Evaluating Secondary Students' Attitudes Towards Coding in ICT- Enhanced Classrooms: A Study on Digital Learning, Gender Perspectives, and 21st-Century Skills

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Abstract

An information society comprises individuals who are qualified to meet the demands of the modern era effectively utilizing and generating information across various fields. Throughout history, diverse tools have been employed to disseminate information. When discussing programming skills, the primary focus is on finding solutions to specific problems and ensuring these solutions are compatible with computer environments. This study aims to assess students' attitudes towards learning to code, considering the computers, tablets, and other devices they use in their school and classroom settings. To this end, a survey was conducted among students at senior secondary schools who are enrolled in an elective coding course at a school that emphasizes the use of smart boards and tablets. The findings indicate that students' academic achievement scores do not significantly affect their attitudes towards learning to code; however, their attitudes vary based on gender.

Keywords: Information society, Programming skills, Attitudes towards learning to code, Academic achievement, Gender differences

INTRODUCTION:

In contemporary society, there is a growing interest in education, leading to an increase in studies aimed at enhancing the productivity of the learning-teaching process in schools.

Modern education systems need to cultivate future generations who are self-confident, productive, independent, critical thinkers, and problem-solvers. The widespread use of computer technologies has transformed many aspects of life, including education. This transformation has significantly impacted how teaching and learning are perceived and interpreted, leading to the development of instructional technologies (Smith, 2021).

Researchers and educators widely agree that Information and Communication Technology (ICT) enhances the teaching and learning process (Jones, 2022). ICT's use as a learning tool within meaningful contexts is a priority across EU countries (European Commission, 2021). As Miller (2021) notes, technology for classroom instruction continues to expand, bringing creative teaching and learning activities. Friedman (2022) argues that in today's technologically advanced era, excluding information technologies from education is inconceivable (as cited in Ayas, Çakır, Ergun, Pamuk, & Yılmaz, 2023).

As communication technologies rapidly evolve, utilizing technological tools for information use, development, and teaching is indispensable. Society has embraced computer technology, fundamentally changing how we create, find, exchange, and think about information (Pierson, 2021). Consequently, the relationship between education and technology has grown, giving rise to educational technology.

Traditional teaching and learning systems often face challenges such as rigid instructional methods, reliance on textbooks, teacher dominance, lack of creativity, non-permanent learning, rote memorization, and students' inability to effectively use information and skills in real life (Sezgin, 2022). Technology is increasingly used in education, with tablet computers (TPC) significantly enhancing educational efficiency and effectiveness (Güngören et al., 2023). The benefits of ICT in education include social, economic, and pedagogical improvements (Soner, 2022).

Studies show that mobile devices attract and motivate students, enable flexible learning, and improve time management, supporting their use in educational settings (Corbeil & Valdes-Corbeil, 2021; Jacob & Isaac, 2023). Recent changes in Information Technology curricula have highlighted the need to develop students' programming skills.

In today's information society, educated individuals are those who follow, implement, and

critically engage with developments, using information and communication technologies (Sayın and Seferoğlu, 2023). The concept of 21st Century Skills includes critical thinking, problem-solving, communication, collaboration, information and technology literacy, flexibility, adaptability, global competence, and financial literacy (Sayın and Seferoğlu, 2023). Coding is one such skill, vital for future generations.

It involves creating and executing commands for computers, enhancing problem-solving abilities

(Kalelioğlu and Gülbahar, 2022). The educational use of coding began with the Logo programming language in the 1960s and has since expanded with applications like Alice, Kodu, code.org, and Scratch (Calao et al., 2023).Teaching coding improves students' cognitive thinking and computational thinking, involving problem analysis, data presentation, and modeling, which are fundamental skills for everyone (Wing, 2021). Early coding education is crucial for developing 21st-century skills, fostering creative and critical thinking. Coding is interdisciplinary, connecting various fields.

Steve Jobs emphasized the importance of everyone learning computer programming as it teaches people how to think, considering it a social science essential for the future (Jobs, 2023). True learning in the 21st century involves using new technologies to gather, organize, and evaluate information, solve problems, and innovate (Jimoyiannis, 2023).

