and ‘never’ like people who are confident about their decision. In addition, 78.2% of participants show a high attitude for liking factual and open-minded people, while 16.8% remain ‘sometimes’, and 5.1% rarely and never like realistic and neutral people.

Additionally, 80% of students ‘always and generally’ expressed confidence in making decisions and their ability to solving problems provided if they had the time, whereas, 17.3% remain ‘sometimes’, and 2% ‘rarely’ to be confident in making decisions and their ability to solving problems provided if they had the time. Furthermore, 66.5% of students ‘always and generally’ believe that they display emotional and sensitive feelings to obtain the right conclusion, while 29% remain ‘sometimes’, and 4% ‘rarely’ and ‘never’ confident of their feeling of the right conclusion. This implies that the students are fully aware of their emotions, self- confidence and independent thinking. Confidence and self-direction were characterized, by Treffinger (1992), as one of the most sentimental characteristic of innovative people.

The average mean score is 3.5796. Table 4 demonstrates that about 100% of the responses on questions measuring creativity are constructed of CT scale are above the average mean score. In this sense, it could be concluded that the students’ creativity skills are at a high level.

Table 4: Students’ response of creativity dimension

Items	Percent %					Mean	Standard deviation
	N	R	S	G	A		
1-I like people who are sure of most of their decisions.	.5	2.0	18.8	37.6	41.1	4.17	.837
2- I like people who are realistic and neutral.	1.5	3.6	16.8	31.5	46.7	4.18	.941
3- I believe that I can solve most problems I face if I have sufficient amount of time and if I show effort.	-	2.0	17.3	45.7	35.0	4.14	.767
4- I believe that I can solve the problems possible to occur when I encounter a new situation.	.5	2.0	35.5	38.6	23.4	3.82	.829
5- I trust that I can apply a plan while trying to solve a problem of mine.	.5	3.6	31.5	40.6	23.9	3.84	.848
6- Dreaming causes my most important projects to come to light.	4.6	8.6	29.9	31.0	25.9	3.65	1.095

7- I trust my intuitions and feelings of “trueness” and “wrongness” when I approach the solutions of a problem.	2.0	2.0	29.4	43.1	23.4	3.84	.877
8- When I encounter a problem, I stop before proceeding to another subject and think over that problem	1.0	10.2	29.4	36.5	22.8	3.70	.967

*n=197, *%=100, *Average mean = 3.5796.*
Rating scale: N-Never, *R-Rarely, *S-Sometimes, *G-Generally, *A-Always.*

In a direct response from student P *"I usually like think with myself but if I could not or somethings like that I will ask my friends. Priority is to think about it by myself. I underline the key words, the things that could help me to find solutions. Actually, I am usually confident about a decision that I take, I feel the conclusion it is like part of my decision, so I feel comfortable about it and I believe my decision"*.

Additionally, students B, H, J, K, N, Q, quoted that *"mostly I am very confident about my conclusion. I trust whatever I do"*.

Student U *"I feel happy, always I am confident of my result"*.

4.1.2 Algorithmic Thinking Dimension

Table 5 below presents the descriptive analysis of 6 algorithmic thinking items constructed of CT scale based on percentages, mean and standard deviation responses.

The analysis of algorithm thinking dimension ,Table 5, indicate that 47.3% of students always and generally think that they have a great ability to create a set of steps to solve a problem, while 44.2% remain sometimes, and just 8.1% never and rarely have the ability to create a set of steps to solve a problem. Furthermore, 44.6% of them always and generally think they could identify patterns and similarities. On the other hand, 40.1% scored 'sometimes', and 16.3% 'never' and 'rarely' have ability to deal with the problem step by step process. In addition to 43.7% of students responded always and generally being interested in using numbers and mathematical process, while 27.4 responded that they never and rarely are interested in using numbers and mathematical process. On the other hand, 40.1% % of the students remain 'sometimes' in their ability to using math to solve daily life problems, while just 30.5% 'always and generally' could using math to solve daily life problem.

Table 5: Students' response of algorithm thinking dimension

Items	Percent %					Mean	Standard deviation
	N	R	S	G	A		
9- I can immediately establish the equity that will give the solution of problem.	1.0	7.1	44.2	34.0	13.3	3.52	.855
10- I think that I have a special interest in the mathematical processes.	14.7	18.8	31.0	16.8	18.8	3.06	1.304
11- I think that I learn better the instructions made with the help of mathematical symbols and concepts.	7.1	20.3	28.9	31.5	12.2	3.21	1.118
12- I believe that I can easily catch the relation between the figures.	4.1	12.2	40.1	32.5	11.2	3.35	.970
13- I can mathematically express the solution of the problems I face in the daily life.	6.6	22.5	40.1	19.8	10.7	3.05	1.058

14- I can digitize a mathematical problem expressed verbally.	10.7	19.8	39.0	22.8	10.7	3.03	1.133

*n=197, *%=100, *Average mean = 3.5796.*
Rating scale: N-Never, *R-Rarely, *S-Sometimes, *G-Generally, *A-Always*

Table 5 shows that about 83.3% of the responses on items measuring algorithmic thinking constructed on the CT scale are lower than the average mean score.

In this sense, it could be concluded that the lowest of students' CT skills occur in the algorithmic thinking dimension.

As student O quoted about his interest in dealing with math *"Maths not really, complex math scares me, but I study algorithms in IT; they are fine"*.

In other side, some student are enjoyable to dealing with mathematical problem. Student P, in a reply, stated, *"Actually, I love maths a lot, I love analysing the problem and finding different ways to solve problems, I find somethings interesting for me. I like maths because it makes your imagination better, you can imagine and find lots and different ways to solve problems. It is funny"*.

Student C added, *"By using maths you have many choices to solve the problem depending on your thinking"*.

Student A further gave his thoughts regarding the interest in using math processes to solve problems. He states *"I am interested in using maths, because it has clear ways to solve questions used in this method to solve problem, step by step it is good"*.

4.1.3 Cooperativity Dimension

Table 6 below presents the descriptive analysis of 4 cooperativity items construct of CT scale based on percentages, mean and standard deviation responses.

