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Enhancing digital citizenship education in Saudi Arabian elementary schools: designing effective activities for curriculum integration

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In an era where digital technologies significantly influence children's lives globally, promoting responsible digital citizenship is crucial to equip them with the skills to navigate the digital world safely and responsibly. This study examines the integration and current state of Digital Citizenship Education (DCE) in Saudi Arabian elementary schools, assessing its alignment with international standards and identifying local challenges faced by educators, and pedagogical strategies used. Employing a mixed-methods approach, quantitative data was collected through surveys from 398 teachers and qualitative insight gained from semi-structured interviews with 15 teachers. Quantitative analysis employed descriptive statistics and multivariate analysis of variance (MANOVA) to explore demographic influences on DCE practices. The findings reveal a strong emphasis on Digital Emotional Intelligence and Digital Security, Privacy, and Health and Wellness; however, significant gaps exist in Digital Participation and Agency, and Digital Footprint and Identity. These gaps are attributed to factors such as insufficient teacher training, lack of effective structured guidelines, and insufficient resources. Significant interaction effects between teachers' demographics and DCE perceptions highlight the need for targeted professional development. The study concludes with actionable recommendations for enhancing curriculum integration, teacher training, and policy development to promote digital citizenship among elementary school students aligned with global standards.

KEYWORDS

digital citizenship education (DCE), digital literacy, cyber safety and privacy, elementary schools, teacher professional development, digital emotional Intelligence, curriculum integration, pedagogical strategies

1 Introduction

The digital landscape has witnessed a significant transformation in recent years, with an increasing reliance on digital technologies influencing multiple aspects of daily life globally (James et al., 2021). This transformation is particularly evident in children's digital habits, as highlighted by the 2018 Edelman's Intelligence report (Intelligence, 2018). The report underscores this trend, revealing that children spend an average of 2 h and 35 min on connected mobile devices daily, with usage increasing with age. Notably, 43% of children aged 5–10 own smartphones, and 57% own tablets, highlighting the early integration of digital technology in their lives (Intelligence, 2018).

In Saudi Arabia, this trend is particularly pronounced, mirroring global trends but with some unique characteristics (Kemp, 2023). As of 2023, social media usage in Saudi Arabia reached 79.3%, equating to approximately 29.1 million users, with a significant portion of this demographic comprising young people (Gazette, 2020a; Hammad and Awed, 2022). Studies indicate that 74% of Saudi children begin using and owning connected devices at an average age of seven, notably younger than the global average, indicating an early onset of digital literacy and social media interaction (Intelligence, 2018; Faqihi et al., 2024). This early and extensive exposure to digital technologies brings both opportunities and challenges.

On the one hand, digital devices can enhance learning experiences and provide children with access to vast information and educational resources. The rise of technologies such as artificial intelligence (AI), machine learning, and the Internet of Things (IoT) presents new educational tools and methods, potentially revolutionizing how children learn and interact with information (OECD, 2019). AI, for instance, has demonstrated its robust potential and capabilities in facilitating personalized learning and automating routine tasks, allowing educators to focus more on direct student engagement (Pedró et al., 2019). Recent advancements in AI-powered educational tools, such as intelligent note-taking assistants and organizers like Goggle's NotebookLM, are redefining how students study. These tools leverage artificial intelligence to help students organize information, generate summaries, and gain deeper insights into their learning materials, thereby enhancing efficiency and comprehension (OECD, 2019; Haleem et al., 2022). Digitalization also expands access to educational resources through online platforms and digital libraries, allowing learners and educators to access information anytime and anywhere (Pedró et al., 2019). This increased accessibility supports inclusive education by providing learning opportunities to individuals who may lack adequate educational facilities, thereby contributing to social well-being and sustainable development (Alam et al., 2023; Timotheou et al., 2023). Additionally, digital technologies enhance education by supporting students with special needs through assistive tools like speech recognition and screen-reading software (Al-Zboon, 2022). These tools also enhance critical thinking and problem-solving skills by offering dynamic, immersive learning experiences through technologies like augmented reality (AR) and virtual reality (VR), while also enabling personalized learning to address individual needs and improve outcomes (OECD, 2019; Haleem et al., 2022).