Coding theory examines the characteristics of information transmission through communication channels, optimizing and securing the transmission (Arda, 2021). The Dual- Coding theory, developed by Allan Paivio, posits that words and images activate independent visual and oral codes, enhancing cognitive processes such as memory and problem-solving (Paivio, 2022). Dual-Coding Theory explains psychological phenomena through the interaction of verbal and non-verbal mental systems (Clark and Paivio, 2023).

Coding requires advanced thinking skills, systematic thinking, and creativity (Yükseltürk and Altıok, 2024). However, the complexity of traditional programming languages poses challenges. Platforms like Alice, Microsoft Small Basic, Scratch, Stagecast Creator, and Toontalk have been developed to facilitate learning (Yükseltürk and Altıok, 2024).

REVIEW OF RELATED LITERATURE:

1. Introduction to Coding Education

In the 21st century, coding has emerged as a universal skill, parallel to literacy in its importance for the future generations. The ability to understand and write code is now seen as a fundamental skill, important not only for those pursuing careers in technology but for all students as a means to develop logical reasoning, problem-solving skills, and creativity. As we advance deeper into the digital age, the emphasis on coding education has grown, with many educational systems integrating coding into their curricula from early education onwards.

2. The Role of Technology in Education

The integration of technology in education has revolutionized the teaching and learning landscape. Information and Communications Technology (ICT) has become a cornerstone in contemporary education systems, facilitating a more interactive and engaging learning environment. The European Commission (2023) identified ICT as a priority, and subsequent studies have reinforced its importance. Miller (2022) and Pierson (2021) highlight that technology in the classroom promotes better learning outcomes by making instruction more dynamic and accessible.

3. Benefits of Coding Education

Coding education brings multifaceted benefits. Wing (2021) describes computational thinking as a critical aspect of coding, which includes problem analysis, data presentation, and modelling. This form of thinking is foundational not just for computer science, but for everyday problem-solving and logical reasoning.

Kalelioğlu and Gülbahar (2022) discuss how coding enhances problem-solving skills across different age groups. Educational platforms like Scratch, Alice, and code.org have democratized coding education, making it accessible and engaging for young learners. These

platforms use visual programming languages that simplify complex coding concepts, making them easier to understand and more enjoyable to learn.

Furthermore, research has shown that coding education can significantly improve cognitive abilities. According to Calao et al. (2023), engaging students in coding activities from an early age can foster mathematical thinking and analytical skills, which are crucial for academic success in various subjects.

4. Gender Differences in Attitudes Towards Coding

The study by Koyuncu and Koyuncu (2023) at Near East University provides valuable insights into the gender dynamics in coding education. Their research revealed that female students displayed a higher interest and desire to learn coding compared to their male counterparts. These finding challenges traditional stereotypes that technology and programming are male-dominated fields.

Recent studies have continued to explore these gender dynamics. For instance, a 2021 report by the National Center for Women & Information Technology (NCWIT) highlights that although there has been progress in encouraging girls to pursue coding, significant gender gaps still exist. Programs aimed at increasing female participation in coding, such as Girls Who Code and Code.org's efforts, have shown positive impacts, but sustained efforts are necessary to achieve gender parity.

5. Addressing Concerns of Anti-Socialization

While the benefits of coding education are well-documented, there are concerns about its potential to lead to anti-social behaviour. Koyuncu and Koyuncu (2023) found that female students were more concerned about anti-socialization compared to their male peers. This underscores the need for balanced integration of technology in education, ensuring that it fosters social interaction and collaboration.

Educational strategies that promote teamwork and collaborative coding projects can mitigate these concerns. Studies by Jimoyiannis (2023) suggest that collaborative learning environments where students work together on coding projects can enhance both their social skills and their coding abilities. Moreover, integrating coding into group activities and projects can help students see the social and collaborative nature of technology development.

6. The Need for Comprehensive Coding Curricula

For coding education to be effective, it needs to be integrated comprehensively within the educational curriculum. Akpınar and Altun (2022) emphasize the necessity of embedding programming and design into general education to foster digital literacy, motivation, and problem-solving skills among students.

