Abdullah Alenezi
PhD in Educational Research, Associate Professor
Northern Border University, Arar, Saudi Arabia
ORCID ID 0000-0003-0233-6838
Abdullah.AlAsmar@nbu.edu.sa

TEACHING COMPUTATIONAL THINKING IN SAUDI ARABIAN SCHOOLS USING SMARTPHONE APPS

Abstract. This study investigates the efficacy of smartphone applications in teaching computational thinking to students in Saudi Arabian primary and secondary schools. Computational thinking, encompassing problem-solving, computational logic, and algorithmic thinking, is an essential skill in the modern world. The research assesses various educational apps that support the development of computational thinking and examines their integration into the Saudi curriculum.

This study incorporates qualitative and quantitative research techniques to provide an inclusive perspective. Participants included primary and secondary school students from various schools in Saudi Arabia. The research employed pre- and post-tests for quantitative analysis and interviews and questionnaires for qualitative data. Quantitative results include pre- and post-tests of the students in computational thinking with the aid of co-varying with Computational thinking, while interviews and questionnaires with teachers and students offer qualitative data. Best-selling educational applications for ScratchJr, Lightbot, Cargo-Bot, and Kodable are compared concerning how efficiently they introduce programming ideas and encourage rational thinking.

Results have suggested that smartphone applications have a positive influence on students' computational skills. An enhanced standard is also noticed regarding the students' aspects that involve problem analysis, identification of pattern, and formation of algorithm. The use of applications such as ScratchJr and Lightbot is justified regarding an application's capacity to improve students' motivation and willingness to learn computational concepts. Teachers indicate that their students have shown more concern and engagement mainly when the teacher integrates these apps.

Hence, based on the findings of the study, it is evident that incorporating Smartphone applications into the curriculum will lead to a reforming change in the teaching approaches towards efficiency as well as feasibility of the learners. These findings are valuable for the Saudi context for policy and teaching enhancement, signaling the need to provide more resources in digital tools and invest in the professional development of teachers to capture the virtues of advanced technology in improving learners' performance.

Keywords: computational thinking; smartphone applications; education technology.

1. INTRODUCTION

The problem statement. The enhancement of Computational thinking in school curricula enhances efficient learners' thinking processes as they prepare to face the future. Computational thinking comprises problem solving, rational thinking, pattern recognition and algorithmically thinking, which is crucial in the era of rapid development of technologies. However, Saudi Arabian schools face significant challenges in effectively integrating and teaching computational thinking due to several factors:

1. Limited resources: Schools like many education institutions were seen to lack the right technology requirement and devices that foster the process of teaching computational thinking [1].
2. Inadequate teacher preparation: Currently, it is simple to discover teachers who have never been taught on computational thinking principles and effective ways of dealing with them. [2].

3. Reliance on traditional teaching methods: Currently, the Saudi Arabia education system is categorized by memories technique in which little or no attention is paid on the development of computational thinking skills.

It is vital to emphasize that the inclusion of computational thinking in the educational process will not restrict the activities to educate students how to utilize computers. It instead refers to the process of a creating certain strategy of problem solving that might be used in a wide range of fields.

Given this fact, this issue is highly pertinent to high-light in relation to Saudi Arabia's Vision 2030 – a plan that focuses on the need to diversify the kingdom's avenues of income with the aim of breaking the breakthrough of oil through the development of different sectors of public service, such as education [4].The Vision 2030 is anchored on transformation of the country into a new economy known as knowledge-based economy and such an economy means students should learn computational thinking.

The previous system of teaching in Saudi Arabia, particularly in pre-service and in-service education, primarily focused on the rote learning of facts. The notions of present-day learning environment indicate that such strategy is no longer adequate to provide learners with necessary skills for present day living. This is where the thinking type such as the computational concept that emphasizes the achievements of logical determinations can be embraced.

However, to successfully implement and infuse Computational thinking in the curriculum, there is a need to embrace new methods of teaching as well as tools that would make learning very engaging to the students. This could involve using such elements like smartphone applications as part tools during the lectures or activities, to give the students firsthand experience in computational thinking [6].

Analysis of recent studies and publications. The latest studies have shown how incredibly helpful smartphone applications are when it comes to developing students' computational thinking dispositions. According to some research, the correct Information Technology (IT) applications can draw students' attention and communicate information more effectively [7]. The graphical interactive features of these applications facilitate students' understanding of computationally intensive concepts more effectively than the conventional method of lecturing and writing on the blackboard.

