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Research article

Education

**EXPLORING THE INTEGRATION OF COMPUTER PROGRAMMING INTO
EARLY CHILDHOOD EDUCATION****探索计算机编程与幼儿教育的整合****Thabet Bin Saeed Al-Kahlan^{a,*}, Mohamad Ahmad Saleem Khasawneh^b, Yusra Jadallah Abed Khasawneh^c**^a Faculty of Education, Department of Curricula and Teaching Methods, King Khalid UniversityAbha, Saudi Arabia, talkhlan@kku.edu.sa^b Special Education Department, King Khalid UniversityAbha, Saudi Arabia, mkhasawneh@kku.edu.sa^c Faculty of Educational Sciences, Department of Educational Administration, Faculty of Educational Sciences, Ajloun National University, Jordan, yusra.khasawneh@anu.edu.jo, yusrajadallahabedkhasawneh@gmail.com*Received: August 18, 2023 ▪ Review: August 27, 2023**▪ Accepted: September 28, 2023 ▪ Published: October 30, 2023**This article is an open-access article distributed under the terms and conditions of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>)***Abstract**

This study examines the pedagogical approaches employed in teaching computer programming to children in Jordan and Saudi Arabia. The objective of this study is to gain a deeper understanding of the challenges that educators encounter, the resultant impact on students' levels of engagement and drive, and the role of parental participation in this context. The data were compiled through interviews with teachers and observations of classroom coding activities. The findings indicate that educators encounter challenges such as inadequate coding proficiency and self-efficacy and limited resources and antiquated technology. The incorporation of computer programming has been observed to enhance students' interest and enthusiasm, stimulate their inquisitiveness, and promote collaborative efforts. The effectiveness of integration is enhanced by the involvement and awareness of parents regarding their child's academic progress. The research emphasizes the necessity of providing opportunities for professional development, appropriate resources, and family involvement to effectively integrate computer programming into early childhood education.

Keywords: Computer Programming, Early Childhood Education, Student Engagement

摘要 本研究探讨了约旦和沙特阿拉伯儿童计算机编程教学中所采用的教学方法。本研究的目的是更深入地了解教育工作者遇到的挑战、对学生参与度和动力水平的最终影响，以及家长参与在此背景下的作用。这些数据是通过采访教师和对课堂编码活动的观察来收集的。研究结果表明，教育工作者面临诸如编码熟练程度和自我效能感不足、资源有限和技术陈旧等挑战。据观察，

计算机编程的结合可以提高学生的兴趣和热情，激发他们的好奇心，并促进协作努力。家长对孩子学业进步的参与和认识可以提高融合的有效性。该研究强调有必要提供专业发展机会、适当的资源和家庭参与，以有效地将计算机编程融入幼儿教育中。

关键词： 计算机编程、幼儿教育、学生参与

I. INTRODUCTION

In contemporary society, proficiency in computer programming is increasingly regarded as a crucial skill [1]. The ubiquitous impact of technology has led to a growing interest among educators worldwide in incorporating programming into their academic programs [2]. Early childhood education plays a crucial role in shaping the cognitive development of young children and equipping them with the necessary skills to navigate life's challenges, as emphasized by Korkmaz [1]. Consequently, it is imperative to examine the potential integration of computer programming within the context of early childhood education.

Several academic studies have demonstrated that instructing children in coding is a successful method for enhancing their problem-solving, logical reasoning, critical thinking, and creative skills [1], [2], [3]. Bers et al. [4] observed that instructing children in coding during their early years can facilitate the development of a robust foundation in computational thinking, which is an essential prerequisite for achieving success in the fields of science, technology, engineering, and mathematics (STEM). According to Barr et al. [3], when children engage in collaborative coding activities aimed at problem solving and bug fixing, they acquire significant social and cognitive competencies.

The extent of the incorporation of computer programming into early childhood education in Jordan and Saudi Arabia remains largely unexplored, although numerous countries have begun to integrate it into their educational programs, acknowledging its significance. Although significant progress has been made in the educational systems of these two Middle Eastern countries, there remains a need for further integration of computer programming into the curricula of elementary schools.

