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A scoping review of the literature on computational thinking in education in the Arab world

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Abstract

This study aims to identify the nature and the extent of recent research studies on computational thinking in the Arab educational systems. The analyzed studies were gathered from English and Arabic educational sources. The selected publications were peer-reviewed journal articles over the past ten years that dealt with computational thinking in education in the Arab world. The selected studies were analyzed based on language, publication date, educational setting, educational discipline, site, primary purpose, research method, sample, and adopted definition of computational thinking. Twenty-eight research articles were selected for the investigation. The analysis revealed that the majority of the examined research studies were published in the Arabic language after the year 2020 in K-12 educational settings. The majority of the examined studies were conducted in programming and computer science in a few Arab countries. In addition, the majority of the examined studies focused on how to develop students' computational thinking levels using various interventions. The majority of the studies employed a limited number of participants and used different forms of experimental research designs. The studies adopted different forms of the definition of computational thinking. Based on the findings, recommendations for future studies were presented.

Keywords: computational thinking, review of the literature, Arab world

INTRODUCTION

There is an agreement among researchers that computational thinking is one of the important skills in the 21st century and one of the requirements of digital transformation. Computational thinking competencies have been associated with the use of information and communication technologies that have been widely adopted by nowadays students and educators. For instance, the International Society for Technology in Education (ISTE) has listed computational thinking as one of the ISTE standards for students (ISTE, 2017). In addition, ISTE published ISTE computational thinking competencies for educators that aimed to assist teachers in incorporating computational thinking with all students across various disciplines (ISTE, 2017). The objective of ISTE standards is to develop computational thinking competencies among students to enable them to use computing to innovate and solve problems. Furthermore, the importance of computational thinking is reflected in integrating computational thinking competencies into the formal curriculum in some countries (Hsu et al., 2019; So et al., 2020).

However, the agreement on the importance of computational thinking is not reflected in the definitions of computational thinking. For instance, there was a debate among researchers regarding the nature of computational thinking competencies. Some researchers believe that computational thinking competencies are associated with everyday living skills for everyone (Wing, 2006), while others believe that computational thinking competencies are associated with the use of technology (Denner et al., 2012). However, computational thinking is strongly associated with analyzing and solving problems with and without the use of technology (Hsu et al., 2018). Several constructs have been listed under the various definitions of computational thinking. Examples of these constructs include analyzing and solving a problem, computer programming, understanding system design,

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Contribution to the literature

- This study reviews computational thinking research specifically in Arab countries, which are underrepresented in global literature. It explores both K-12 and higher education settings and identifies trends and characteristics of research in the region.
- By analyzing studies from 2012 to 2022, this review highlights the growing interest in computational thinking in Arab education, capturing prevalent methodologies, interventions, and definitions adopted by researchers. The study shows a significant increase in research after 2020.
- This review highlights gaps across several dimensions, including language, educational setting, and geographical focus, pointing out the limited research in higher education and small sample sizes. It calls for more research to expand computational thinking across disciplines and regions in the Arab world.

understanding human behavior, logical thinking, algorithmic thinking, development of thinking habits, mathematical thinking, decomposition, abstraction, algorithm design, debugging, iteration, and generalization (Shute et al., 2017; Taslibeyaz et al., 2020). Computational thinking constructs were categorized based on the relationship between learning outcomes associated with computational thinking and other subject domains. In this context, there are two types of learning outcomes associated with computational thinking that are first-order and second-order learning outcomes (Sullivan & Heffernan, 2016). First-order learning outcomes, associated with computational thinking, are the outcomes that are evaluated separately from other domains topics while second-order learning outcomes are evaluated in the context of other specific subject domains (Sullivan & Heffernan 2016; Tang et al., 2020).

Mastering computational thinking competencies provides several benefits for students. It helps develop logical thinking and problem-solving skills, enhances programming abilities, strengthens learning in science, technology, engineering, and mathematics (STEM), and promotes cognitive development (García-Peñalvo & Mendes, 2018; Mohaghegh & McCauley, 2016; Swaid, 2015). Computational thinking has been connected to several competencies that are crucial for nowadays students including creativity, algorithmic thinking, critical thinking, problem-solving, cooperation, communication, data analysis, abstract thinking, modeling, representing data, separating issues into parts, computerization, efficiency, generalizing, and transferring (Swaid, 2015). Computational thinking competencies are strongly associated with programming and computer science, where computational thinking competencies have been taught using a variety of programming languages (Lye & Koh, 2014). However, computational thinking has also been studied in a variety of other educational fields such as mathematics, biology, science, engineering, language, and music (Hsu, Chang & Hung, 2018).