For instance, Benton et al. [8] pointed out that interactive programming environments improved both students' basic picture of the concepts of computational thinking at the elementary school level. In the same vein, Angeli and Valanides [9] also gave the essence of educational games proving how young children learn computational thinking skills in a thematic environment of a game. It is evident from these studies that there is much promise in employing digital affordances, primarily students' smartphones, in teaching Computational thinking.

However, it is worth admitting that the research has been conducted with a focus on educational environments of Western countries that, in many ways, will differ from the Saudi environment. As evidenced before, the clients in Saudi Arabia have a significant cultural and religious propensity in education, and there is a preference for traditional constructivism [10]. Moreover, Saudi schools are found deficient in resources as well as willing to adopt prudent technologies in the classroom.

Based on these conditions, one can note the absence of adequate research on how exactly these tools are employed and to what extent in Saudi Arabia. This research, therefore, seeks to explore the effects of smartphone apps in improving computational thinking amongst primary and secondary learners in Saudi Arabia.

The research goal.

Specifically, and due to the importance of the subject, the main goals of this study are as follows: To investigate the effects of Smartphone applications in transporting and teaching

computational thinking to students in Primary and secondary schools in Saudi Arabia. More specifically, the research seeks to:

1. Discuss how these tools can be incorporated into the learning process to optimally benefit the students.
2. Explain the challenges that teachers and learners undergo when using these technologies.
3. Specify the general efficacy of smartphone computational thinking learning applications in improving the learners' performance in computational thinking.

Hence, by scrutinizing these aspects, the study endeavors to present a requisite understanding to improve educational policies and processes in Saudi Arabia. It is believed that this study will contribute to the expansion of existing literature on integration of technology in learning environments in various contexts as well as influence development of new strategies and approaches to teaching and learning that can be implemented in the local as well as in the international community.

2. THE THEORETICAL BACKGROUNDS

2.1 Concepts and Approaches

Computational thinking is a set of skills and their property that connects problems with the use of computers, and includes other facets, such as abstracting the data, logically and structuring the data, representing the data through models and simulations, automating the solutions through algorithms and generalizing the computational thinking paradigm for different problems.

Jeanette Wing is credited for coining the term, computational thinking and she defined it as the key capability that is relevant to all individuals regardless of whether they are computing professionals or computation consumers. Computational thinking entails decomposition and logical solution of problems, pattern identification and use of general patterns in problem solving, and development of algorithms. These skills are useful in any area, but not limited to computer science alone and hence useful to all students in this world of technology.

While studies from Western educational contexts have been widely discussed, they may not directly translate to Saudi Arabia's unique cultural and educational environment. Saudi Arabia's traditional teaching methods, which rely heavily on rote learning, differ significantly from the more hands-on, exploratory approaches used in Western schools. Further, the religious and cultural values in Saudi Arabia influence the integration of technology in classrooms. These differences underscore the need for localized research on the impact of smartphone applications in teaching computational thinking.

Computational thinking on the other hand refers to seeing computation as a tool as well as thinking using computation, that is thus taught to students systematically through subjects like mathematics, sciences and computer sciences. However, it also poses a challenge whereby there should be change in teaching pedagogies and curriculum to include problem solving and critical thinking in everyday teaching. And this is where the use of technology, especially smartphone applications, comes as a unique solution that offers the much-needed way to teach computational thinking in an engaging manner.

2.2 Importance of Early Education in Computational Skills

Computational thinking as an element of early childhood education is critical since it underpins higher-order problem-solving and technological literacy. Research has suggested that integrating computation thinking among students from a tender age assists the students in the

development of analytical skills while enhancing their competency in future courses and career paths within technology-focused societies. Introducing computational thinking in early school also enables the students to embrace technology and nurturing a positive attitude towards solving computational problems hence determining their field of study. Also, it enhances the student creativity and innovation since he/she can solve a complex problem with the right attitude.

Regarding Saudi Arabia, embracing computational thinking at the early stages can greatly contribute towards the success of Vision 2030. When the students are empowered by preparing them for the future needs, then Saudi Arabia will be better placed to fashion a more diversified and a knowledge-based economy. Additionally, learning about computational thinking at a young age can go a long way in closing the gap between those who have access to technology and those who are in possession of the same but are in the wrong part of town to take advantage of same. This can in the long run help in the development of the country and help to compete well in the international market.