On the other hand, the potential adverse effects of digital media use, including social isolation, internet addiction, exposure to inappropriate content, and cyberbullying, are well-documented (Liu et al., 2016; Booker et al., 2018). Moreover, extensive use of social media has been linked to mental health problems, including depression and anxiety, particularly among adolescents (UNESCO, 2016; Booker et al., 2018). Additionally, this digital immersion also raises significant concerns, particularly regarding data security, privacy, and the potential psychological impacts on children (Affia et al., 2023; Fabbrizio et al., 2023). Recent research indicates that IoT (Pinto et al., 2024), wearable fitness and health trackers (Lu et al., 2020; Yang et al., 2024), and AI-powered virtual assistants (Bolton et al., 2021) introduce risks related to data security and privacy, as these devices often collect and transmit personal information. These issues are particularly relevant and concerning for young children who may be vulnerable due to their developmental stage and lack of experience navigating the complexities of the digital world.

In Saudi Arabia, these risks, concerns, and challenges are compounded by cultural and societal factors. Despite globalization, the conservative nature of Saudi society, guided by Islamic principles, traditions, and gender politics, influences attitudes towards interaction and content consumption (Lewis, 2019; Alqirnas, 2022; Wahid, 2024). For instance, there is heightened concern about exposure to inappropriate content and the preservation of cultural and religious values online. There is also great emphasis on collective well-being and familial privacy and this focus on familial values and protection extends to the emphasis placed on the protection of familial and individual information from digital threats (Almekhled and Petrie, 2024). Moubarak and Afthanorhan (2024) conducted a risk assessment of virtual interactions on Saudi families, and reported that social media platforms, especially TikTok, Twitter (now X), and Snapchat pose significant cultural and behavioral risks. Their study found that virtual interactions were perceived to lead to the adoption of atheistic ideas, spread of hate speech, undermining family values, and exposure to cybercrime and cyberbullying. A recent study also found that Saudi parents express significant concerns regarding their children's privacy when using smart device apps (Alashwali and Alashwali, 2022). However, the study indicated that concerns expressed by Saudi parents about their children's use of smart device apps predominantly focused on the appropriateness of the content of the apps rather than privacy issues such as the apps' requests for sensitive data (Alashwali and Alashwali, 2022). This disconnect implies that while parents are concerned, they may not fully understand or align their concerns with the actual privacy and other risks posed by these apps and digital devices. This indicates a need for increased parental awareness and engagement in overseeing and managing their children's digital interactions to ensure safety and appropriateness in app usage.

These risks have necessitated a proactive approach to digital literacy that encompasses ethical, safe, and responsible use of technology. The international community has recognized the importance of addressing these concerns and equipping young people with the skills they need to thrive in a digital world. UNESCO's Education 2030 Agenda highlights the role of Information and Communication Technologies (ICTs) in strengthening education systems and promoting access to information, knowledge, and quality learning (So et al., 2018). It emphasizes the need for students to develop essential ICT skills to become confident and responsible citizens in a globalized, knowledge-based, and technology-driven world (So et al., 2018).

In response to the growing advocacy for safeguarding children in the digital world, the Saudi government has recently initiated several programs. Notably, the Global Cyber Security Forum held in 2020 and the Qayyim platform, launched in 2019 under the "Values Compass" initiative (translated from the "Misk Al-Qiyam initiative"), exemplify a proactive approach to promoting safe and ethical digital practices among children and adolescents (Gazette, 2020a, 2020b). This platform is particularly noteworthy as it aims to evaluate and regulate video game content, providing parents with essential tools to make informed decisions about their children's digital consumption (Arab News, 2019). Established in cooperation with education and psychological experts, the Qayyim platform classifies video games according to appropriate age groups and offers brief descriptions of game content. This helps parents understand the potential religious, psychological, mental, moral, and financial impacts of these games,

thereby contributing to a supportive and healthy digital environment for children. These government efforts reflect a growing recognition of the need to create a supportive and healthy digital environment for this age group, ensuring a balanced and informed approach to children's engagement with digital technologies (Gazette, 2020b).