Table 6: Students' response of cooperativity dimension

Items	Percent %					Mean	Standard deviation
	N	R	S	G	A		
15- I like experiencing cooperative learning together with my group friends.	3.0	9.1	27.9	40.1	19.8	3.64	.668
16- In the cooperative learning, I think that I attain/ will attain successful results because I am working in a group.	3.0	14.2	27.4	31.5	23.9	3.59	1.092
17- I like solving problem related to group project together with my friends in cooperative learning.	5.1	9.1	22.8	39.6	23.4	3.67	1.087
18- More ideas occur in cooperative learning.	1.5	3.6	22.3	37.6	35.0	4.01	.926

*n=197, *%=100, *Average mean = 3.5796.*
Rating scale: N-Never, *R-Rarely, *S-Sometimes, *G-Generally, *A-Always*

The analysis of cooperativity dimension ,Table 6, indicate that 72.6% of students 'always and generally' believe that in a collaborated learning environment they get more ideas from members, while just 5.1% of them 'never and rarely' think that, and 22.3% remain sometimes. Furthermore, 63% of them 'always and generally' have more concern to deal with problems in collaborated environment.

On the other hand, 22.8% remain 'sometimes', and 14.2% 'never' and 'rarely' interest in dealing with problem collaborative environment. In addition, 59.9% of students were 'always and generally' interested in working in a team group, while, just 12.1% of them never and rarely have concerns in working in a team, and 27% remain 'sometimes'.

The analysis of cooperativity skills items, Table 6, which constructed of CT scale, demonstrates that students' cooperativity skills were to be in satisfactory sufficient level. In table 6, out of 4 cooperativity questions the students indicated their beliefs about the positive side of cooperative leaning where all questions above the mean score (M=3.5796).

In a direct response from students A, H, and L *"if I face a problem, I prefer to be in team group, because each member group has his responsibility, and it improves my knowledge of solving a problem".*

Another Student B answered that *"Working in team could be good because everyone has his own responsibility and some people are very good in particular programming so we better our skills so it will be great actually, and some people are skilful I will try to get that experience and learn something from them".*

Moreover, Student R said: *"I prefer team group because in a team group every member gives his idea and different ideas to work together to make a project better, working in a team helps you to find your own specialty of what can you do best"*.

Additionally, student W *"I learn how to respect the people and sometimes this gives me more energy and more motivation"*.

4.1.4 Critical Thinking Dimension

Table 7 below presents the descriptive analysis of 5 critical thinking items constructed of CT scale based on percentages, mean and standard deviation responses.

The analysis of critical thinking dimension, Table 7, demonstrates that 70% of students are 'always and generally' interested in dealing with challenging problems to learn, while just 5.1% of them remain 'never and rarely', and 23.4% 'sometimes' like to deal with challenging problems. In addition, 70% of students 'always and generally' are able to think divergently and flexibility. On the other hand, 24.4% remain 'sometimes', and just 1.5% 'never and rarely' think as such. In addition, 55.8% of students 'always and generally' enjoy dealing with complicated problems, while just 31.5% remain 'sometimes'. As well as, 52.3% of them 'always and generally' have ability to find alternative plans and solutions of the problem.

Critical thinking skills of students were examined in Table 7, which concentrates on the ability of students dealing with complex problems critically, pointed out that students' critical skills were to be in satisfactory sufficient level. The results show out of 5 critical items the students indicated their beliefs about the positive side of thinking critically, where all questions above the mean score (M=3.5796).

Table 7: Students' response of critical thinking dimension

Items	Percent %					Mean	Standard deviation
	N	R	S	G	A		
19- I am good at preparing regular plans regarding the solution of the complex problem.	1.5	5.1	41.1	34.0	18.3	3.62	.893
20- It is fun to try to solve complex problems.	3.6	9.1	31.5	33.5	22.3	3.62	.960
21- I am willing to learn challenging things.	1.5	5.1	23.4	35.5	34.5	3.96	.960
22- I am proud of being able to think like with a great precision.	1.5	4.1	24.4	42.6	27.4	3.90	.901
23- I make use of a systematic method while comparing the options at my hand and while reaching a decision.	2.0	8.6	34.5	38.6	16.2	3.58	.931

*n=197, *%=100, *Average mean = 3.5796.*
Rating scale: N-Never, *R-Rarely, *S-Sometimes, *G-Generally, *A-Always*

Students A, B, D, J, N, and O gave their thoughts regarding the interest in dealing with challenging problems. They clearly stated, *"I prefer challenging problems, with new problems you will learn new and different things and different methods, which we were not taught at university or school or in class. Working with difficult questions make you working better with simple questions and it helps you to improve your performance in a job"*.

Another student C said, *"I prefer challenging problems. I am trying to solve it by any way, such as searching and defining words with this problem and then I start to thinking about the solution. I know that by solving challenging problems I will be stronger in that area. I am feeling stronger and fight with myself and want to win this"*.

In addition, student R states *"it makes you think and make you do something special, something different. It is fun for me to solve complex problems. It makes you think and discover your potential and lets you think differently"*.

Student T stated, *"when you put your energy to try to solve complicated problems and train and keep training and when you finally you kind of enjoy and become confident"*.

4.1.5 Problem Solving Dimension

Table 8 below presents the descriptive analysis of 6 problem-solving items constructed by CT scale based on percentages, mean and standard deviation responses.

Finally, Table 8 analyses the responses of students to issues that are faced with in dealing with problems. To analyse accurately, coding variables have been reversed to revise the 6 negative questions. In Table 8, students' responses in this dimension indicate that, 53.8% 'never' and 'rarely' have issues in improving their own ideas in

Table 8: Students' response of problem solving dimension

Items	Percent %					Mean	Standard deviation
	N	**R**	**S**	**G**	**A**		
24- I have problems in demonstration of the solution of a problem in my mind.	7.1	15.7	40.6	25.9	10.7	2.830	1.050
25- I have problems in the issue of where and how I should use the variables such as X and Y in the solution of a problem.	20.8	24.4	36.0	11.2	7.6	3.400	1.159
26- I cannot apply the solution ways I plan respectively and gradually.	12.2	33.0	31.5	18.3	5.1	3.290	1.061
27- I cannot produce so many options while thinking of the possible solution ways regarding a problem.	16.2	22.8	32.5	22.3	6.1	3.210	1.144

28-I cannot develop my own ideas in the environment of cooperative learning.	28.4	25.4	24.9	15.2	6.1	3.550	1.222
29- It tired me to try to learn something together with my group friends in cooperative learning.	23.9	25.4	25.4	14.7	10.7	3.370	1.286

*n=197, *%=100, *Average mean = 3.5796.*
Rating scale: N-Never, *R-Rarely, *S-Sometimes, *G-Generally, *A-Always*

collaborative learning environment, while 21% of them 'always and generally' face difficulties in developing their ideas in collaborative learning environment, and 24% remain 'sometimes'. Additionally, 45.2% of students 'never and rarely' have issues in using the variables like X and Y easily to solve problems, while 36% remain 'sometimes', and 18.8% of them 'always and generally' faced this problem. 49.3% of students 'never and rarely' have problems in trying to teach something to member group which, makes them tired, whereas, 25.4 % of them 'always and generally' have difficulties in explaining something to group members.