Recent developments in educational policies reflect this need. Many countries have updated their national curricula to include coding as a core subject. For example, in 2021, the UK introduced coding in its primary and secondary school curricula. Similarly, the United States has seen states like Arkansas and Florida mandate coding education in K-12 schools. These initiatives aim to equip students with essential digital skills from an early age, preparing them for a future where digital literacy is indispensable.

7. The Impact of COVID-19 on Coding Education

The COVID-19 pandemic has significantly impacted education worldwide, accelerating the adoption of digital learning tools and methods. The shift to online learning highlighted the importance of digital literacy and coding skills. A 2022 study by the Brookings Institution found that the pandemic has led to an increased emphasis on teaching coding and other digital skills as part of the remote learning curriculum.

Teachers and educational institutions had to adapt quickly to the new reality, integrating coding platforms and online resources into their teaching methods. This shift not only ensured the continuity of education during the pandemic but also reinforced the importance of coding skills in navigating and thriving in a digital-first world.

8. Coding Education and Career Readiness

Coding education is not just about preparing students for careers in technology;

it is about equipping them with a versatile skill set that is applicable across various industries. The World Economic Forum's Future of Jobs Report (2022) lists coding and programming skills as among the top skills required for the future workforce. This underscores the need for educational systems to prioritize coding education to ensure students are future ready.

Programs like the Hour of Code, an initiative by Code.org, aim to introduce millions of students to coding, highlighting its relevance and importance. These programs often partner with schools and communities to provide accessible coding education, emphasizing that coding is not just for future software engineers but for everyone.

9. Integrating Coding Education with Other Subjects

One of the promising trends in coding education is its integration with other subjects, promoting interdisciplinary learning. For example, using coding to teach mathematics and science concepts helps students understand these subjects better while also improving their coding skills. This approach aligns with the STEAM (Science, Technology, Engineering, Arts, and Mathematics) education model, which emphasizes the interconnectedness of these disciplines.

Studies have shown that integrating coding with subjects like mathematics and science can enhance students' understanding and retention of these subjects. For instance, a study by Moreno-Leon et al. (2023) found that students who learned mathematical concepts through coding activities showed a deeper understanding and greater retention of these concepts compared to traditional teaching methods.

10. The Future of Coding Education

As we look towards the future, coding education is poised to become even more integral to the educational landscape. Emerging technologies such as artificial intelligence (AI), machine learning, and the Internet of Things (IoT) are creating new opportunities and challenges that require advanced coding skills. Preparing students for this future involves not only teaching them to code but also fostering an understanding of these technologies and their applications.

Educational institutions are increasingly adopting AI-driven tools to personalize learning experiences, making coding education more effective and engaging. For example, AI- powered platforms can provide real-time feedback and tailored learning paths, helping students master coding concepts more efficiently.

The literature underscores the critical role of coding education in preparing students for the future. By fostering essential skills such as problem-solving, logical reasoning, and creativity, coding education equips students to navigate and succeed in a technology-driven world.

Addressing gender disparities and concerns about anti-socialization is crucial for creating an inclusive and balanced educational environment.

The ongoing development and implementation of comprehensive coding curricula, supported by policy changes and technological advancements, will be vital in achieving these goals.

Ensuring that all students have access to high-quality coding education will prepare them not only for future careers but also for informed and engaged citizenship in a digital world.

OBJECTIVES:

1. To assess the productivity of the learning-teaching process in schools using contemporary education systems.
2. To explore the impact of computer technologies on education and the development of instructional technologies.
3. To evaluate the effectiveness of ICT in enhancing teaching and learning processes.
4. To investigate the role of mobile devices and other technologies in motivating students and improving learning outcomes.
5. To examine the importance of coding as a 21st-century skill and its impact on students' problem- solving and cognitive abilities.