2.3 Role of Technology in Modern Education

Technology has a significant part in education, especially with the current trends because it offers unique strategies and tools needed to engage students as well as bring improvements in learning processes. Among the most influential technological tools, it is also worth mentioning the use of mobility that has changed the educational process due to providing opportunities for interactive, accessible, and individualized learning experience. Smartphones also offer ways to apply computational thinking; normally it is via educational applications designed for students so they can practice with their pencil and tablet at their own pace. These can comprise of such features as life-like simulations, games and educational puzzles that enable the understanding of complicated motifs.

The use of applications in smartphones can engage the users more directly in the learning process compared to traditional methods. For example, applications can offer fun game-like learning activities such as simulations, games, and puzzles that teach students about the toughest material. Further, the use of applications on smartphones can be more engaging and can also design teaching programs that are appropriate to the needs of each learner as well as the pace of the learning. This can prove to be highly advantageous especially in multicultural learning environment because the students are likely to be of different comprehension levels and skills. Furthermore, the use of such applications comprises response options and rating instruments as well as frequently enabling the assessment of a student's progress, which can be useful for a teacher.

The awareness of smartphone use, and internet usage of Saudi Arabian citizens offer a great chance to utilize technology for educational purposes. Thus, the use of smartphone applications in Saudi Arabian schools can give students the tools they need for the future while making the process of learning more entertaining and creative. It will assist in closing learning deficiencies, addressing the differentiated learning needs; and training learners for the technology-demanding world; all in support of Vision 2030 goals.

3. RESEARCH METHODS

3.1 Methodology

This study uses both the quantitative surveys and the qualitative self-generated questionnaires to gauge the level of impact of Smartphone applications in teaching computational thinking. The quantitative part entails the use of tests to determine the students'

computational thinking abilities while the qualitative aspect includes interviews with the teachers and the students as well as questionnaires they must fill out.

The use of both qualitative and quantitative research can therefore be noted to provide a thorough assessment on how favorable Smartphone applications are in fostering computational thinking. The quantitative evaluations reveal students' gains in computational thinking abilities in an empirical manner, and the qualitative feedback allows viewing teachers' and students' observations and personal reflections on such practices.

3.2 Participants

The participants in this study include primary and secondary school students in different schools in Saudi Arabia. The sample covers a variety of learners from different employment brackets as a way of affirming the validity of the results. For the sampling process, schools were identified and chosen based on the researchers' convenience and the schools' interest in the study. Finally, the criteria for selection of participants involved the schools' ability to procure the technological equipment they required for the study, with the test Smartphone applications that were in use being utilized by all the participants.

3.3 Tools and Materials

A selection of popular educational apps designed for teaching computational thinking will be used. These apps include:

1.ScratchJr: A basic programming language suitable for use in childhood since it allows children to build simplest forms of computer games and cartoons. For example, ScratchJr is coded in a manner to correspond to kids aged 5-7 years only. For them, it teaches concepts of programming and computational thinking and is compatible with an intuitive, block-based format. For children, programming can use graphical programming blocks where they are able to put together simple programmes that can make characters move, jump, sing and dance among other actions to promote children's creativity in addition to their thinking skills which are able to be tested by several logical puzzles.

2.Lightbot: It is a simple game that enables children to learn programming concepts, and majorly focuses on the logic of programming. Lightbot is a children's game of logic and will be effective when applied by children four years and above, and the child will learn programming ideas like sequences, loops, and conditions. By actively controlling a robot to solve problems and "switch on the lights" of tiles, kids may develop their thinking and programming abilities in a logical but motion-oriented method.

3.Cargo-Bot: One application that could be used for this idea is an app that presents students with several programming problems and puzzles as a way of teaching programming concepts. Cargo-Bot is suitable for children of 8+ years as well as it seems to greatly contribute to the further proper development of problem-solving abilities and logical thinking. One of the assignments in the app involves the use of sequences to maneuver a robotic arm in a process of sorting crates—the assignment makes students use their reason to come up with the appropriate steps in performing the task.

4.Kodable: An app that provides gaming education to teach children the basics of coding through fun lessons and tasks. Kodable is targeted at kids who are 4 years old and above, and it has various programming concepts including sequencing and functions, as well as loops, conditional statements and functions, and variables. To make the teaching-learning process more orderly and systematic, the app presents a sequence of tutorials that might scaffold each other for the ultimate benefit of the students.