The concept of computational thinking started to appear in literature in 2006 (Wing, 2006). Since then, an increasing number of research studies have been conducted to examine computational thinking in teaching and learning activities (Hsu et al., 2018; Lyon & Magana, 2020). However, several studies showed that there were spikes in computational thinking research studies in the years 2017 and 2018 (Taslibeyaz et al., 2020). The geographical location of the research studies that examined computational thinking was biased toward some countries such as the United States and Spain (Cutumisu et al., 2019). Computational thinking research studies have been published in major international databases such as SpringerLink, ScienceDirect and Scopus, ERIC, ACM Digital Library, and IEEE Explore (Cutumisu et al., 2019). The research studies that appeared with the emergence of the concept of computational thinking focused on K-12 education (Lyon & Magana, 2020). However, with time computational thinking research studies started to cover different educational levels that include K-12 and higher education (Gasaymeh & AlMohtadi, 2024; Tang et al., 2020). The majority of these studies focused on assessing and enhancing students' and teachers' computational thinking competencies using different research methods (Hsu et al., 2018; Lyon & Magana, 2020).

In the Arab world, there is increasing interest in using and applying various information and communication technologies in education. Such increasing interest is evident in the increasing literature that examines the use of technology in education (Alsswey & Al-Samarraie, 2019; Gasaymeh, 2017a, 2017b, 2018; Gasaymeh & Waswas, 2019; Gasaymeh et al., 2024; Khtere & Yousef, 2021). However, the integration of technology in Arab education should be directed by pedagogical guidelines to ensure the best practice of technology integration in education. Teachers' and students' computational thinking competencies are important for effective technology integration in education. Computational thinking competencies are foundational competencies that can be taught across disciplines with the aid of technology. Worldwide, there were variations in the results of research studies that examined computational thinking in education based on different variables. In the Arab world, there is a lack of review research studies that examine computational thinking in education to identify the current status and gap of the research

concerning computational thinking in education. The purpose of this research study is to present an overview of the recent educational research studies that have been conducted in Arab countries on computational thinking in education. The review aims to analyze educational research studies based on language, publication date, educational setting, educational discipline, site, primary purpose, research method, sample, and adopted definition of computational thinking. The following section presents an examination of some research studies that represent a review of previous research studies that investigated computational thinking in education.

LITERATURE REVIEW

Reviewing the computational thinking approach in teaching and learning took place in several studies. Some of these studies focused on specific fields such as programming education in higher education (Agbo et al., 2019) and programming education in K-12 education (Fagerlund et al., 2021; Tikva & Tambouris, 2021; Zhang & Nouri, 2019) science subjects in K-12 education (Ogegbo & Ramnarain, 2022) mathematical subjects in K-12 education (Hickmott et al., 2018; Nordby et al., 2022). In addition, some of the review studies regarding computational thinking focused only on preschool settings (McCormick & Hall, 2021).

However, some studies focused on empirical studies that examined computational thinking in education. For instance, Tang et al. (2020) conducted a study that systematically reviewed previous studies regarding the ways of assessing computational thinking skills in the educational fields, the study involved reviewing 96 research studies. The findings indicated that the majority of the studies were conducted in elementary, middle, and high schools. However, the K-elementary level was the most common educational level of the studies. The majority of the studies were conducted in computer science, programming, game design, and robotics. About half of the studies measured computational thinking skills independently from other subject domains. The used tools to assess computational thinking skills include typical tests, portfolio evaluations, interviews, and surveys. Some studies used a combination of these tools. The most commonly used tools were tests and surveys. In a similar study, Cutumisu et al. (2019) conducted a scoping literature review to examine experiential studies concerning computational thinking assessments. The researchers reviewed 39 studies that were conducted from 2014 to 2018. The findings showed that most of the studies were conducted in the K-12 context and grades 4 to 6 were the most popular sample in the studies. There were limited research studies that assessed computational thinking among students in grades 1 to 3 and university students. Most of the studies were conducted in either Europe or North America with a few studies conducted in Asia and South America. In addition, the results showed that computational thinking skills were assessed using a range of tools. However, the most common tools were computational thinking tests that included two types of questions: multiple-choice questions and open-ended questions followed by programming projects that involve using programming tools such as Scratch, Dr. Scratch, and Alice. In addition, some studies employed computational thinking scales to assess participants' computational thinking skills through this self-reporting method. Others employed combinations of more than one method to assess computational thinking skills. Furthermore, the results showed that the quasi-experimental design was the most popular in the examined studies. The great majority of the examined studies used computational thinking interventions. Examples of these interventions include formal courses in computer science and mathematics, informal workshops, or informal projects. Close to two-thirds of the studies employed more than 100 participants and close to one-third of the studies employed more than 300 participants. The commonly assessed constructs of computational thinking in the examined studies include algorithmic skills, abstraction, problem decomposition, and logical thinking.