Multiple justifications exist for the significance of developing an understanding of the current state of coding education for young children in Jordan and Saudi Arabia. One advantage is that it enables the categorization of existing policies, programs, and methodologies of programming education. Additionally, it functions as a means of assessing the hindrances

that have impeded seamless integration. Third, it enables researchers and policymakers to examine the potential impacts and benefits of integrating computer programming

Numerous academic investigations have demonstrated favorable results for pupils who receive early exposure to computer programming. Bers et al. [4] demonstrated that instructing young children in programming and robotics resulted in enhanced problem-solving skills, logical reasoning, and creative thinking. The advantages of programming on the enhancement of children's mathematical abilities, including their spatial reasoning, numerical comprehension, and foresight, were underscored by Clements et al. [2].

The significance of imparting computational thinking skills to children for their future achievements in mathematics and science has been established by research [3], [5]. According to Brennan and Resnick [5], computational thinking facilitates the enhancement of analytical, creative, and problem-solving skills.

Although research on the topic of instructing young children in computer programming is more extensive in certain nations, the literature regarding this matter is still in its nascent stages in Jordan and Saudi Arabia. Nonetheless, scholarly investigations into computer science education in its entirety illuminate the challenges and opportunities presented by such environments. Al-Bataineh et al. [6] conducted a study that underscores the necessity of providing training and support to educators. This study examined the attitudes of primary school teachers in Saudi Arabia toward integrating computer programming into their instructional practices. Al-Sukkar and Althunibat [7] emphasized the importance of computer science education in Jordan's educational reforms in relation to teacher preparation and curriculum development.

This research contributes to the existing literature by examining the use of computer programming in preschools in Jordan and Saudi Arabia. The outcomes of this study will provide policymakers, educators, and other relevant stakeholders with an enhanced comprehension of the current status of coding education in academic settings, the challenges it encounters,

and the prospects it offers. Moreover, the outcomes of this investigation will provide insights for developing recommendations and strategies based on empirical evidence to enhance young children's access to computer programming.

A. Research Objective

This research contributes to existing knowledge by elucidating the use of computer programming in preschools in Jordan and Saudi Arabia. The findings of this study can provide valuable insights to policymakers, educators, and other stakeholders regarding the current state of coding education, the challenges it encounters, and the potential benefits it could offer. Moreover, this research aids in guiding the development of evidence-based approaches and recommendations for effectively introducing children to computer programming.

II. LITERATURE REVIEW

The increasing recognition of the advantages of introducing computer programming to young children by educators and governments worldwide has propelled the movement to incorporate computer programming into early childhood education. This section provides a comprehensive overview of the existing research conducted on the subject of instructing young children in computer programming with a particular focus on Jordan and Saudi Arabia.

Numerous studies have demonstrated favorable results for pupils who are introduced to computer programming during their formative years. Bers et al. [4] conducted a study that introduced robots and programming into early childhood schools, which resulted in an improvement in children's problem-solving abilities, logical thinking, and creative capacities. Clements et al. [2] reiterated the notion that programming has advantageous implications for the mathematical education of young children, specifically in terms of enhancing their spatial reasoning, numerical proficiency, and strategic cognition.

This research proposes that it is advisable to introduce children to computational thinking at an early age because it is a valuable skill. According to Smith [8], computational thinking refers to the ability to utilize computational principles in problem solving, system design, and understanding human behavior. According to Barr et al. [3], the acquisition of fundamental programming skills, such as logical reasoning, algorithmic analysis, and abstraction, is established through this process. According to

Brennan and Resnick's [5] research, instructing young children in computational thinking can enhance their critical thinking, creativity, and problem-solving skills.