In Table 8, out of 6 problems solving items, demonstrates that about 83.3% of the responses on questions measuring problem solving skills construct of CT scale are lower than the average mean score. In this sense, students' problem solving skills are at a slightly low level where the average mean score of problem solving dimension was (M=3.266).

Student H gave his thoughts regarding to deal with cooperative learning environment, he answered, *"I don't have a problem with explaining my ideas to others"*.

In otherwise, student P answered *"Actually, I prefer to work individually, because I like to make decisions by myself. I sometimes find it hard to work with people with a strong personality as you have to fight for your decision and some kinds of people do not accept your ideas so I just prefer to work individually*.

Student W said: *"Sometimes I find difficult to deal with members who are not interested in working"*

Student D added, *"When I study in a group it lets me down"*.

Overall, CT score has the descriptive values of M = 3.579 (SD = 0.4512). Additionally, the descriptive analysis suggests that students' CT skills as even the low mean scores are well above the average mean which is between 2.60 to 3.39 of the scale. Therefore, this finding affirms that students at sufficient level of CT skills.

Otherwise, it has been highlighted that the intercommunication of the learners with the technology is deemed as significant in regards to production of the CT skills. In this respect, it can be argued that the occurrences of students on the usage of ICT might also influence the level of CT skills. In particular, there is an extensive agreement on the significance of programming education in regards to teaching and improvement of CT skills(Lye & Koh, 2014). A variety of papers have been written proposing that programming includes portraying the designed products and the CT skills (Durak & Saritepeci, 2018). For instance, Basawapatna, et al (2011) study mainly focused on using game designs or video games to teach CT across Colorado's middle age schools. Conclusively, students can tangibly gain CT competences through the application of game design in classrooms.

Additionally, Werner et al. (2012) described the context for measuring game-programming course in the middle through the examination of a total of 311 students for a period of 2 years in central California's public schools. The outcome shows that CT can be enhanced via pair-programming as student's assessment improved with increasing number of hours spent together with colleague.

4.2 Differences in the Level of CT Skills of IT According to Gender

In this part of the study, the Independent sample T-test tool has been used to compares the mean score on gender variables. In addition, it portrays the cross tabulation on the foundation of the most important results derived from t-test results with a p-value which is lower than 0.05 highlighting the use of an equal-variance t-test estimate.

In this part of study the independent t-test was conducted to determine the differences in CT skills level according the variables of gender.

Table 9: Gender relationship on individual items

Items	Gender	n	Mean	Standard deviation	df	T	p
I14.	Male	153	3.15	1.062	195	2.816	.005
	Female	44	2.61	1.280	61.051	2.541	
I20.	Male	153	3.75	1.010	195	3.238	.001
	Female	44	3.18	1.040	68.052	3.185	
I21.	Male	153	4.04	.917	195	2.054	.041
	Female	44	3.70	1.069	62.318	1.886	

Table 9 displays the statistics of T-test analysis on the basis of gender, and also presents total number (N) and their mean differences for female and male in their reactions regarding their response to items of CT scale. The I14, I20 and I21 include the ability to transform a verbally spoken mathematical problem into numerical, tend to be interested to learn challenging problems and to think divergently and flexibility demonstrated a significant dissimilarity at a point of (I14 = 0.005, I20 = 0.01 and I21= 0.041) < 0.05, which is the most important point scale for this research.

The cross tabulation on the foundation of the most significant results that getting from the t-test results in tables 9 was used. The results show that the questionnaires with T values were significant at P<0.05.

Table 10: Cross tabulation of gender students and responses of item ‘I can digitize a mathematical problem expressed verbally’

		Never	**Rarely**	**Sometimes**	**Generally**	**Always**	**Total**
Gender	Male	11	27	59	40	16	153
	Female	10	12	12	5	5	44
Total		21	39	71	45	21	197

Table 10 above showed that, 56 (28 %) students, which are male, ‘generally and always’ have ability to transform a verbally spoken mathematical problem into numerical. 59 (29.9%) stated that ‘sometimes’ they have that skill, and just 11(5.5%) they think they ‘never’ have had this skill. In contrast, only 10 (5.07%) students, which are female, believe they ‘always and generally’ could transform a verbally spoken mathematical problem into numerical. While 22 (11%) of them ‘never and rarely’ believe that they have this skill.

Table 11: Cross tabulation of gender students and responses of item 'It is fun to try to solve complex problems'

		Never	Rarely	Sometimes	Generally	Always	Total
Gender	Male	4	11	45	53	40	153
	Female	3	7	17	13	4	44
Total		7	18	62	66	44	197

Table 11 above showed that most of the responses are of males that possess high level of these skills. Whereas, 93 (47.2%) male students that 'generally and always' they enjoy solving complex problems, just 4(2%) 'never' enjoy solving complex problems. In contrast, the most responses of females were on medial level where 17(8.6%) 'sometimes' enjoy trying solving complex problems and 10(5%) 'never and rarely' enjoy solving complex problems.

Table 12: Cross tabulation of gender students and the responses of item 'I am willing to learn challenging things'

		Never	Rarely	Sometimes	Generally	Always	Total
Gender	Male	1	8	31	57	56	153
	Female	2	2	15	13	12	44
total		3	10	46	70	68	197

As showed in Table 12 above, more than half of male participants, 113 (57.3%), tend to be interested to learn challenging things, whereas, just 9 (4.5%) ‘never and rarely’ are interested to learn challenging things. While 25 (12.6%) of the female instructors believe that they tend to be interested to learn challenging things, 15(7.6%) female of students were sometimes interested in learning challenging things, and 4 (2%) of female students were not interested in learning challenging things at all.