In another study, Lyon and Magana (2020) conducted a study that aimed to review previous studies that examined the use of computational thinking in higher education teaching and learning environments. After reviewing 13 studies, the findings indicated that most of the studies were in the STEM academic discipline. Only four studies were conducted outside STEM fields including English, humanities, and education fields. The focus of the examined studies was on students' performance and impressions of a learning intervention among students. Studies have shown that there is no unified agreement for the definition of computational thinking. In the examined studies, computational thinking was used to design instruction, activities, content, and assessments. Most research used self-reported data collection tools such as questionnaires. Only one research in the data set concentrated on describing computational thinking using extensive interview data. The dominant used research paradigm was quantitative analysis, and the majority used inferential statistics.

Some previous studies focused on how to develop computational thinking skills through reviewing previous studies. For instance, Hsu et al. (2018) conducted a literature review study to examine the ways to learn and teach computational thinking. For the study, 120 studies were analyzed. The findings indicated that more than half of the studies were published in the United States followed by Spain, Greece, and the United Kingdom. The most common learning strategies for computational thinking were problem-based learning, project-based learning, collaborative learning, and game-based learning. In addition, the findings revealed

that the most common fields of the studies were programming subjects, computer science, mathematics, and biology. However, the issue of computational thinking was examined in a wide range of academic fields. The most common teaching instruments were a programming language, experiment, computer game, and robot. Scratch was the most commonly used programming language. The great majority of the studies were conducted in formal learning systems. The studies were conducted with students in K-12 and higher education settings. In a similar study, Taslibeyaz et al. (2020) conducted a review of previous studies intending to identify how to develop computational thinking skills in educational settings. For the study, 29 research papers were selected for analysis. The results revealed that there were variations in the definitions of computational thinking. The examined studies discussed the importance of developing computational thinking for students in terms of enhancing problem-solving skills, achieving lifelong learning, developing programming and algorithmic thinking skills, developing numerical/logical thinking skills, and enhancing students' ability to solve problems with technology. The great majority of the examined studies were examined in a programming context that includes programming education. However, nine studies were conducted in a non-programming context such as game design, software learning, interactive writing, and online learning. The participants in the examined studies were K-12 and higher education students. The analyzed studies focused on developing students' computational thinking through the use of a variety of tools including programming tools and non-programming tools. Examples of programming-related tools were computer programming, scratch, and robotics. Examples of non-programming tools include STEM and interactive writing tools. Two types of tools were used to measure computational thinking: Formative tools and summative tools. The most common formative tools include performance tests, educational activities, and observation. The most common summative tools include achievement tests, surveys, and attitude scales.

Worldwide, the number of research undertaken on computational thinking has dramatically increased during the last ten years (Hsu et al., 2018; Lyon & Magana, 2020). The review of the previous studies showed variations in purposes, where some studies focused on assessing computational thinking competencies (Cutumisu et al., 2019; Tang et al., 2020) and others focused on ways of teaching computational thinking skills (Hsu et al., 2018; Taslibeyaz et al., 2020). In addition, some studies focused on computational thinking in specific educational fields (Agbo et al., 2019; Fagerlund et al., 2021; Hickmott et al., 2018; Nordby et al., 2022; Ogegbo & Ramnarain, 2022; Tikva & Tambouris, 2021; Zhang & Nouri, 2019). Moreover, some previous studies only focused on empirical research concerning computational thinking education (Cutumisu et al., 2019). Furthermore, the reviewed studies examined the issue of computational thinking in education worldwide. The current study differs from previous studies in terms of aiming to provide a general scoping review of the published literature in Arab countries concerning computational thinking in all fields.

METHOD

Search and Analysis of the Literature

The selected sources for the search of research papers that addressed computational thinking in education in the Arab world include popular Arabic research databases, i.e., namely the Shamaa database, Almandumah, and Iraqi academic scientific journals. In addition, Google® scholar was searched for related papers. The main search phrases include "computational thinking", "computational thinking + names of the Arab countries", and "computational thinking + Arab world". Two forms of search phrases were used, one in Arabic and one in the English language. The inclusion criteria for the founded research papers include discussing a topic related to computational thinking in education, meeting the requirements of educational research standards, being published in peer-reviewed journals, being published in or after the year 2012, and being written in Arabic or English language.

The selected research papers were classified based on several criteria. The selected research studies were categorized based on the language into Arabic or English research. The selected research studies were categorized based on publication year from 2012 to 2022. The educational setting criteria involve two options that were K-12 and higher education. In addition, the selected research studies were categorized based on the educational disciplines. However, when the educational disciplines were not stated and the research studies were conducted either at the school or university level, general school education, and general university education were used as educational disciplines. The selected research studies were categorized based on the site of the research, the options for the site of the research include all the Arabic countries which are 22 countries. In addition, the selected research studies were categorized based on their primary purposes, research methods, sample type, and number, and adopted definitions of computational thinking. The following section provides a summary of the main results.