A critical skill set identified in the efforts implemented by the international community and national government to address the social and ethical concerns relating to children's online activity is digital citizenship. Digital citizenship is a multifaceted concept that encompasses a variety of competencies, attitudes, and behaviors necessary for individuals to navigate and engage responsibly, effectively, and ethically in the digital world. Defined variably across different frameworks, digital citizenship generally involves the effective and responsible use of digital technologies, emphasizing critical thinking, ethical behavior, and the capacity to interact positively online (Ghamrawi, 2018; Öztürk, 2021; Lynn et al., 2022). UNESCO (2024) definition emphasizes that digital citizenship extends beyond mere digital skills to include cognitive, critical, and creative abilities that empower individuals to participate ethically and effectively in the digital world.

Building on its experience in Asia and the Pacific, UNESCO developed a model comprising five key domains to guide the development of a generation of active, ethical digital citizens, including Digital Literacy, Digital Safety and Resilience, Digital Participation and Agency, Digital Emotional Intelligence, and Digital Creativity and Innovation (UNESCO, 2024). Each domain targets specific competencies essential for holistic digital citizenship. Digital Literacy involves the ability to seek, critically evaluate, and use digital tools and information effectively to make informed decisions. Digital Safety and Resilience focus on protecting oneself and others from harm in the digital space, encompassing personal data privacy, health and well-being, and digital resilience (UNESCO, 2016; UNESCO, 2024). Digital Participation and Agency highlight equitable interaction and positive societal influence through ICT, promoting skills in civic engagement and netiquette (UNESCO, 2016; UNESCO, 2024). Digital Emotional Intelligence emphasizes recognizing and expressing emotions in digital interactions, promoting self-awareness, self-regulation, and empathy (Leeuw and Joseph, 2023; UNESCO, 2024). Additionally, Digital Creativity and Innovation empower, children to express themselves and explore through creating content with ICT tools, promoting creative literacy and expression (UNESCO, 2024). This model reflects a holistic approach to developing a generation of active, ethical digital citizens who are well-equipped to navigate the complexities of the digital world responsibly and effectively.

On the other hand, Rible's framework identifies nine elements of digital citizenship: digital access, commerce, communication, literacy, etiquette, law, rights and responsibilities, health and wellness, and security (Ribble, 2015). These nine elements can be further grouped into three core goals, including improving student learning outcomes, influencing student behavior and overall school environment, and preparing students to become responsible and informed participants in the digital world outside the school environment (Ribble, 2015). These elements highlight the multifaceted nature of digital engagement, encompassing legal, ethical, and social dimensions. Similarly, the International Society for Technology in Education (ISTE) framework outlines research-based standards critical for digital citizenship education emphasizing safe, legal, and ethical use of technology as well as advocating for digital literacy, etiquette,

privacy, and security (Aldosari et al., 2020; ISTE, 2023). Additionally, Common-Sense Education's digital citizenship curriculum emphasizes digital literacy as a critical component of digital citizenship and outlines critical aspects including media balance and well-being, privacy and security, digital footprint and identity, relationships and communication, cyberbullying, news and media literacy, as well as digital drama, and hate speech (Common Sense Education, 2019; Common Sense Media, 2022). This holistic approach to digital citizenship is crucial in mitigating risks and concerns associated with digital media, ultimately contributing to a more secure, inclusive, and active engagement in the digital society (UNESCO, 2016; Aldosari et al., 2020).

Digital citizenship for children is set within a rights-based framework, emphasizing children's right to benefit from the fullest exercise, enjoyment, and participation in society through the use of ICTs. This rights-based framework is grounded on the human rights-based approach (HRBA) conceptual framework for human development normatively based on international human rights standards and operationally directed to promoting and protecting human rights (UNSDG, 2024). Consequently, the concept of digital citizenship has been reinforced in various global forums, including the United Nations Committee on the Rights of the Child through its General Comment No. 25 (2021) on children's rights in relation to digital environment (Committee on the Rights of the Child, 2021). In a recent forum, Irene Khan, the United Nations Special Rapporteur for Freedom of Expression emphasized the need for protecting privacy and freedom of expression online, especially for children and adolescents, as key aspects of digital citizenship (United Nations Information Service, 2023). Other notable forums that have actively advocated for digital citizenship include the Internet Governance Forum and the Council of Europe (Pajuste et al., 2022).