Such three items, which are approximately 11% of the total questions, show that male and female students from the EMU IT department have significant differences on their perception of gender. The rest of the 89% of questions portray that there is no important significance on the whether male or females have better CT skills. Additionally, the average mean for Table 9 demonstrates 3.6015 for male students and 3.5031 for female students. Therefore, they hold comparable responses concerning gender. It can be determined via statistical analyses that both male and female students of the IT department in EMU hold a high score of CT and no significant differences occur between group.

A related study proves similar finding; Atmatzidou and Demetriadis (2016) in their research examined how students’ CT skills are developed using the learning activities in educational robotics (ER). Findings from their research displayed that while comparing genders, girls required more training time in all the events presented for them in order to reach the same level of skill as the boys. Therefore, it may be assumed that regardless of their gender or age, the CT skill development of students will reach the same level, even if achieved in different times.

In contrast, some studies have shown that gender has a great influence on CT skills. Román-González et al. (2017) have found through a study conducted with the participation of 5 to 12 grade students that the CT skills differ according to the gender, in favour of male students.

4.3 Differences in the Level of CT Skills of IT Students According to Age

In this section, in order to discover if age difference has an effect on student's CT skills, a one-way ANOVA analysis was conducted.

Table 13: Group statistics of independent analysis on age

Items	**Age**	**n**	**Mean**	**Standard deviation**	**P**
I1	18-20	76	4.21	.718	.847
	21-22	67	4.13	.919	
	23 and older	54	4.15	.899	
	Total	197	4.17	.837	
I2	18-20	76	4.16	.967	.869
	21-22	67	4.16	.947	
	23 and older	54	4.24	.910	
	Total	197	4.18	.941	
I3	18-20	76	4.08	.726	.600
	21-22	67	4.21	.769	

	23 and older	54	4.13	.825	
	Total	197	4.14	.767	
I4	18-20	76	3.70	.749	.083
	21-22	67	4.00	.816	
	23 and older	54	3.78	.925	
	Total	197	3.82	.829	
I5	18-20	76	3.82	.828	.878
	21-22	67	3.88	.808	
	23 and older	54	3.81	.933	
	Total	197	3.84	.848	
I6	18-20	76	3.47	1.227	.100
	21-22	67	3.87	.936	
	23 and older	54	3.63	1.051	
	Total	197	3.65	1.095	
I7	18-20	76	3.79	.899	.697
	21-22	67	3.91	.883	
	23 and older	54	3.81	.848	
	Total	197	3.84	.877	

I8	18-20	76	3.68	.912	.143
	21-22	67	3.87	.952	
	23 and older	54	3.52	1.041	
	Total	197	3.70	.967	
I9	18-20	76	3.37	.763	.132
	21-22	67	3.63	.885	
	23 and older	54	3.61	.920	
	Total	197	3.52	.855	
I10	18-20	76	3.14	1.344	.581
	21-22	67	3.09	1.323	
	23 and older	54	2.91	1.233	
	Total	197	3.06	1.304	
I11	18-20	76	3.21	1.181	.858
	21-22	67	3.16	1.095	
	23 and older	54	3.28	1.071	
	Total	197	3.21	1.118	
I12	18-20	76	3.39	.981	.839
	21-22	67	3.33	.975	

	23 and older	54	3.30	.964	
	Total	197	3.35	.970	
I13	18-20	76	3.00	1.143	.865
	21-22	67	3.07	1.049	
	23 and older	54	3.09	.957	
	Total	197	3.05	1.058	
I14	18-20	76	2.97	1.189	.420
	21-22	67	2.96	1.147	
	23 and older	54	3.20	1.035	
	Total	197	3.03	1.133	
I15	18-20	76	3.68	.969	.905
	21-22	67	3.63	1.057	
	23 and older	54	3.61	.979	
	Total	197	3.64	.998	
I16	18-20	76	3.53	1.039	.571
	21-22	67	3.55	1.158	
	23 and older	54	3.72	1.089	
	Total	197	3.59	1.092	

I17	18-20	76	3.54	1.137	.380
	21-22	67	3.72	1.139	
	23 and older	54	3.80	.939	
	Total	197	3.67	1.087	
I18	18-20	76	4.11	.810	.279
	21-22	67	3.87	1.013	
	23 and older	54	4.06	.960	
	Total	197	4.01	.926	
I19	18-20	76	3.58	.942	.684
	21-22	67	3.70	.853	
	23 and older	54	3.59	.880	
	Total	197	3.62	.893	
I20	18-20	76	3.55	1.012	.472
	21-22	67	3.75	1.106	
	23 and older	54	3.56	1.003	
	Total	197	3.62	1.041	
I21	18-20	76	4.04	.944	.659
	21-22	67	3.94	.936	

	23 and older	54	3.89	1.022	
	Total	197	3.96	.960	
I22	18-20	76	3.72	1.028	.062
	21-22	67	4.07	.785	
	23 and older	54	3.94	.811	
	Total	197	3.90	.901	
I23	18-20	76	3.38	.938	**.047**
	21-22	67	3.67	.927	
	23 and older	54	3.76	.889	
	Total	197	3.58	.931	
I24	18-20	76	3.03	1.006	.085
	21-22	67	2.76	1.102	
	23 and older	54	2.63	1.015	
	Total	197	2.83	1.050	
I25	18-20	76	3.45	1.171	.857
	21-22	67	3.39	1.193	
	23 and older	54	3.33	1.116	
	Total	197	3.40	1.159	

I26	18-20	76	3.32	1.023	.174
	21-22	67	3.43	1.048	
	23 and older	54	3.07	1.113	
	Total	197	3.29	1.061	
I27	18-20	76	3.25	1.145	.686
	21-22	67	3.25	1.064	
	23 and older	54	3.09	1.248	
	Total	197	3.21	1.144	
I28	18-20	76	3.57	1.268	.748
	21-22	67	3.61	1.180	
	23 and older	54	3.44	1.223	
	Total	197	3.55	1.222	
I29	18-20	76	3.46	1.290	.272
	21-22	67	3.46	1.235	
	23 and older	54	3.13	1.332	
	Total	197	3.37	1.286	