RESULTS AND DISCUSSION

Language of the Reviewed Articles

Based on the search and inclusion criteria, the number of selected research articles was 28. The great

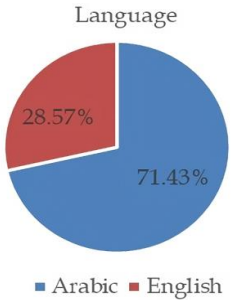

Figure 1. Classification of the reviewed articles by their language (Source: Author's own elaboration)

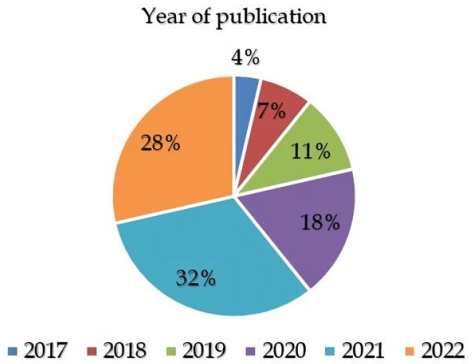

Figure 2. Classification of the reviewed articles by year of publication (Source: Author's own elaboration)

majority of these articles (71%, n = 20) were published in the Arabic language while only 8 (29%) articles were published in the English language. The distribution of the articles based on their language can be seen in **Figure 1**.

Publication Date of the Reviewed Articles

The classification of the reviewed articles by year of publication shows that the research that discusses computational thinking in education in the Arab world is still in its infancy stage. More than three-quarters of the articles (79%, n = 22) were published after the year 2020. The results indicate that studies dealing with computational thinking are increasing with time in the Arab world. The findings differ from the findings of previous studies that showed that the growing interest in computational thinking began a few years before 2020 (Taslibeyaz et al., 2020). The distribution status of the articles based on their year of publication can be seen in **Figure 2**.

The Educational Setting of the Reviewed Articles

The results showed that the great majority of the examined articles (75%, n = 21) investigated computational thinking-related topics in K-12 educational settings. These articles were conducted in kindergarten, elementary, secondary, and high schools. One-quarter of the examined articles (25%, n = 7) were examined at the higher education level. Out of the 21 studies that were conducted in K-12 educational settings, only one study was at the kindergarten level

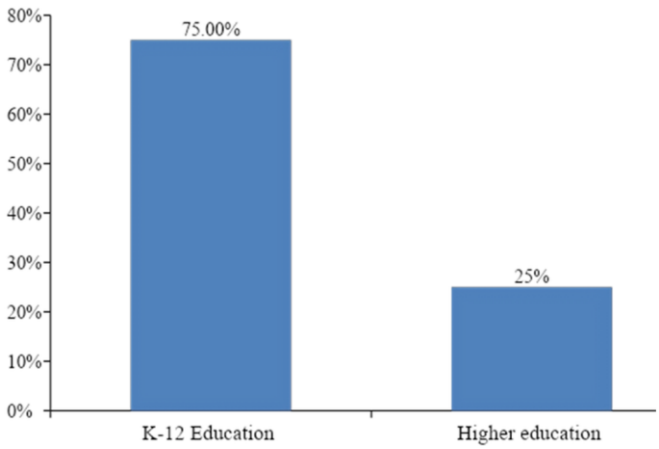

Figure 3. Classification of the reviewed articles by the educational setting (Source: Author's own elaboration)

(Elmonayer, 2019). In addition, only two studies were conducted at the elementary level (Akl & Siam, 2021; Owais & Wali, 2021). Some studies had participants from middle and high school levels. Out of the studies that were conducted in K-12 educational settings, thirteen studies were conducted at the middle school level. The findings aligned with the findings of some previous studies that showed that computational thinking studies were popular at the middle school level (Cutumisu et al., 2019). The findings did not align with the findings of some previous studies that showed K-elementary was the most popular level in the computational thinking studies (Hsu et al., 2018; Tang et al., 2020). The distribution of the articles based on educational settings can be seen in **Figure 3**.