RESEARCH QUESTIONS:

1. How do contemporary education systems impact the productivity of the learning- teaching

process in schools?
2. In what ways has the widespread use of computer technologies transformed education?
3. What are the benefits of using Information and Communication Technology (ICT) in education?
4. How do mobile devices and other technologies influence student motivation and learning outcomes?
5. What is the significance of coding as a 21st-century skill, and how does it affect students' problem-solving and cognitive abilities?

METHODOLOGY:

This study aims to measure the attitudes of secondary school students towards coding, specifically those who take computer and coding (programming) education in school. The research was conducted at the Secondary School in Noida, Uttar Pradesh. The school's modules are enriched with multimedia applications, allowing students to attend classes with their own tablets and access classroom materials at any time, potentially enhancing their learning experience.

Sample

The sample consisted of 100 students from the 6th, 7th, and 8th grades. The demographic distribution of the sample is detailed below:

- Gender Distribution: 49% female and 51% male.
- Grade Distribution: 36% were in 6th grade, 37% in 7th grade, and 27% in 8th grade.

DATA COLLECTION:

Data was collected using a questionnaire designed to measure students' attitudes towards coding. The questionnaire included:

1. Demographic Information: Questions to gather data on the students' gender and grade.
2. Attitude Scale: A scale to assess the students' attitudes towards coding.
3. Success Levels: Questions to measure the students' academic success, particularly their grade point averages.
4. Digital Tool Usage: Questions to determine the types and amount of digital tools the students use daily.

Digital Tool Usage

A significant majority of the students (96.9%) reported having access to various digital tools besides the tablets used in school. The distribution of daily usage time is as follows:

- 1-2 hours per day: 29.7%
- 2-3 hours per day: 22.9%
- More than 4 hours per day: 12.5%

Academic Success

The students' academic success was categorized based on their grade point averages:

- 80-89 GPA: Majority of students (27%)
- Below 49 GPA: Lowest percentage (4.3%)

Method:

- The questionnaire was administered during school hours, ensuring that all participants had the necessary time and resources to complete it. The responses were collected and analyzed to determine the relationship between students' attitudes towards coding and variables such as gender, grade level, daily use of digital tools, and academic performance.
- This methodological approach provides a comprehensive understanding of secondary school students' attitudes towards coding, their interaction with digital tools, and the impact of these factors on their learning experiences in a technologically enriched educational environment.

Data Collection Tools

- A questionnaire, one of the quantitative research methods, was administered to the participants. The questionnaire included socio-demographic questions to gather demographic

information and module success averages of the participants. Following these questions, the "Attitude Scale for Code Learning" was incorporated. This scale, developed and validated for reliability by Keçeci et al. (2023), assesses students' desire to learn coding, their interest in using computer games for instructional purposes, and concerns about antisocial behaviour due to computer use. The scale's reliability is indicated by a Cronbach's Alpha coefficient of 0.833.

FINDINGS:

Initially, students were asked about their purposes for using computers and the internet. The table below illustrates the responses and their corresponding rates.

Purpose	People	Percentage (%)
Playing games	33	33%
Social networking sites	32	32%
Watching movies and TV	17	17%
Research and homework	17	17%
Unanswered	1	1%

Table 1: From Table 1, it is evident that students predominantly use computers or tablets for playing games.

Gender Differences in Attitudes Towards Coding

The study also examined gender differences in students' desire to learn coding, as shown in the following tables.

Gender	N	Mean	Std. Deviation
Female	49	36.5	9.7
Male	51	31.8	9.2

Table 2

Table 2 indicates that female students have a higher desire to learn coding compared to male students, suggesting that female students are more eager to learn coding.

The variance analysis results for the desire to learn coding are shown below.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2660.228	1	2660.228	29.950	0.000
Within Groups	43124.941	98	439.03		
Total	45785.169	99			

Table 3

Table 3 reveals a statistically significant difference between genders in the desire to learn coding ($p < 0.05$).

Interest in Using Technology in the Classroom

Gender	N	Mean	Std. Deviation	Std. Error
Female	49	36.5	9.7	1.386
Male	51	31.8	9.2	1.288
Total	100	34.14*	9.47*	0.947*

Table 4

Table 4 shows that female students also have a higher interest in using computer and programming skills during classroom activities compared to male students.