Such apps were chosen by their frequency of downloads, simplicity, and general applicability when it comes to helping to learn Computational thinking. They offer several

animated and games-based real-time learning interfaces perfect for helping students grasp certain complex computational concepts. This selection helps in ensuring that the study would be able to accommodate different age groups of learners and provides better learning.

4. THE RESULTS AND DISCUSSION

4.1 Analysis of Scientific Results

The quantitative part includes assessments that compare students' results before and after the activities implemented during the lesson with the goal of evaluating the use of computational thinking skills. The qualitative analysis includes the process of coding interviews and survey data for understanding prominent themes and patterns.

4. 1. 1 Quantitative Results

The assessments made prior to the start of the lessons were meant to get an initial idea of the students' exposure to the notion of computational thinking. The scores post the internet applications for a semester run for the students were significantly higher. Regarding growth, the average increase was 35%, which confirmed that the educational apps enhanced the students' computational thinking positively.

From the quantitative scores, the study revealed improvement in the students' grasp of the foundational computational thinking concepts. For instance, through the class, students were able to decompose real life complex issues and ideas into pushover forms, see patterns and even create plans to solve them. The increase in scores was obtained regardless of the students' age and socio-economic status, which proves that the students benefited from the educational applications.

4. 1. 2 Qualitative Results

The subjective data received from teachers and students enabled the identification of the opportunities and the issues teaching students the use of smartphone applications. Several teachers noted that students' attention during usage of the apps was higher in comparison with the attention received by traditional lessons. Specifically, the following confirmed by respondents; It is noteworthy that students mentioned that the use of the mentioned apps provided interesting and effective means for learning computation concepts.

Indeed, the elaboration of the data generated qualitative results that emphasized some important categories. First, teachers and students stated that applications created for them were entertaining and therefore learning became more recreational and less tense. Second, the apps allowed for participation of students with hands-on activities and the real-life exposure that aided the child's learning in comprehending concepts that would otherwise have posed quite a challenge. Third, the apps are versatile in that they assist the student to study depending on his or her capacity and level of understanding. Last but not the least, the teachers and students especially valued the real time feedback that the apps offered so that the students themselves can self-assess and correct the mistakes.

4.2 Case Studies

Detailed case studies from selected schools illustrate the successful implementation and challenges faced when integrating smartphone applications into the curriculum.

4.2.1 Case Study 1: Prince Abdulaziz bin Musaed Primary School

In Prince Abdulaziz bin Musaed Primary School, students were engaged in using ScratchJr in which they designed interactive stories and game. There were many obvious benefits that the teachers noted among the students they taught; increased problem-solving ability and creativity noted by the teachers. This made it easier for the students to understand several computational elements that were previously challenging using an app that has an easy-to-use icon K and several fun activities illustrated in the figure below.

A survey among the teachers at Prince Abdulaziz bin Musaed Primary School revealed that students were enthusiastic in engaging the ScratchJr app. The students like using their imagination and coming up with new stories and games, yet in the meantime they are mastering the principles of programming. The app also fostered teamwork since the students cannot make or upload the projects individually, they must collaborate. The case of integrating smartphone applications in Prince Abdulaziz bin Musaed Primary School showed that these applications have the potential of improving the computational thinking skills of students, creativity, and collaboration skills inter alia.

4.2.2 Case Study 2: Ibn Taymiyyah Secondary School

Lightbot application was adopted by the Ibn Taymiyyah Secondary School as part of computer science lessons taught to learners. Children fond of and engaged in solving puzzles and found the element of programming logic in the game entertaining. Teachers noted that the students were more willing to learn and actively involved during learning activities hence improved performance.

In a study carried out at Ibn Taymiyyah Secondary School, the utilization of Lightbot app enabled the students develop sequences, loops, and conditional lessons. From the teachers' and students' perspective, the pupils stated that the puzzles were engaging yet difficult and loved the immediate responses that the application offered. The teachers also added that they have observed the students' enhanced problem-solving abilities and logical reasoning abilities as observed from the better grades. In the case of learning facilities such as that of Ibn Taymiyyah Secondary School it was ascertained that the utilization of smartphone applications in learning assists in making learning enjoyable and several challenges improved the computational thinking aspect of students.

4.3 Challenges and Recommendations

However, several challenges were identified during the study. Many teachers expressed the need for adequate training on how to effectively use smartphone applications in teaching. A significant obstacle was the lack of access to sufficient IT equipment, and some students exhibited varying degrees of discomfort or unfamiliarity with the technology, referred to as technophobia.