Educational Disciplines of the Reviewed Articles

The distribution of the reviewed articles based on educational discipline showed that the majority of the reviewed articles (42.85%, n = 12) were conducted in programming and computer science disciplines. Some reviewed articles did not specify the fields of study at the K-12 level. For instance, one study examined computational thinking levels among school students in general (Al-Otti & Al-Saeedeh, 2022), another one aimed to develop a training program based on computational thinking skills to overcome the difficulties of employing technology among schoolteachers (Akl & Siam, 2021), and another one examined the dimensions of computational thinking in pre-university education stages (Faris, 2018). Two reviewed articles did not specify the fields of study at the university level. These two studies aimed to examine computational thinking levels among university students from different fields (Hammadi & Muhammad, 2020; Ibrahim. 2021). Two studies were conducted in the instructional technology field, the two studies aimed to enhance instructional technology students' level of computational thinking through the use of peer assessment in an e-learning environment (Ahmad et al., 2022) and the use of

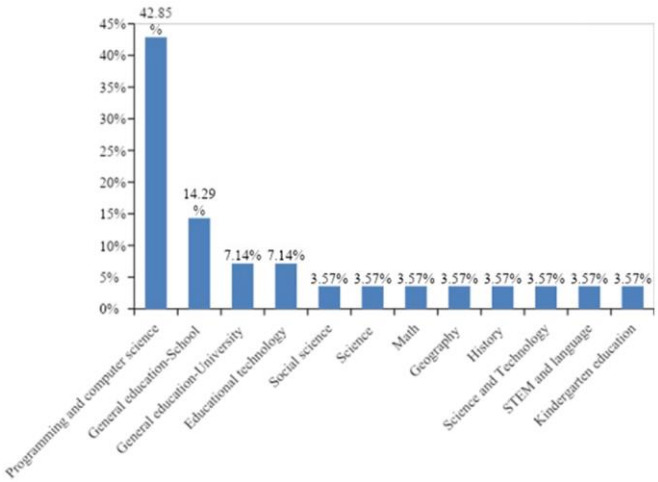

Figure 4. Classification of the reviewed articles by educational discipline (Source: Author's own elaboration)

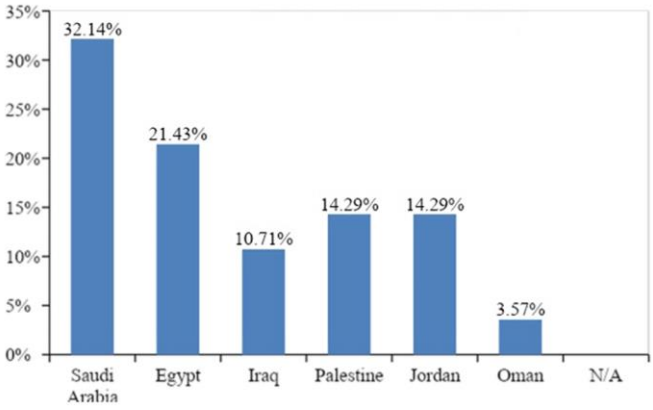

Figure 5. Classification of the reviewed articles by their site (Source: Author's own elaboration)

intelligent tutorial systems based on structured learning (Faris & Ismail, 2017). The number of research studies that examined computational thinking in other fields rather than programming and computer science fields was limited; only one study related to computational thinking was conducted in each of the following disciplines: basic education, education science, science, math, geography, history, science and technology, STEM and language, and kindergarten education. The popularity of computational thinking studies in programming and computer science fields aligns with the findings of previous studies (Hsu et al., 2018; Tang et al., 2020; Taslibeyaz et al., 2020). **Figure 4** shows the classification of the reviewed papers by educational discipline.

Site of the Reviewed Articles

The distribution of the reviewed articles based on the site in which the study took place in the Arab world showed that computational thinking research studies were conducted in 6 Arab countries out of the 22 countries. These countries were Saudi Arabia, Egypt, Iraq, Palestine, Jordan, and Oman. More than half of the reviewed articles (n = 15, 53.57%) were conducted in Saudi Arabia and Egypt. The findings aligned with the general research profiles of the Arab countries (Almisad et al., 2022). Reviewing the studies that were published in either Arabic or English language might contribute to the limited number of studies and the sites of the studies, as some Arab countries adopt other languages such as the French language for academic and research purposes. The results aligned with the results of previous studies that examined computational thinking research worldwide, these studies showed that most of the computational thinking research studies were conducted in a few countries (Cutumisu et al., 2019; Hsu et al., 2018). The distribution status of the articles based on their site can be seen in **Figure 5**.