Attaining the digital citizenship skills required for effective participation in a digital and globalized context necessitates relevant educational support. Recent research highlights the importance of early education in promoting digital literacy and ethical online behavior among young children (Alashwali and Alashwali, 2022). Scholars argue that introducing digital citizenship concepts at an early age helps children develop critical thinking skills and a strong ethical foundation for navigating the digital world (Alashwali and Alashwali, 2022). Moreover, embracing digital citizenship opportunities requires accurate education about the power of digital technologies, positive judgment, meaningful relationship-building, self-worth appreciation, and respectful interactions with diverse individuals (Opria and Momanu, 2023). Thus, Digital Citizenship Education (DCE) has been emphasized as a potential solution to equip children with the necessary skills to navigate the digital world responsibly and ethically (UNESCO, 2016; Mirra et al., 2022; Opria and Momanu, 2023).

However, while existing research has explored DCE in most developed nations, including Germany (Vajen et al., 2023), the USA (Jones et al., 2023), Spain (Vallès-Peris and Domènech, 2024), and the UK (OECD, 2019; Jang and Ko, 2023; O'Reilly et al., 2024), a comprehensive understanding of the status and effectiveness of DCE in cultivating digital citizenship skills within the Middle East remains limited. Additionally, despite the increased national efforts to promote responsible digital engagement of young learners in Saudi Arabia, there is a critical gap in understanding how effectively DCE is integrated into the elementary school education. Existing studies on DCE in Saudi Arabia have primarily focused on older age groups,

especially intermediate, middle, and high school students (Aldosari et al., 2020; Aljenobi, 2023) as well as college and university students (Binjwair and Bingimlas, 2024) and have highlighted varying levels of digital literacy and the need for earlier intervention. This study aims to fill these gaps by examining the current state of DCE in Saudi Arabian elementary schools, exploring its alignment with international standards, and identifying challenges to inform effective educational interventions that incorporate best practices from international models. The research also sought to understand how digital citizenship is conceptualized and integrated within the curricula and evaluate the effectiveness of pedagogical strategies and resources used in teaching these concepts. Through this comprehensive analysis, the study also intended to propose effective educational interventions that incorporate best practices from international models, tailored to the local Saudi context to better prepare students as safe, responsible, and empowered digital citizens within the global digital community.

This study is grounded in two complementary theoretical frameworks, the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra and Koehler, 2006) and Ribble's Digital Citizenship Model (Ribble, 2015). The TPACK framework provides a comprehensive model for understanding the integration of technology in teaching by emphasizing the intersection of technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). It is relevant for examining how teachers incorporate DCE into their curriculum, as it emphasizes the need for educators to develop knowledge about digital citizenship content as well as the pedagogical strategies and technological proficiency required to effectively teach it (Koehler et al., 2013). This framework helps in analyzing the competencies teachers need to integrate DCE holistically into their teaching practices.

Complementing the TPACK framework, Ribble's Digital Citizenship Model outlines nine elements essential for responsible and appropriate use of technology: digital access, commerce, communication, literacy, etiquette, law, rights and responsibilities, health and wellness, and security (Ribble, 2015). This model serves as a content-specific framework that defines the scope of digital citizenship, providing a structured understanding of the concepts teachers need to impart to students. Integrating TPACK with Ribble's model, allows the examination of both the pedagogical approaches and the specific content areas of digital citizenship, allowing for a robust analysis of how teachers in Saudi Arabian elementary schools conceptualize and implement DCE within their classrooms. This dual-framework approach also enables the identification of the interplay between teachers' knowledge domains and the practical challenges they face, that could ultimately contribute to the development of effective strategies for enhancing DCE integration in the curriculum.