*Significant point=*p=<0.05, group average mean=3.57, Rating scales Never, Rarely, Sometimes, Generally, Always.*

Table 14: LSD multiple comparison analysis for effect of age on item 'I make use of a systematic method while comparing the options at my hand and while reaching a decision'

	Age	**n**	**Mean**	**Mean difference**	**p**
18-20	21-22	76	3.67	.290	.062
	23 and older	54	3.76	.378	.022

As it is clear from Table 13, there is not any significant difference between the points of respondents obtained from the scale in term of age. With exception to I23, all the questions, which cover such dependable factors, have an increased score over the P=0.05 value, which is the significant point. This statistically implies that there is a strong correlation, which exists regarding the view of possessing CT skills among the differing age. The lowest significant difference point is recorded at 0.047 for I23 which proves that students of different age have different responses on their perception on the ability to 'make use of a systematic methods while comparing the options in my hand and while reaching a decision'. To get more detail, LSD analysis was conducted. As it can observed. from Table 14, that a meaningful difference existed between groups of a 18-20 age range and groups of a 23 and higher age range. On the other hand, no significant difference was found between groups of the 18-20 age range and groups of a 21-22 age range. Group 3 and higher age scored increased mean ratings (M = 3.76) than groups of a 21-22 age range (M=3.67), as well as groups of a 18-20 age range (M = 3.38).

Therefore, Table 13, visibly demonstrates that, no significant difference occurred on the attitudes of opposite ages of EMU- IT undergraduate students regarding their skills of CT to carry out various activities noted in the questions.

As the group average mean was 3.57 ,therefore, it can be seen that, 62% of responses of students are significantly above the group average mean score and the average mean of each group (3.5, 3.6, 3.5) are near to each other. Thus, it could be stated that the CT skills level of participants do not differ significantly according to the age variable.

4.4 Differences in the Level of CT Skills of IT Students According to Years of Study

This section of the study compares the mean score on variables for groups depending on their years of study and their CT skills, by using a one-way between groups ANOVA. In addition, an LSD multiple comparison analysis for effect of year on CT skills was conducted to obtain more details about the variance with p-value lower than 0.05.

In order to examine if the number of years students have been in school have an effect on student's CT skills, a one-way between groups ANOVA was conducted to find the difference in effect number of years studies student on their CT skills.

Table 15: Group statistics of independent analysis on years of study

	Years of studies	**n**	**Mean**	**Standard deviation**
I1	1	59	4.17	.834

	2	33	3.94	.899
	3	53	3.98	.772
	4 and higher	52	4.50	.780
	Total	197	4.17	.837
I17	1	59	3.39	1.099
	2	33	3.39	1.391
	3	53	3.81	.900
	4 and higher	52	4.02	.918
	Total	197	3.67	1.087
I18	1	59	3.92	.952
	2	33	3.67	.990
	3	53	4.19	.878
	4 and higher	52	4.15	.849
	Total	197	4.01	.926

Table 16: Attitudinal differences of CT skills based on years of study responses

		Sum of Squares	df	Mean Square	F	P
I1	Between Groups	9.307	3	3.102	4.672	.004
	Within Groups	128.165	193	.664		
	Total	137.472	196			
I17	Between Groups	14.547	3	4.849	4.312	.006
	Within Groups	217.007	193	1.124		
	Total	231.553	196			
I18	Between Groups	7.188	3	2.396	2.876	.037
	Within Groups	160.792	193	.833		
	Total	167.980	196			

*p<.05

Table 15 displays the descriptive statistics and table 16 portrays the relationship between and within years that students have studied and their level of CT skills. 29 questions include the CT skills as a reliant factor on the years of studies, just I1, I17 and I18 have noteworthy results, which seem to be minimize than the P value of <0.05, which is the significant point established for this study. The three items, approximately 10.3% of the total items, which cover areas of like people who are confident about their decision, interested in working with team group to solve problem and believes in a collaborated learning environment they get more ideas from members. Results show that 1, 2, 3, and 4 and higher years of IT undergraduates learners have variable differences on their perception on CT skills. The remaining 89.6% of responses of questions in Table 16, show the significant points of response were far above the P=<0.05 and consequently display that there is no meaningful difference on the knowledge of years contrary of EMU IT students on their CT skills to implement various different activities mentioned in the above questions. Subsequently, a durable correlation exists between the years of studies and knowledge of their CT skills.

The descriptive statistics of student's CT skill level across four groups of years in school is reported in table 15. It can be seen that the students which have spent more years in school are numerically associated with highest mean for CT skills where average mean score of group 4 and higher was (M = 3.63), while the average mean score 3.51, 3.56, 3.54 of 1, 2 and 3 year respectively. To get more details, the LSD test was used as shown in the next part.

LSD (Least Significant Difference) multiple comparison analysis was conducted to get more details about the variance with p-value lower than 0.05. The following tables, compiled of multiple comparisons, display the outcomes of the LSD test. The LSD test contrasts individual groups (years of studies category) to all other groups (years of studies categories).

Table 17: LSD multiple comparison analysis for effect of year on item 'I like the people who are sure of most of their decisions'

Years of studies	n	M	Mean difference	P
1	59	4.17	.331	.035

4 and higher	2	33	3.94	.561	.002
	3	53	3.98	.519	.001

Table 17, compiled from the LSD post hoc test, portrays that a significant difference exists between Groups 4 and higher and 1, 2 and 3 group (p < .05) in their responses on Q1 which covers creativity skills as their attitude to prefer people who are decisive. Whereas 4 and higher years of study had significantly higher mean ratings (M = 4.50) than 1-year group (M=4.17), 2 years group (M=3.94), and 3 years group (M = 3.98).

Table 18: LSD multiple comparison analysis for effect of year on item 'I like the people who are realistic and neutral'

	Years of studies	**n**	**Mean**	**Mean difference**	**P**
2	1	59	4.14	.16590	.415
	3	53	3.13	.16238	.434
	4 and higher	52	4.42	.45338	.031

Table 18, compiled of the LSD post hoc test, shows that a significant difference exists between the group of 2 years and 4 and higher years of study(p=.031) in their feedback to preferring when people are genuine and do not take sides, whereas no significant difference existed between group 2, 1 and 3 group (p=.415, .434). 4 and higher years of study had significantly higher mean ratings (M = 4.42) than 1 year group (M=4.14), 2 years group (M=3.97), and 3 years group (M = 3.13).