The Primary Purpose of the Reviewed Articles

The results regarding the primary purpose of the reviewed articles showed the majority of the studies (n = 12, 42.85%) aimed to examine how to develop students' computational thinking levels using different interventions that include enrichment and immersive-based learning program (Abu-Zeid, 2021) different patterns of electronic course design such as holistic and sequential (Al-Zahrani & Yunus, 2020) program based on the principles of education for the future (Abdel-Fattah & Abdel-Hakim, 2021) proposed training programs based on the requirements of the fourth industrial revolution (Al-Frm & Al-Enezi, 2021) programming curriculum in the light of creative computing (Sorour et al., 2021) use of peer assessment in e-learning (Ahmad et al., 2022) use of internet-based coding game (Elmonayer, 2019) training program based on communication theory (Seitan & Al-Jarah, 2021) using Lego Mindstorms robotics programming (Alalawi & Said, 2020) use of STEAM approach (Al-Haj Bedar & Al-Shboul, 2020) use of WeDo 2.0 robot workshop (Khodabandelou & Alhoqani, 2022) use of intelligent tutorial systems based on structured learning (Faris & Ismail, 2017).

Besides the issue of developing students' computational thinking levels using different interventions, some studies (n = 5, 17.85%) aimed to measure students' level of computational thinking among school and university students (Alfayez & Lambert, 2019; Al-Otti & Al-Saeedeh, 2022; Hammadi & Muhammad, 2020; Ibrahim, 2021; Majeed et al., 2022). In addition, some studies (n = 5, 17.85%) aimed to measure the inclusion of computational thinking in the different curricula (Al-Mashrawi & Salman, 2020; Al-Obaikan et al., 2022; Al-Otaibi & Al-Iqab, 2021; Barshid & Mohammedi, 2022; Faris, 2018). A limited number of studies (n = 3, 10.85%) examined issues related to teaching computational thinking skills in terms of the training needs for teachers to teach computational thinking (Aljowaed & Alebaikan, 2018) the educational

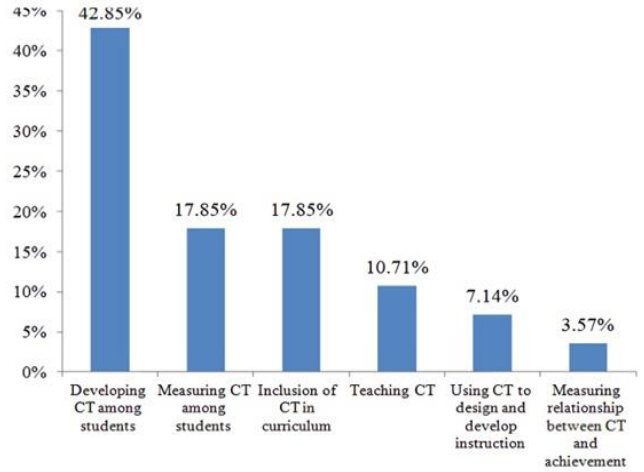

Figure 6. Classification of the reviewed articles by their primary purpose (Source: Author's own elaboration)

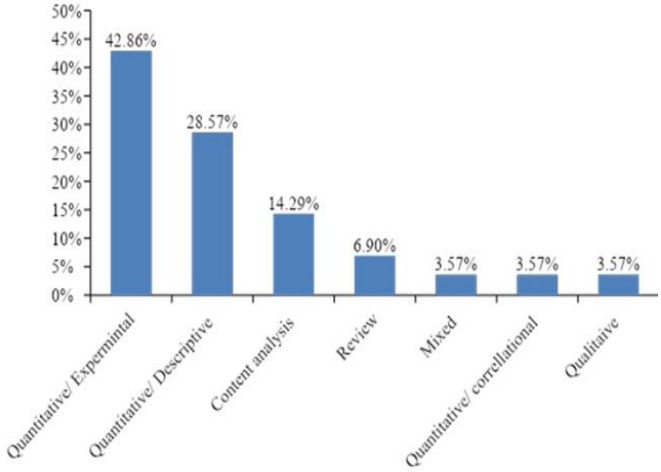

Figure 7. Classification of the reviewed articles by their research method (Source: Author's own elaboration)

requirements for teaching the computational thinking course (Owais & Wali, 2021) and developing teaching practice in computational thinking (Ghani et al., 2022). Only two studies (n = 2, 7.14%) aimed to examine the use of computational thinking to design and develop instruction related to technology (Akl & Siam, 2021) and history (Al-Karasneh, 2022). Only one study examined the impact of computational thinking on trends in international mathematics and science study (TIMSS) achievement (Alyahya & Alotaibi, 2019). The distribution status of the articles based on their primary purposes can be seen in **Figure 6**.