This study addresses the following research questions:

1 How effectively does the current digital citizenship curriculum align with international digital citizenship standards, and what improvements are needed to better prepare students for the global digital community?
2 What are the perceived challenges and barriers that educators face in effectively teaching digital citizenship in Saudi Arabian elementary schools?
3 To what extent do teachers' demographic characteristics and school contexts influence their perceptions and practices of

digital citizenship education in Saudi Arabian elementary schools?
4 What pedagogical strategies, activities, and resources are perceived as effective by teachers in facilitating digital citizenship education?
5 How can curriculum and instruction design be enhanced to better support the development of digital citizenship skills among elementary school students in Saudi Arabia, considering international best practices and local contextual factors?

2 Materials and methods

2.1 Research design

This study employed a mixed-method approach, integrating both quantitative and qualitative methodologies to provide a comprehensive analysis of digital citizenship education in Saudi Arabian elementary schools. An explanatory sequential mixed method was used, where quantitative data collection and analysis were conducted first, followed by qualitative data collection and analysis that built on the quantitative results as well as helped identify emerging themes (Creswell, 2014). This approach allowed for an in-depth exploration of the research problem by integrating numerical trends with rich, contextual insights gathered through interviews with individual teachers. The rationale behind adopting a mixed-methods approach was to triangulate data sources and methods, thereby enhancing the validity and reliability of the findings (Creswell and Plano Clark, 2018). The quantitative component enabled statistical analysis of trends and patters across a broader sample, identifying perceptions and practices related to DCE. On the other hand, the qualitative component provided deeper insight into teachers' experiences and perspectives, uncovering underlying reasons behind the quantitative results.

2.2 Sample selection

The study targeted elementary school teachers in Saudi Arabia, focusing on teachers within Urban, suburban, and rural districts to capture diverse educational contexts and ensure regional diversity and representation. The sample size for the quantitative phase was determined based on Krejcie and Morgan's (1970) guide for sample size calculation. Considering the large population of elementary teachers in Saudi Arabia, an initial pool of 600 teachers was identified through a stratified random sampling technique, ensuring representation across different school types (public vs. private), regions (urban, suburban, and rural schools), and demographic backgrounds. The sample pool of 600 was deemed adequate to ensure the representativeness of the final sample after accounting for potential non-responses. Six hundred invitations to participate were sent via email, accompanied by a copy of the survey and a detailed cover letter explaining the study's purpose while emphasizing confidentiality, and outlining the data collection procedures. Of the 600 invitations, 412 responses (69% response rate) were received. After excluding incomplete or improperly filled surveys, the final sample comprised 398 valid responses ($N = 398$). This sample size was sufficient in ensuring representativeness of the broader teacher population at a 95% confidence level and a 5% margin error aligned with the recommendations of Krejcie and Morgan's (1970). On the

TABLE 1 Integration of digital citizenship elements within UNESCO's five domains.

UNESCO's 5 domains of digital citizenship	Elements of DCE
Digital Literacy	**Ribble's:** Digital literacy (Ribble, 2015)
	ISTE's: Empowered Learner (Customized Learning Environments, Feedback, Technology Operations), Knowledge Constructor, Computational Thinker (ISTE, 2023).
	Common Sense's: News and Media Literacy (Common Sense Education, 2019; Common Sense Media, 2022).
	UNESCO's: ICT Literacy, Information Literacy (UNESCO, 2024).
Digital Safety and Resilience	**Ribble's:** Digital Law, Digital Rights and Responsibilities, Digital Health and Wellness, Digital Security (Ribble, 2015).
	Common Sense's: Privacy and Security, Digital Footprint and Identity, Media Balance and Well-Being, Cyberbullying, Digital Drama and Hate Speech (Common Sense Education, 2019).
	ISTE's: Digital Citizen (Rights and Responsibilities, Digital Footprint, Online Behavior, Intellectual Property, Digital Privacy) (ISTE, 2023).
	UNESCO's: Understanding Child Rights, Personal Data, Privacy and Reputation, Promoting and Protecting Health and Well-Being, Digital Resilience (UNESCO, 2024)
Digital Participation and Agency	**Ribble's:** Digital Access, Digital Communication, Digital Commerce, Digital Etiquette (Ribble, 2015).
	Common Sense's: Relationships and Communication (Common Sense Education, 2019).
	UNESCO's: Interacting, Sharing, and Collaboration, Civic Engagement, Netiquette (UNESCO, 2024).
	ISTE's: Global Collaborator (ISTE, 2023).
Digital Emotional Intelligence	**UNESCO's:** Self-Awareness, Self-Regulation, Self-Motivation, Interpersonal Skills, Empathy (UNESCO, 2024).
Digital Creativity and Innovation	**ISTE's:** Innovative Designer, Creative Communicator (Aldosari et al., 2020; ISTE, 2023)
	UNESCO's: Creative Literacy, Expression (UNESCO, 2024).