Several studies have investigated the challenges associated with instructing young learners in computer programming. Nieveen et al. [9] identified several challenges that hinder the successful implementation of technology in education, including inadequate teacher training, insufficient access to appropriate technology, and concerns regarding the suitability of educational materials for different age groups. Alsmadi et al. [10] conducted a study in Saudi Arabia that revealed that early childhood classrooms encountered challenges stemming from inadequate funding, insufficient teacher training, and unfavorable cultural perceptions toward technology [11].

The policy frameworks of certain nations, such as the United Kingdom and Estonia, have exhibited notable progress in integrating computer programming into the curriculum of early childhood education. The framework known as "Computing in the Early Years" has been identified in the United Kingdom as an important tool for instructing young children in the principles of computational thinking and coding [12]. The approach employed in Estonia, as outlined by Kuuse et al. [13], places significant emphasis on the acquisition of coding skills through gamification and hands-on training. By using these frameworks, we can enhance our comprehension of effective methodologies for teaching computer programming to young children.

A scarcity of research exists regarding the pedagogy of computer programming instruction for young children in Jordan. However, scholarly investigations have been conducted regarding computer science curricula in secondary schools. Al-Sukkar and Althunibat [7] underscored the imperative need for enhancing teacher training and curriculum development in the domain of computer science education as a constituent of the ongoing educational reforms in Jordan. Al-Dmour and Al-Dmour's [14] study provides insight into the challenges and potential advantages of implementing technology in educational settings in Jordan.

Recognition of the significance of acquiring coding skills is increasingly evident in Saudi Arabia. The study by Al-Bataineh [15] sheds light on the attitudes of primary school teachers in Saudi Arabia toward the integration of computer programming into their curriculum. The findings underscore the importance of

equipping teachers with adequate resources and training to effectively incorporate programming into their instructional practices. According to the research conducted by Du et al. [16], instructing pupils in Saudi Arabia on programming has demonstrated a positive impact on their aptitude to solve problems.

III. METHODS

This study employed a mixed-methods approach to investigate the pedagogical methods employed in teaching computer programming to preschool-aged children in Jordan and Saudi Arabia. The methodology employed for data collection encompassed both quantitative and qualitative techniques. The research process involved distinct stages of data collection, processing, and interpretation.

The participants of the study comprised educators and principals from preschools located in Jordan and Saudi Arabia. This study employed purposive sampling to enlist a diverse group of individuals with varying backgrounds and levels of experience in coding integration. A sample of one hundred individuals was selected, with fifty participants hailing from each nation, on the basis of their level of interest in and dedication to preschool programs.

Numerical information was obtained by administering the surveys to the participants. The survey instrument was developed in consultation with specialists in the domains of coding and early childhood education. The study used closed-ended questions to gather information on individuals' perceptions regarding the benefits and limitations of incorporating computer programming into their daily routines. Participants were administered electronic surveys, and their responses were collected confidentially.

Qualitative data were obtained through semi-structured interviews conducted with a sample of participants. The conducted interviews facilitated a comprehensive investigation into the backgrounds, perspectives, and recommendations of the respondents regarding the integration of computer programming. After obtaining consent from the participants, audio recordings of the interviews were conducted to facilitate further examination.

Quantitative data analysis of the survey involved the use of descriptive statistics, specifically frequencies and percentages. The data were systematically arranged and exhibited to uncover shared characteristics, patterns, and hindrances in the adoption of computer programming within pre-school educational environments.

IV. RESULTS

Table 1 presents a comprehensive overview of the current state of coding education for young children across the globe.

Table 1.
Current state of computer programming integration in early childhood education

Country	Percentage of schools integrating computer programming	Percentage of teachers trained in computer programming
Jordan	42%	68%
Saudi Arabia	56%	45%
Total	49%	57%

The aforementioned figures provide insight into the number of classrooms that offer computer science education and the number of instructors who have received formal training in the field. Within the educational context of Jordan, a notable proportion of 68% of educators have undergone training in computer-related skills. Additionally, a significant percentage (42%) of schools have integrated computer programming into their curricula. Saudi Arabian schools exhibit a significant level of integration of computer programming (56%) and teacher training (45%). In both countries, computer programming is presently incorporated into the curriculum of 49% of classrooms, which can be attributed to the instruction provided by 57% of educators.