Research Methods and Data Collection Tools in the Reviewed Articles

The findings regarding the main research methods showed that the quantitative methods were the dominant research methods (n = 21, 75%). The majority of these research studies (n = 12, 42.85%) employed quasi and pre-experimental research designs. The second popular research design was the quantitative descriptive research design (n = 8, 28.57%). Only one study followed a quantitative correlation research design that aimed to examine the impact of computational thinking on (TIMSS) achievement (Alyahya & Alotaibi, 2019). The findings showed that a limited number of studies (n = 4, 14.29%) followed content analysis research methods. Only one study was based on literature reviews that aimed to examine the educational requirements for teaching the computational thinking course in the curricula of basic education in specific countries (Owais & Wali, 2021). In addition, one study employed a mixed research design that aimed to develop a model based on computational thinking skills to overcome the difficulties of employing technology among primary school teachers (Akl & Siam. 2021), and one study employed a qualitative research design that aimed to develop teaching practice in computational thinking (Ghani et al., 2022). The findings aligned with the findings of previous studies that showed that quasi-experimental design was the most popular design in the studies that examined computational thinking assessments (Cutumisu et al., 2019). **Figure 7** shows the classification of the reviewed articles by their research method.

The findings regarding the used data collection tools in the reviewed articles showed the test was the most commonly used data collection tool. Twelve studies (42.86%) used a test as a data collection tool. In addition, four studies (14.28%) of the studies used note cards. The finding aligned with the results that showed that quasi and pre-experimental research designs were the most commonly employed research designs. Quasi and pre-experimental research designs usually rely on tests, and/or note cards as data collection tools. The findings differ from the findings of some of the previous studies that showed that some other tools were used to measure students' computational thinking such as portfolios (Tang et al., 2020). The second most popular used tool was a questionnaire (n = 11, 39.29%). Some research studies used more than one data collection tool. In addition, four studies (14.28%) of the studies used content analysis cards. **Figure 8** shows the classification of the reviewed articles by their data collection tool.

Research Sample and Number of Participants in the Reviewed Articles

The great majority of the studies (n = 18, 64.28%) employed students as the research sample. However, the largest percentage of students was school students (n = 10, 35.71%) and then university students (n = 7, 25%), and there was only one study that employed preschool students. Few studies have recruited teachers at school and university levels, where there were three studies (10.71%) that had a research sample of schoolteachers and only one study had a research sample of university instructors. Four studies (14.29%) used curriculum as a research sample. One study collected data from experts

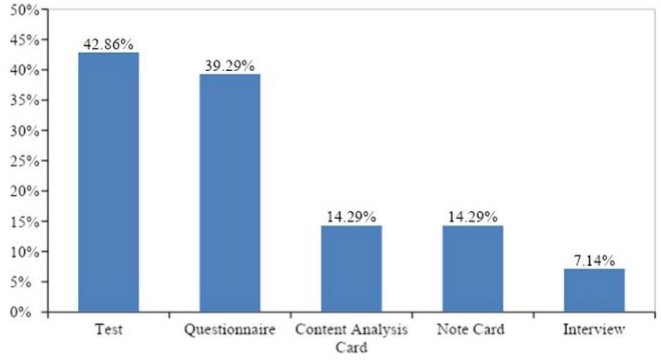

Figure 8. Classification of the reviewed articles by their data collection tool (Source: Author's own elaboration)

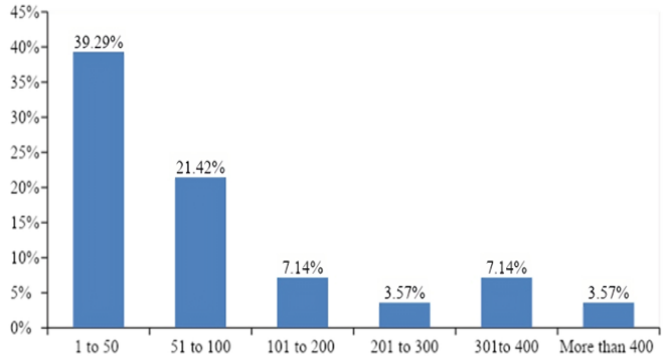

Figure 10. Classification of the reviewed articles by their number of participants (Source: Author's own elaboration)

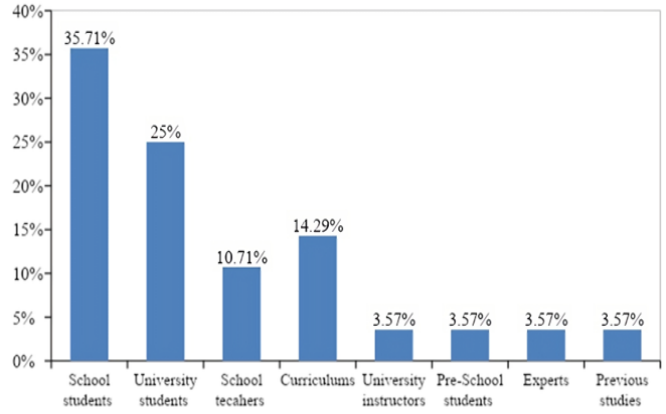

Figure 9. Classification of the reviewed articles by their sample (Source: Author's own elaboration)