Table 19: LSD multiple comparison analysis for effect of year on item 'I have a belief that I can solve the problems possible to occur when I encounter with a new situation'

	Years of studies	**n**	**Mean**	**Mean difference**	**P**
4 and higher	1	59	3.78	.297	.058
	2	33	3.79	.289	.115
	3	53	3.64	.435	.007

Table 19, the LSD post hoc test, shows that a significant difference exists between the group consisting of 4 and higher years in university education compared with the group 3 (p= .007) correspondingly, in their feedback on the ability to overcome the issues when I am faced with a new problem, whereas no significant difference existed between group 4 and higher and group 2 (p=.115) and group 1 (p=.058). On the other hand, 4 and higher years of study had a significantly higher mean rating (M = 4.08) than 1-year group (M=3.78), 2 years group (M=3.79), and 3 years group (M = 3.64).

Table 20: LSD multiple comparison analysis for effect of year on 'I can mathematically express the solution ways of the problems I face in the daily life'

	Years of studies	n	Mean	Mean difference	P
1	2	33	3.12	.29070	.206
	3	53	3.23	.39591*	.049
	4 and higher	52	3.08	.24641	.221

Table 20, the LSD post hoc test, shows that a significant difference occurred between group 1 years and 3 group (p=.049) in their responses on the ability to mathematically express the solution of the issues, they an encountered daily, whereas no significant difference existed between group 1 and 2 group (p=.206) and the 4 and higher group (p=..221). As it can observed from table 20, the group containing 3 years of studies had higher mean ratings (*M* =.3.23) than the 1 year of study group (M=2.83), the 4 years of study and higher group (M=3.08), as well as the 2-year group (*M* = 3.12).

Table 21: LSD multiple comparison analysis for effect of year on 'I like experiencing cooperative learning together with my group friend'

	Years of studies	n	Mean	Mean difference	P
2	1	59	3.75	.433	.041
	3	53	3.60	.301	.173
	4 and higher	52	3.79	.485	.029

Table 21, the LSD post hoc test, shows that a significant difference was established between the group containing 2 years and 1(p= .041), 4 and higher group (p= .029) in their responses on preferring to collective learning together with my group friend, whereas no significant difference existed between the group containing 2 to 3 years of study (p=.173). As it can perceived from table 21, group 4 and higher years of studies had a higher mean rating (M =3.79) than the 2 years group (M=3.30), 3 years group (M=3.60), and 1-year group (M = 3.75).

Table 22: LSD multiple comparison analysis for effect of year on 'I like solving problem related to group project together with my friends in cooperative learning'

	Years of studies	**n**	**Mean**	**Mean difference**	**P**
3	1	59	3.39	.42149	.037
	2	33	3.39	.41738	.077
	4 and higher	52	4.02	.20791	.316
4 and higher	1	59	3.39	.62940	.002
	2	33	3.39	.62529	.009
	3	53	3.81	.20791	.316

Table 22, the LSD post hoc test, shows that a significant different existed between the group consisting of 3 years of studies 1(p= .037), as well as between group 4 and higher and 1 and also the 2 years of studies group (p= .002, .009) correspondingly, in their responses on like overcoming issues connected to group projects together with my friends in a collaborated learning environment, whereas no significant difference existed between group 3 and 2, 4 and higher group (p=.077, .316). As it can seen from table 22, group 4 and higher years of studies had significantly higher mean ratings (*M* =4.02) than 2-year group (M=3.39), 3 group (M=3.39), and 1 years group (*M* = 3.81).

Table 23: LSD multiple comparison analysis for effect of year on item 'more ideas occur in cooperative learning'

	Years of studies	n	Mean	Mean difference	P
3	1	59	3.92	.273	.115
	2	33	3.67	.522	.011
	4 and higher	52	4.15	.035	.845
4 and higher	1	52	3.92	.238	.171
	2	33	3.67	.487	.017
	3	53	4.19	-.035	.845

Table 23, the LSD post hoc test, shows that there is a significant difference which exists between the group containing 3 years of education and 2 years of education (p= .011), as well as, between group 4 and higher and the 2 year and higher group (p= .017) in their responses on several occurring in collaborative learning environment. On the other hand, there are no significant differences found between group 3 and 1, 4 and higher group (p=.115, .845) as well as between group 4 and higher and the 1 year group (p=.171). As it can observed from table 23, the group consisting of 3 years of studies had a higher mean rating (M =4.19) than the 4 and higher year group (M=4.15), 1 group (M=3.92), and 2 years group (M = 3.67).

Table 24: LSD multiple comparison analysis for effect of year on item ‘I am willing to learn challenging things’

	Years of studies	**n**	**Mean**	**Mean difference**	**P**
4 and higher	1	59	4.02	.156	.391
	2	33	3.85	.325	.128
	3	53	3.77	.399	.033

Table 24, the LSD post hoc test, shows that a significant difference occurring between the group 4 and higher years and group 3 (p= .033) in responses on they wish to be more knowledgeable in challenging projects. On the other hand, there is no significant difference existing between the 4 and higher group and group 1 and 2 (p=.391, .128). As it can observed from table 24, group 4 and higher year of studies had higher mean ratings (M =4.17) than group 3 year (M=4.02), 2 group (M=3.85), and 3 years group (M = 3.77).

Table 25: LSD multiple comparison analysis for effect of year on item 'I am proud of being able to think with a great precision'

	Years of studies	n	Mean	Mean difference	P
2	1	59	3.90	.201	.340
	3	53	3.85	.152	.446
	4 and higher	52	4.10	.399	.047

Table 25, the LSD post hoc test, shows that a significant difference occurs between group 2 and group 4 and higher years (p= .047) in responses to they feel proud if they able to think with a great precision. On the other hand, no significant difference has been established between the 2 group and the group 1 and 3 (p=.304, .446). As it can observed from table 24, the group 4 and higher year of studies had higher mean ratings (M =4.17) than group 3 year (M=4.02), 2 group (M=3.85), and 3 years group (M = 3.77).