Table 2 presents a regional breakdown of the numerous challenges encountered in the implementation of computer programming education for preschool-aged children on a global scale.

Table 2.
Challenges faced in integrating computer programming in early childhood education

Country	Lack of resources (%)	Lack of teacher training (%)	Limited time in curriculum (%)
Jordan	24%	31%	16%
Saudi Arabia	18%	45%	22%
Total	21%	38%	19%

The data indicates the proportion of individuals who encountered specific challenges such as insufficient learning resources, instructors lacking the necessary qualifications, and limited instructional hours. The survey participants in Jordan identified three primary

factors that hindered the effectiveness of education. These factors included insufficient funding, which was cited by 24% of the respondents, inadequate teacher preparation, which was reported by 31% of the participants, and time constraints, which were mentioned by 16% of the respondents. The study revealed that a significant proportion of Saudi educators, specifically 18%, identified insufficient funding as a challenge. In addition, 45% of the participants reported inadequate teacher preparation as a concern, while 22% cited time constraints as a limiting factor. Overall, 21% of participants in both countries identified a dearth of resources, 38% identified inadequate teacher training, and 19% identified time limitations as problematic factors.

Table 3.
Perceived benefits of computer programming integration in early childhood education

Country	Enhanced problem-solving (%)	Improved critical thinking (%)	Fostered creativity (%)
Jordan	65%	78%	52%
Saudi Arabia	73%	61%	68%
Total	69%	70%	60%

Table 3 illustrates the expected benefits of integrating computer programming into early childhood education across various countries. The presented data indicates the percentage of individuals who prioritize benefits such as problem-solving instruction, critical-thinking enhancement, and creative-thinking stimulation. According to the survey results, most Jordanians reported an improvement in their problem-solving abilities, critical thinking skills, and creativity, with 64%, 78%, and 52% of respondents indicating such enhancements, respectively. According to a survey conducted in Saudi Arabia, 73% of respondents reported an improvement in their problem-solving skills, 61% claimed to have enhanced their critical thinking abilities, and 68% reported an increase in their creative thinking skills. Overall, most participants in both countries, specifically 70%, reported an augmentation in critical thinking skills, whereas 60% reported an enhancement in creative thinking abilities.

A. Lack of Teacher Confidence and Knowledge

"The advantages of computer programming for kids are clear, but I'm not confident in my own ability to teach it. I'm nervous that I won't

be able to adequately convey the ideas to my pupils."

This illustrates the instructors' perceived deficiency in self-confidence and their apprehensions regarding their aptitude to instruct coding to pupils at the primary education level. It is evident that educators require additional training and support to attain a level of comfort in using programming as a pedagogical tool within the classroom setting. To effectively integrate computer programming into early childhood education, it is imperative to address the issue of inadequate confidence and comprehension.

B. Limited Access to Resources and Infrastructure

The challenges associated with acquiring resources and establishing a suitable infrastructure to facilitate the integration of computer programming are encapsulated in this topic, as deliberated upon by the participants. resources and suitable infrastructure to support computer programming integration.

"Our school only has a handful of antiquated computers, and that number is sometimes insufficient to meet the needs of the pupils. When there aren't enough computers or internet, it's hard to engage in coding activities."

The aforementioned quotation underscores the challenge of incorporating coding exercises within an educational setting because of the limited accessibility of resources such as computing devices and internet connectivity. This underscores the necessity of allocating resources toward establishing adequate infrastructure and educational materials to facilitate the seamless integration of computer programming into early childhood education. Insufficient access to resources may impede educators' ability to provide children with significant and practical coding opportunities.

C. Need for Professional Development and Training

This statement underscores the significance of participants' desire to enhance their programming proficiency through professional development and training.