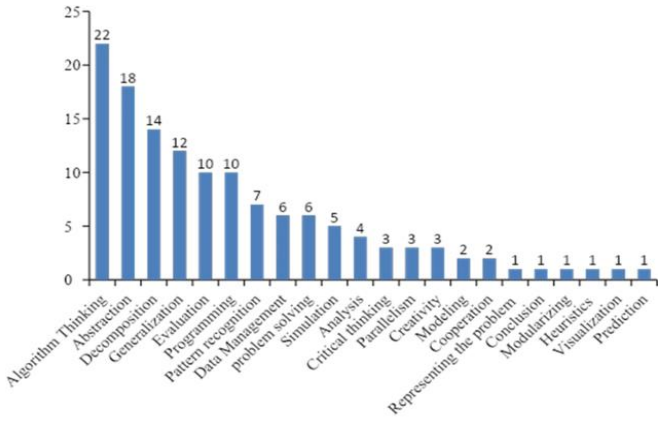

Figure 11. Components of the definition of computational thinking in the reviewed articles (Source: Author's own elaboration)

and one study collected data from previous studies. One of the examined studies was conducted in K-12 educational settings but the participants were university faculty members, where that study aimed to acquire university faculty members' proposed vision for the development of computational thinking among teachers of computer and information technology at the high school stage in the light of the requirements of the fourth industrial revolution. (Al-Frm & Al-Enezi, 2021).

The number of participants in most of the examined empirical studies was less than 100 participants. For instance, eleven studies (39.29%) had less than 50 participants and six studies (21.42%) had 51 to 100 participants. A limited number of studies (n = 3, 10.71%) had more than 300 participants. The findings differ from some previous studies that showed that experiential computational thinking studies employed a higher number of participants (Cutumisu et al., 2019). **Figure 9** and **Figure 10** show the classification of the reviewed articles by their sample and number of participants, respectively.

Components of the Definitions of Computational Thinking in the Reviewed Articles

The reviewed articles adopted various components of the definition of computational thinking; there were 22 different components of the definition of computational thinking in the reviewed articles. The most common components were related to individuals' ability to algorithm thinking, abstraction, decomposition, and generalization. On the other side, the least common components were related to individuals' ability to represent the problem, conclusion, modularizing, heuristics, visualization, and prediction. Four studies did not present the adopted components of the definition of computational thinking. The findings aligned with the previous studies that showed a variation in the adopted definitions of computational thinking literature (Lyon & Magana, 2020). **Figure 11** shows the components of the definition of computational thinking in the reviewed articles.

CONCLUSION AND RECOMMENDATIONS

The current study reviewed computational thinking research studies in the Arab world between 2012 and 2022 that were published in peer-reviewed journals. The results showed that most of the studies were published in the Arabic language. It was discovered that the quantity of computational thinking research studies has significantly increased after the year 2020, indicating the

significant relevance of computational thinking for reaching future educational objectives. It was revealed that most of the research studies were conducted in K-12 education. Most of the studies were conducted in programming and computer science, however previous studies indicated that computational thinking should be integrated into various subjects due to the importance of computational thinking as an everyday living skill for everyone (Wing, 2006). It was revealed that there was a geographical gap in computational thinking studies; the reviewed studies were published in a few Arab countries. That implies that the issue of computational thinking did not receive enough attention in several Arab educational settings.

It was revealed that the purposes of the majority of the examined studies focused on how to develop students' computational thinking levels using various interventions. The majority of the studies employed a limited number of participants and used different forms of experimental research designs. The findings suggest that the use of computational thinking in educational systems in the Arab world is still in the process of experimentation and growth. The disagreement among the definitions of computational thinking in the literature is reflected in the reviewed articles, there were various components of the definitions of computational thinking in the reviewed articles.

The findings suggest that there is a need to conduct more studies to examine the application of computational thinking in higher education fields. In addition, there is a need to expand the applications of computational thinking in more subjects and consider computational thinking as a distinct field. The geographical gap in computational thinking studies suggests the need to pay greater attention to computational thinking in several Arab countries by introducing computational thinking to their curricula and evaluating such integration. The limited topics of the reviewed studies suggest the need to examine the effect of more educational strategies on developing students' computational thinking. In addition, more studies are needed concerning measuring students' computational thinking and the ways of teaching computational thinking. The research methodologies suggest the need to examine the in-depth issue related to computational thinking by relying more on qualitative studies. Furthermore, there is a need to examine the applications of computational thinking with a larger group of participants to improve the generalizability of the findings of future studies. In addition, there is a need to conduct more studies to reach a standard definition of computational thinking in the educational field.

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