Table 26: LSD multiple comparison analysis for effect of year on item 'I have problems in the issue of where and how I should use the variables such as X and Y in the solution of a problem'

	Years of studies	n	Mean	Mean difference	P
2	1	59	3.29	.5300	.036
	3	53	3.30	.5163	.045
	4 and higher	52	3.35	.4720	.067

Table 26, the LSD post hoc test, shows that a significant difference has occurred between the group 2 year and group 1 (p= .036) and the group 3 (p=.045) in their responses on they have difficulties of in which place and when to use the variables like X and Y in the solution of an issue. On the other hand, no significant difference exists between group 2 and group 4 and higher (p=.067). As it can observed from table 26, the group containing 2 year of studies had higher mean ratings (M =3.82) than the group 4 and higher year (M=3.35), 3 group (M=3.30), and group 1 year (M = 3.29).

Table 27: LSD multiple comparison analysis for effect of year on item ‘I cannot apply the solution ways I plan respectively and gradually’

	Years of studies	**n**	**Mean**	**Mean difference**	**P**
1	2	33	3.61	.5382	.020
	3	53	3.34	.2718	.174
	4 and higher	52	3.29	.2206	.272

Table 27, the LSD post hoc test, shows that a significant difference existed between group 1 year and group 2 year (p= .020) in their responses on they cannot use the solution in a method that I had planned respectively and gradually whereas, no significant difference existed between the group consisting of 1 and group 3 year (p=.174) and also the group containing 4 and higher (p=.272). As it can perceived from table 27, the group with 2 year of studies had higher mean ratings (M =3.61) than the group with 3 years (M= 3.34), group with 4 and higher years (M=3.29) and the group with 1 year (M=3.07).

Table 28: LSD multiple comparison analysis for effect of year on item ‘I cannot develop my own ideas in the environment of cooperative learning’

	Years of studies	**n**	**Mean**	**Mean difference**	**P**
2	1	59	3.46	.4704	.115
	3	53	3.45	.6449	.033
	4 and higher	52	3.52	.3898	.199

Table 28, the LSD post hoc test, shows that a significant different existed between the group with 2 years of studies and the group with 3 years of studies (p= .033) in their responses on they cannot expand my own ideas in the setting of cooperative learning. On the other hand, no significant difference has been established between the group consisting of 2 years of studies and group 1 year (p=.115) and group 4 and higher (p=.199). As it can observed from table 28, the group with 2 year of studies had higher mean ratings (*M* =3.91) than the group with 4 and higher years of study (M= 3.52), the group with 1 year (M=3.46) and the group with 3 year (M=3.45).

González et al. (2017) attempted to address the issue of how CT can be incorporated into the curricula of the educational system through psychometric approach in their research. The study was carried out on Spanish students who were from the 5th to the 10th grade and findings, which were 1,251 in total. Findings revealed that as the level of grade increases, the CT test score also increases.

Contrary to the findings of Durak & Saritepeci, (2018) which insists that education has a negative influence on the development of CT skills, our result suggest otherwise. This is possibly due to the nature of course being study in school. In this study, respondents are students enrolled in information technology course, which we expect to impact the outcome of our study as information technology also involves CT skills such as algorithmic thinking, problem solving and so forth.

Chapter 5

CONCLUSION

5.1 Conclusion

It is the notion that information and communication technologies (ICT) will bring about phenomenal changes resulting in a sustainable society. Most industries, such as; automotive, finance, healthcare, journalism, law and manufacturing, are continuously being enhanced with improved computer science. In order to progress and maintain careers in these industries people must change their mind sets towards thinking more computationally (Wing , 2017). For this reason, it is necessary for scientists in the future generations to be immensely involved with computing. In higher education, many campuses are revising their curriculum of computer science and changing it to include the essential elements and concepts of CT (Wing, 2017). Thus, individuals in the digital age are anticipated to have CT skills in different disciplines, but still there is no evidence to what extent they have these skills and if they are at the sufficient level (Korkmaz et al., 2017).

Therefore, the purpose of this study was to find out the level of Computational Thinking (CT) skills of IT- EMU students. Additionally, the study paid special attention to understanding the impact of gender difference, age variance as well as length of years of study on the development of computational thinking skills among the students. This study was inspired by using the framework outlined by Korkmaz et al., (2017) within its 5 construction creativity, algorithmic thinking, cooperativity, critical thinking and problem-solving.

To achieve the objective of the study and to gain a better understanding of which particular CT skills of IT students were used, the study was not limited to quantitative or qualitative methods. Convergent parallel mixed-method approach was employed to carry out data gathering and analysis. Semi-structured interviews were conducted with selected students to gain deeper understanding of the concepts. Further, survey questionnaire were also distributed and data analysed in SPSS. All undergraduate students, enrolled in Information Technology department in spring 2017-2018 have been invited to participate in the study. 197 questionnaires were received from undergraduate students from the IT department of EMU. A convenience sample of students were used for 23 interviewees based on their years of study.

Considering the 1st research question 'What is the level of CT skills of students?', the research study concluded that the students have high level of CT skills. It was found that, approximately 73% mean score of participated students were above the moderated mean score of Scale. Furthermore, the study was able to help us to understand various students' attitudes on CT dimension. As it can observed from result, students possess a moderate skill ability on problem solving (M =3.266) and algorithm thinking (M =3.2039) of compared with creativity (M =3.9169), critical thinking (M =3.7391) and cooperativity(M =3.7284).

Considering the 2nd and 3rd research questions 'To what extend the differences of CT skills of student according to gender and age variables?' This study reveals that, there are no significant differences in gender and age variables. However, the differences that take place in the students' perception of CT score according to years of studies especially between 1^{st} and 4^{th} and higher. Where students who have spent more years in school are numerically associated with highest mean for CT skills where average mean score of group 4 and higher was (M = 3.630), while the average mean score 3.51, 3.56, 3.54 of 1, 2 and 3 year respectively. This implies the educational courses taken of IT could effect on CT skills of student.