"To successfully incorporate computer programming, I feel that adequate training and assistance are required. We might better prepare to instruct our kids in coding if we attend seminars or received specialized training."

The aforementioned quotation underscores the imperative of affording educators opportunities for professional growth and instruction in computer programming thereby enabling them to

seamlessly integrate it into their instructional practices. The aforementioned statement indicates that the provision of funding programs aimed at educating teachers and offering ongoing support could surmount the challenges associated with the implementation of coding education for young children.

D. Curriculum Constraints and Time Limitations

The present subject matter encompasses the observations of the respondents regarding the constraints inherent in the extant curriculum and the insufficient duration allocated for the integration of computer programming activities.

"Finding time for coding tasks is difficult because of our dense curriculum and limited time. There must be greater leeway in the curriculum and more time set up specifically for teaching coding."

The aforementioned quotation highlights the challenges posed by the contemporary curriculum and the scarcity of time, emphasizing the necessity for flexibility and dedicated time allocation for coding instruction. This statement underscores the necessity of reassessing and modifying the educational program to accommodate coding exercises. This aligns with the imperative to recognize the significance of instructing young children in computer programming and integrating it into their academic syllabus.

E. Engaged and Motivated Learners

The incorporation of computer programming activities into pre-school settings has been found to enhance students' interest and motivation, as concluded by the experiences of the participants.

"When we started doing coding in class, I saw a big jump in student interest and enthusiasm. When faced with a coding difficulty, they become energized, intrigued, and start working together with their classmates to find solutions."

The aforementioned quotation serves to demonstrate how computer programming instruction has the potential to enhance students' levels of engagement, inquisitiveness, and aptitude for collaborative work. The heightened engagement of students in class and their improved social interactions with peers can be inferred from their eagerness and curiosity toward coding activities. The presented data indicate that the introduction of coding to young learners could enhance student engagement and foster a more positive classroom environment.

F. Parental Support and Awareness

The topic of parental involvement and comprehension of computer programming in pre-school education was extensively deliberated by the participants.

"Student achievement and interest in coding both gain greatly from parents' being well-informed about the subject and providing active assistance at home."

The aforementioned quotation underscores the importance of parental support and expertise in fostering academic achievement and engendering enthusiasm among students in the field of computer science. The text underscores the advantages of parental engagement in their offspring's acquisition of coding proficiency. This suggests that the involvement of parents and the provision of coding education could exert a significant influence on students' academic performance and promote a favorable atmosphere for learning both within and beyond the confines of the school setting.

V. DISCUSSION

A. Challenges Faced by Teachers in Integrating Computer Programming

Educators encounter multiple challenges when introducing computer programming to young children. According to Smith [8], a significant obstacle to success in the field of coding is teachers' insufficient coding proficiency. A prevalent concern among educators is their perceived inadequacy in instructing students on coding due to limited exposure to fundamental programming concepts. The aforementioned deduction aligns with the research conducted by Johnson [17], which implies that educators require additional opportunities for professional growth and instruction to confidently integrate coding into their teaching practices. Continuous support, training initiatives, and workshops can enhance the coding proficiency, pedagogical strategies, and self-assurance of educators.

Brown [18] identified a significant challenge in the form of inadequate resources and infrastructure. The insufficiency of resources, such as computers, software, and internet access, posed a challenge in executing coding activities among the participants' educational institutions. Prior studies have indicated that providing adequate technical resources to schools poses a considerable challenge [19], [20]. The acquisition of coding skills and the enhancement of computational thinking among students are contingent on the availability of computers, suitable software, and reliable internet connectivity. To surmount this impediment and

obtain the requisite resources for successful integration, collaboration with educational authorities and policymakers is imperative [20].

B. Impact on Student Engagement and Motivation

The incorporation of computer programming into early childhood education has a positive impact on the degree of involvement and enthusiasm demonstrated by young learners in the academic setting. The inclusion of coding exercises in the curriculum resulted in a significant increase in student engagement, as reported by one of the participants [21], [22]. The students exhibited a heightened level of enthusiasm and inquisitiveness as they engaged in collaborative problem-solving activities related to coding. This deduction aligns with previous research that underscores the captivating quality of coding exercises and their potential to enhance student motivation and foster a positive learning atmosphere [20].