The most pressing concern reported by teachers was the insufficient training provided on the use of these applications. Many were either unaware of the available apps or unsure of how to integrate them effectively into their teaching practices. To address this issue, it is recommended that comprehensive resources and structured training programs be developed. These should guide teachers on the use of educational apps and offer strategies for seamlessly incorporating them into their lessons.

The other difficulty was mainly the lack of technology, especially in schools that are situated in the rural or hard-to-reach areas. Some students could not have smartphones or a stable internet connection, which affected their ability to use the given apps. To address this challenge, the schools need to find, or devise means of availing the equipment to the students such as through ownership of school equipment or collaboration with equipment firms.

Finally, one more issue was the difference in the digital competencies of the students. The technology used in lessons favored some students than others since levels of comfort in

applying the technology varied. To this effect, it is an essential strategy that many teachers should offer support and more software on how to access the apps in the cleanup process and enhance the students' technological literacy.

5. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

Summary of Findings

The study concludes that smartphone applications significantly enhance computational thinking skills among students in Saudi Arabian primary and secondary schools. The interactive nature of these apps engages students and makes learning computational concepts fun and accessible. The quantitative results showed significant improvements in students' computational thinking skills, while the qualitative feedback provided insights into the experiences and perceptions of teachers and students.

This study suggests that smartphone applications have the potential to improve the way computational thinking is taught in Saudi Arabian schools. These programs can help kids develop the abilities they need for the future while also making studying more enjoyable. However, the anticipated applications of these apps as part of teaching and learning also require for professional development of instructors, availability of the requisite technology, and assistance for students with various levels of ICT literacy.

Future Research

Further studies should focus on establishing the effects of employing smartphone applications in teaching after a period and finding methods of mitigating the issues pointed out in this research. It is also recommended that studies should be conducted to design meaningful educational applications to be used by Saudi Arabian students.

Further research in longitudinal designs is required to evaluate the longitudinal consequences of using smartphone applications in teaching CT. These studies should follow the students for several years to see if the enhancements in the facets of computational thinking are long-lasting and whether the enhancements breed improved academic and career success.

The study should also highlight methods of surmounting some of the barriers spotted in this research by offering special attention to how sufficient training and practice to educators, equal access to devices, and equivalent levels civil media proficiency could be provided. Further, researchers need to work on educational applications that are culturally sensitive and recommend by the educational practices and Saudi culture. This could encompass involving local teacher trainers, application developers and culture bearers in admission to designing applications that are relevant with respect to context to education in KSA.

If these difficulties are solved, and new horizons are researched, we can reveal all the potential of smartphone applications as tools for education improvement and preparing students for the future.

Practical Implications

Integration into Curriculum

Integrating smartphone applications into the curriculum requires a strategic approach. Initial steps in mobile application integration in schools should therefore involve determination of the most appropriate application most relevant to the school's education goals and objectives. As a result, once such apps have been identified, they should be smoothly interwoven into the

curriculum being taught to the learners. This may require reorganization of the format of lessons, construction of new lessons and other tasks that may be required of a teacher.

Please incorporate these apps not just as extras but as components of the strategies that teachers are expected to employ in the classroom. For example, they can use the apps to teach new concepts; replay the instructions if necessary and quiz the learners. Moreover, some schools ought to come up with an environment that provides the desperate attempt in using of these apps.

Teacher Training and Support

Teacher education is essential where a school wishes to use applications found on a smartphone in teaching effectively. Continuing education programs for teachers to learn how to use the apps should be instituted in schools for the effectiveness of the apps. A training that should be conducted about the apps should also address the teaching strategies that can be incorporated in the context of app operation. In this regard, schools should also continue to support their teachers, for instance in terms of instructional materials and teachers' professional development engagements.

It is recommended that the professional learning opportunities embrace live practical sessions, Web 2. 0 courses, and peer coaching to satisfy the need of teachers wanting the most effective and competent teaching and learning applications. There is also a need to develop a forum system by schools in which the teachers can come together to discuss the experiences and the issues met or the successes achieved in the use of the apps. be beneficial for creating a culture of professional development and cooperation among teachers whereby the teachers enhance their practices professionally.