The outcomes of this study indicate that there is a need to improve the collaborative problem solving skills such as establishing and maintaining shared understanding and establishing and maintaining team organisation. In addition, it appears they have some difficulties and with dealing with math and algorithm problem. Therefore, to handling these shortages, students should be motivated and engaged in collaboration learning environment and simulations conducted by a computer device, instructor or learners are operated to help make algorithms more concrete (Futschek, 2006; Futschek & Moschitz, 2010). Betrancourt (2005) argues that simulations are especially significant in assisting the imagination of dynamic processes that are not characteristically visual. They can decrease the mental loss of cognitive simulations and subsequently keep cognitive resources for the learning tasks especially in the case of beginner learners.
This study is not free of limitation, for instance, when the revised questionnaires were distributed to the students, some problems occurred. 230 questionnaires were given out to students, but only 210 were returned. However, some of these questionnaires have missed values and few of them were incorrectly filled so 197 usable questionnaires were included for the analysis.

5.2 Recommendation for Future Research

It may be suggested that a needs analysis is carried out in CT processes for different purposes, such as for teachers and the curriculum. Future studies could examine the CT skills of learners related to the students' success and course results within their groups which were linked with different factors such as academic backgrounds. A further study could examine the CT models in courses where the students are required to perform their projects and in class activities individually compared with in a team.

Furthermore, future studies could seek to discover the appearance of CT processes in a non-problem based learning environment such as in a class whereby CT activities are infrequently provided to the students after their lectures have been completed during the course period. In addition, future studies could analyse the main curriculum and examine which constituents of the curriculum assist to enhance CT both as a process and construct in university learning environments.

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APPENDICES

Appendix A: Questionnaire

Dear student,

Please answer the following question by selecting the appropriate level by ticking (✓) on the following statements.

Section 1: Demographics

Please tick (✓) the appropriate choices and provide the necessary information bellow:

Gender: Male ☐ Female ☐

Age: 18 – 20 ☐ 21 – 22 ☐ 23 and older ☐

Year of Studies: 1 ☐ 2 ☐ 3 ☐ 4 and higher ☐

Section 2:

N	*Items*	*Never (1)*	*Rarely (2)*	*Sometimes (3)*	*Generally (4)*	*Always (5)*
1	I like the people who are sure of most of their decisions.					
2	I like the people who are realistic and neutral.					
3	I believe that I can solve most problems I face if I have sufficient amount of time and if I show effort.					
4	I have a belief that I can solve the problems possible to occur when I encounter with a new situation.					
5	I trust that I can apply the plan while making it to solve a problem of mine.					
6	Dreaming causes my most important projects to come to light.					
7	I trust my intuitions and feeling of “trueness” and “wrongness” when I approach the solutions of a problem					
8	When I encounter with a problem, I stop before proceeding to another subject and think over that problem					
9	I can immediately establish the equity that will give the solution of problem.					
10	I think that I have a special interest in the mathematical processes.					
11	I think that I learn better the instructions made with the help of mathematical symbols and concepts.					

12	I believe that I can easily catch the relation between the figures.					
13	I can mathematically express the solution ways of the problems I face in the daily life.					
14	I can digitize a mathematical problem expressed verbally.					
15	I like experiencing cooperative learning together with my group friends.					
16	In the cooperative learning, I think that I attain/ will attain successful results because I am working in a group.					
17	I like solving problem related to group project together with my friends in cooperative learning.					
18	More ideas occur in cooperative learning.					
19	I am good at preparing regular plans regarding the solution of the complex problem.					
20	It is fun to try to solve complex problems.					
21	I am willing to learn challenging things.					
22	I am proud of being able to think like with a great precision.					
23	I make use of a systematic method while comparing the options at my hand and while reaching a decision.					
24	I have problems in demonstration of the solution of a problem in my mind.					
25	I have problems in the issue of where and how I should use the variables such as X and Y in the solution of a problem.					
26	I cannot apply the solution ways I plan respectively and gradually.					
27	I cannot produce so many options while thinking of the possible solution ways regarding a problem.					
28	I cannot develop my own ideas in the environment of cooperative learning.					
29	It tired me to try to learn something together with my group friends in cooperative learning.					

Appendix B: Guide of Semi-Structured Interview

Topic: Assessment of the Computational Thinking Skills of IT students: A Case study of EMU-IT

Time of interview: **Date:** **Place:**

Have the interviewee read and sign the consent form: ☐

Turn on the tape recorder and test it: ☐

Gender: Male ☐ Female ☐

Age: 18 – 20 ☐ 21 – 22 ☐ 23 and older ☐

Year of Studies: 1 ☐ 2 ☐ 3 ☐ 4 and higher ☐

Questions:

1- When attempting to solve a new problem, do you seek help from your friends to explain the meaning of the problem? or, will you try to understand the problem by redefining it using your own words?

2- How do you feel in adopting and embedding other's work or different information into your own in a meaningful way?

3- Do you enjoy while trying to solve a complex problem, yes / no, please explain?

4- When you face a new problem and given a choice, what do you do, do you avoid challenging problems or prefer challenging problems? Why?

5- How confidently do you draw the right conclusion and assess your solution?

6- Do you enjoy and interested in using math to solve a problem? Why?

7- Do you prefer to work on your project or study individually or with team group, yes/no why?

8- How working in a team influenced your performance on study and design project?

Appendix C: Student Consent Form

Dear student,

I am MSc. student and I am conducting my thesis on the **assessment of the Computational Thinking skills of EMU-IT students**.

You are being asked to take part in this research study by filling questionnaire about computational thinking skills on order to assess the level of computational thinking skills of IT students according to their gender and years.

You are under no obligation to participate in this research, it is your choice whether to be a part of the study or not, and you are free to withdraw from participation at any time without penalty. Even if you decide to participate, Please answer all the questions sincerely and it will take about 20 Minute. And be informed that your personal information and individual responses will be kept confidential and used only for research purpose. Collected data can be used for further publications. For more information, please feel free to contact me or my MSc. thesis supervisor.

Thank you for your participation and cooperation.

MSc. Maren Omer Zaghdoud
MSc Computer and Instructional Technology
Teacher Education Department
Faculty of Education
Eastern Mediterranean University(EMU)
marnaamr353@gmail.com.

PROF .DR. Mustafa ILKAN
School of Computing and Technology
Eastern Mediterranean University(EMU)
Mustafa.ilkan@emu.edu.tr

Your signature below indicates that you understood what is explained by researcher and what participating in this research entails, and agree to participate on voluntary basis.

Student’s name and surname:

Signature:

Date: / /