The interactive and hands-on nature of coding exercises has been found to enhance students' engagement and motivation. The students are capable of engaging in activities and conducting explorations of their environment. Brown [20] asserts that coding activities afford students the opportunity to apply their problem-solving aptitude, critical thinking skills, and collaborative working abilities. The process of coding involves iterative problem-solving, where learners are motivated to engage in exploration, make errors, and derive insights from those experiences. As per Davis' [19] findings, this particular approach fosters a mindset of growth in children and aids in the cultivation of their resilience and perseverance. The involvement of students in coding activities can enhance their level of engagement in the learning process, thereby fostering a sense of ownership and autonomy in their education. This, in turn, can stimulate their motivation and enthusiasm toward education in general.

C. Parental Support and Awareness

The efficacy of early childhood education programs that incorporate computer programming is significantly reliant on parental support and familiarity with the subject matter. The study participants emphasized the advantageous outcomes of parental involvement in facilitating their children's coding education within the household [22]. The involvement of parents in their children's coding education and their awareness of the benefits of coding have been found to significantly enhance student

performance and foster enthusiasm toward coding. This conclusion aligns with previous research that underscores the importance of establishing a cooperative partnership between the school and the family [8].

Parental involvement in code-related activities at home, such as engaging in coding apps or games with their children, fostering open-ended inquiry, and initiating discussions about the practical implications of coding, can significantly contribute to the coding education of their offspring. Children derive advantages not only from the reinforcement of their learning but also from receiving aid in establishing connections between coding and other domains of their existence. Furthermore, educational institutions and instructors can promote parental education and involvement through various means such as communication channels, seminars on communication, and informational sessions [16]. These programs aim to facilitate parental understanding of the importance of coding education and equip them with the necessary knowledge and resources to assist their children in their pursuit of coding proficiency.

In summary, the integration of computer programming into early childhood education presents challenges that are linked to the self-assurance and proficiency of educators, as well as the limited availability of resources and technology. The findings highlight the positive impact on student engagement and motivation, particularly when coupled with parental support and expertise. By tackling the challenges encountered by young learners and leveraging the benefits associated with engaging in coding pursuits, it is feasible to establish a stimulating and fulfilling educational setting. Collaboration among schools, educators, parents, and policymakers is imperative to facilitate the successful integration of computer programming into early childhood education. This requires significant investment in adequate support, training, resources, and parental involvement.

VI. CONCLUSION

The aim of this study was to examine the potential integration of computer programming within preschool curricula in Jordan and Saudi Arabia. The analysis of data collected from interviews conducted with educators and observations made during coding exercises led to the identification of several significant findings. One of the challenges faced by teachers was their limited access to resources and infrastructure, coupled with insufficient coding knowledge and self-confidence. To facilitate the integration of

coding activities into classroom instruction, it is imperative to provide educators with professional development opportunities, training programs, and adequate technological resources.

The incorporation of programming has demonstrated a propensity to enhance students' curiosity and eagerness toward education. The involvement of students in coding exercises was positively associated with increased levels of enthusiasm, interest, and teamwork. The interactive and hands-on nature of coding facilitated the acquisition of problem-solving, critical thinking, and teamwork skills among students. Based on these findings, coding exercises possess the capacity to enhance students' interest and motivation, thereby establishing a more favorable classroom environment.

The significance of parental engagement and awareness in the implementation of computer programming in preschool settings was emphasized. The academic literature indicates that parental involvement and awareness of the significance of coding are positively correlated with enhanced academic achievement and motivation among students. The active involvement and endorsement of parents, facilitated through workshops, informative sessions, and accessible channels of communication, can yield favorable outcomes with regard to students' inclination toward and eagerness to code.

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