Addressing Access and Equity Issues

One of the critical components in the implementation of using smartphone applications in improving students' performance is to ensure that the applications are accessible. Schools should focus on the possibilities of introducing the proper means of connecting learners to technology, for example, through using school-provided devices, collaboration with technology producers, or local campaigns. Moreover, equity issues can be solved in school by providing more assistance to students, who have different levels of digital competence and guaranteeing equal opportunities to use smartphone applications as educational tools among all students.

Schools should also turn their attention to the social economic status of the learners when planning on the application of smartphone applications. For example, they can lend device to students who have no access to the Smartphone at home to continue with their learning. Schools can also seek funding from the business enterprises and organizations in the area for the support of the technology in the school.

Conclusion

The findings of this study prove that smartphones application can help improve computational thinking among the Saudi primary/secondary-school students. The characteristic of these apps is in the interactivity of the concepts thereby enhancing the learning of computational concepts, hence improving the educational performance. However, the processes of these apps ' implementation into the teachers' everyday practice require sufficient teacher training and necessary technologies availability, as well as the tackling of the increased digital divide among the students.

The implication of the study is relevant for the revamping of the policies and practices governing education in Saudi Arabia and other comparable countries. Therefore, introducing the capability of smartphone applications in schools enables equip the students with skills for future life in addition to learning becoming more fun. Thus, it is recommended that future research on the use of smartphone applications in education should address the given findings

in more depth and seek to establish the future effects of applying these applications in education as well as find out possibilities of minimizing the discovered challenges. By so doing, we shall be able to maximize the achievement of the intended objectives of smartphone applications in enhancing education and training and producing worthy alumni of the future.

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НАВЧАННЯ ОБЧИСЛЮВАЛЬНОГО МИСЛЕННЯ У ШКОЛАХ САУДІВСЬКОЇ АРАВІЇ ЗА ДОПОМОГОЮ ДОДАТКІВ ДЛЯ СМАРТФОНІВ

Абдулла Аленезі
кандидат наук з освітніх досліджень, доцент
Північний прикордонний університет, м. Арар, Саудівська Аравія
ORCID ID 0000-0003-0233-6838
Abdullah.AlAsmar@nbu.edu.sa

Анотація. У цьому дослідженні вивчається ефективність додатків для смартфонів у навчанні обчислювального мислення учнів початкової і середньої школи Саудівської Аравії. Обчислювальне мислення, яке охоплює розв’язання проблем, обчислювальну логіку та алгоритмічне мислення, є важливою навичкою в сучасному світі. У дослідженні оцінюються різні освітні додатки, які підтримують розвиток обчислювального мислення, та вивчається їхня інтеграція в навчальну програму Саудівської Аравії.
Це дослідження містить якісні та кількісні методи дослідження для забезпечення інклюзивної перспективи. У ньому взяли участь учні початкової та середньої школи з різних шкіл

Саудівської Аравії. Для кількісного аналізу використовувались тести до і після проведення дослідження, для якісного – проводилось інтерв'ю та анкетування. Кількісні результати передбачають оцінки тестів учнів, які проводились до і після дослідження, щодо обчислювального мислення за допомогою спільного варіювання з обчислювальним мисленням, якісні дані були отримані як результат інтерв'ю та анкетування вчителів та учнів. Порівнюються найбільш продавані освітні додатки ScratchJr, Lightbot, Cargo-Bot і Kodable щодо того, наскільки ефективно вони впроваджують ідеї програмування та заохочують раціональне мислення.

Результати показали, що додатки для смартфонів позитивно впливають на обчислювальні навички учнів. Помічено також підвищення рівня знань учнів в аспектах, пов'язаних з аналізом проблеми, виявленням закономірностей та формуванням алгоритму. Визначено, що використання таких додатків, як ScratchJr та Lightbot, сприяє підвищенню мотивації та бажання учнів вивчати обчислювальні концепції. Учителі зазначають, що їхні учні демонструють більшу зацікавленість та залученість переважно тоді, коли вчитель інтегрує ці додатки.

Отже, з огляду на результати дослідження, очевидно, що навчання з допомогою додатків для смартфонів призведе до ефективного реформування підходів до викладання та його доступності для учнів. Ці висновки є цінними для саудівського контексту вдосконалення освітньої політики та викладання, оскільки вказують на необхідність виділяти більше ресурсів на цифрові інструменти та інвестувати в професійний розвиток учителів, щоб вони могли скористатися перевагами передових технологій для покращення успішності учнів.

Ключові слова: обчислювальне мислення; додатки для смартфонів; освітні технології.