other hand, the 15 interviewees for the semi-structured interviews were selected through purposive sampling aligned with Guest et al.'s (2006) recommendation that data saturation is often achieved with 12 to 15 participants for semi-structured interviews. Moreover, this sample size is sufficient to explore the themes identified in the qualitative data while allowing for rich, contextual insights (Creswell and Plano Clark, 2018).

2.3 Instrumentation

2.3.1 Quantitative data collection

Participants completed an online survey titled "Digital Citizenship Education in Saudi Arabian Elementary Schools." The survey was developed, drawing on established frameworks such as Ribble's nine elements of digital citizenship (Ribble, 2015), ISTE's digital citizenship standards (ISTE, 2023), UNESCO's competencies and five digital citizenship domains for global citizenship (UNESCO, 2016; UNESCO, 2024), and Common Sense's digital citizenship curriculum (Common Sense Education, 2019). The first section aimed at collecting demographic data including the teachers' age, gender, and years of teaching experience in DCE.

The second section assessed the integration of digital citizenship elements within the curriculum and teachers' perceptions of their school's Digital Citizenship Education (DCE) curriculum, alongside their students' mastery and application of DCE concepts in alignment with international standards. To achieve a comprehensive analysis, a structured framework was developed by categorizing Ribble's nine elements, ISTE's standards, and Common Sense Media's elements under UNESCO's five domains of digital citizenship, as illustrated in Table 1. Some of the items included in this section were adapted from

Martin et al. (2019). The third section assessed teachers' perceptions of the status of digital citizenship education, their self-reported challenges, and practices in integrating DCE into their teaching. Responses were recorded using a 5-point Likert scale (1 = Strongly Disagree through 5 = Strongly Agree).

The survey underwent a pilot test with 30 teachers to assess its validity and reliability. Feedback from the pilot test led to minor revisions in wording to ensure clarity and coherence. Cronbach's alpha for the survey items was 0.974, indicating high internal consistency. The content validity of the instrument was established through expert reviews and feedback during the pilot study.

2.3.2 Qualitative data collection

Semi-structured interviews were conducted to gain deeper insights using a subset of 15 teachers who had provided more positive responses, were more knowledgeable about or experienced in DCE, and indicated a high engagement with DCE in the survey. The semi-structured interview protocol was developed based on themes identified in the literature and insights from the quantitative survey results, focusing on teachers' conceptualizations of digital citizenship, pedagogical strategies and resources used, challenges encountered in integrating DCE, and recommendations for enhancing DCE in the curriculum while allowing for emerging themes. A pilot test with five teachers was conducted to refine the questions for clarity and relevance, following the recommendations of van Teijlingen and Hundley (2002) on the importance of piloting qualitative research instruments to enhance validity. The interviews were conducted in person and via video conferencing, each lasting approximately 45–60 min. To ensure reliability and credibility, the interviews were recorded and later transcribed verbatim, and coding performed

TABLE 2 Demographic characteristics of the participants.