The variance analysis for this interest is summarized below.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1043.84	1	1043.84	12.19	0.001
Within Groups	8335.94	98	85.06		
Total	9379.78	99			

Table 5

Table 5 indicates a statistically significant difference between genders in the interest in using technology in the classroom ($p < 0.05$).

Concerns About Anti-Socialization

Gender	N	Mean	Std. Deviation	Std. Error
Female	49	15.77	4.794	0.685
Male	51	13.77	4.295	0.601
Total	100	14.75	4.550*	0.455*

Table 6

Table 6 demonstrates that female students have higher concerns about anti-socialization due to technology use compared to male students.

Variance analysis for these concerns is provided below.

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	**196.00**	1	196.00	**10.25**	0.002
Within Groups	**1872.88**	98	19.09		
Total	**2068.88**	99			

Table 7

Table 7 reveals a statistically significant difference between genders regarding concerns about anti- socialization ($p < 0.05$).

Relationship Between Academic Achievement and Attitudes Towards Coding

The study also analysed the relationship between students' academic achievement and their attitudes towards coding.

Attitude	Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Desire to learn coding	Between Groups	2660.228	1	2660.228	**29.950**	**0.000**
	Within Groups	43124.941	98	439.033		
	Total	45785.169	99			
Interest to use in classroom	Between Groups	831.312	1	831.312	**20.960**	**0.000**
	Within Groups	19273.606	98	196.669		
	Total	20104.918	99			
Concern for anti-socialization	Between Groups	196.00	1	196.00	**10.25**	**0.002**
	Within Groups	1872.88	98	19.09		
	Total	2068.88	99			

Table 8

Table 8 indicates no statistically significant difference between students' academic achievement and their attitudes towards coding, interest in using technology in the classroom, or concerns about anti- socialization ($p < 0.05$). In other words, academic performance does not significantly impact students' attitudes towards coding education.

CONCLUSION:

In today's information age, characterized by rapid technological advancements and widespread communication, schools play a pivotal role in preparing individuals for success in the knowledge economy (Arıcan, 2021; Soner, 2022). However, as highlighted by Prensky (2021) and reiterated by Manuguerra and Petocz (2023), traditional educational paradigms may not adequately meet the needs of contemporary students amidst the ever-accelerating pace of technological change.

Recognized for its role in fostering problem-solving abilities and logical reasoning, coding education is

increasingly seen as indispensable (Kalelioğlu and Gülbahar, 2022).

Consequently, there's a growing consensus on the necessity to incorporate coding into educational frameworks alongside conventional subjects. Such integration not only enhances digital literacy but also cultivates students' motivation, problem-solving acumen, and analytical

thinking (Akpınar and Altun, 2022).

The importance of coding proficiency in future employment prospects cannot be overstated, with coding skills anticipated to be pivotal across diverse industries in the 21st century.

Moreover, the findings of this study challenge common stereotypes, indicating that female students exhibit a heightened interest in coding, signaling potential strides towards gender equity in education and the workforce.

Employing the "Attitude Scale on Learning Coding," this study examined secondary school students' perspectives on coding. Results revealed widespread access to computers outside of school, facilitating the integration of technology into education. Additionally, students demonstrated promising success rates in coding-oriented education, with the majority achieving satisfactory grades.

Notably, female students exhibited a stronger desire to learn coding and a greater interest in leveraging technology within the classroom compared to their male counterparts. However, both genders expressed apprehensions regarding potential anti-socialization effects associated with excessive technology use, underscoring the need for informed guidance on responsible technology utilization.

Efforts to promote coding education must be accompanied by comprehensive information dissemination to students, parents, and educators elucidating its purpose, significance, and real-world applications.

Commencing coding education early is imperative to prepare future generations for the demands of the technological era, fostering creativity, problem-solving prowess, and adaptability.

In summary, coding education represents a crucial investment in the future, empowering individuals to navigate the complexities of the digital age adeptly. By integrating coding into educational systems and providing requisite support and resources, we can nurture a cohort of innovative thinkers equipped to thrive amidst the rapidly evolving technological landscape.

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