Demographics		Frequency	Percent
Gender	Female	210	52.8%
	Male	188	47.2%
Age	20–30	101	25.4%
	31–40	110	27.6%
	41–50	98	24.6%
	51 and above	89	22.4%
Years of experience teaching DCE	<=5	136	34.2%
	6–10	132	33.2%
	11–15	99	24.9%
	16 and above	31	7.8%
School type	Private	213	53.5%
	Public	185	46.5%
Region	Rural	120	30.2%
	Suburban	145	36.4%
	Urban	133	33.4%
Total		$N = 398$	

TABLE 3 Overall mean and standard deviation of all domains.

Variable	Mean	Std. deviation
Digital Literacy	3.457	0.757
Digital Safety and Resilience	3.311	0.677
Digital Participation and Agency	3.223	0.698
Digital Emotional Intelligence	3.542	0.795
Digital Creativity and Innovation	3.428	0.676

independently by two researchers using thematic analysis, incorporating deductive codes from existing literature and inductive codes emerging from the data (Miles and Huberman, 1994; Strauss and Corbin, 2008). The independent coding processes were then compared and discussed to resolve any discrepancies, enhancing the consistency, and reducing potential bias. An intercoder reliability coefficient of 0.85 was achieved, indicating high agreement between coders (Miles and Huberman, 1994). Member checking was also employed to enhance the credibility and confirmability of the findings, allowing participants to review and confirm the accuracy and resonance of the transcripts and interpretation (Lincoln et al., 1985).

2.4 Data analysis

The quantitative data were analyzed using SPSS version 29. Descriptive statistics, including percentages and frequencies for the demographics and mean scores and standard deviations, for each survey item, were calculated. Inferential statistics, such as multivariate analysis of variance (MANOVA), were employed to examine differences across demographic groups and identify significant factors influencing digital citizenship education. This qualitative analysis provided a comprehensive overview of the current state of digital citizenship education in Saudi Arabian elementary schools, highlighting areas of strength and opportunities for improvement based on teachers' feedback and demographic variations.

Interview transcripts were analyzed thematically using NVivo software. The thematic analysis involved coding the data, identifying patterns, and developing themes related to teachers' conceptualization and integration of digital citizenship, the challenges faced, and the resources and strategies deemed effective. An iterative process was followed, with initial codes refined and grouped into broader themes. Coding consistency was checked by having two independent researchers code a subset of transcripts, achieving an agreement rate of 90%. Additionally, triangulation with survey data helped validate the qualitative findings.

3 Results

3.1 Demographics

The sample consisted of 398 elementary school teachers from different regions in Saudi Arabia. The demographic characteristics of the participants are summarized in Table 2.

3.2 RQ1: How effectively does the current digital citizenship curriculum align with international digital citizenship standards, and what improvements are needed to better prepare students for the global digital community?

Table 3 presents the mean scores and standard deviations for each of the five domains of digital citizenship. The scores reflect the teachers' perceptions of how well each domain is integrated into their school's curriculum. The findings are organized according to UNESCO's five domains of digital citizenship: Digital Literacy, Digital Safety and Resilience, Digital Participation and Agency, Digital Emotional Intelligence, and Digital Creativity and Innovation.

The highest mean score was observed in the Digital Emotional Intelligence domain ($M = 3.542$, SD = 0.795), indicating that teachers perceive a strong emphasis on teaching self-awareness, regulation, empathy, and interpersonal skills in digital interactions. The domain with the lowest mean score was Digital Participation and Agency ($M = 3.223$, SD = 0.698), suggesting that elements such as digital commerce, access, and communication need further integration into the curriculum.

On the other hand, Table 4 provides a breakdown of the mean scores and standard deviations for specific elements within each domain. The Digital Literacy domain, with items emphasizing the critical evaluation of online resources and integration of technology tools in education, indicated that the teachers generally had a positive perception of the digital literacy curriculum ($M = 3.457$, SD = 0.757). This indicates that educators agree and believe there is an adequate

TABLE 4 Mean and standard deviation of survey responses by domain and elements.

Domain	Elements of Digital Citizenship Within the Curriculum	Mean	Std. Deviation
Digital Literacy	Digital Literacy	3.457	0.757
Digital Safety and Resilience	Digital security, Privacy, and Health and Wellness	3.504	0.720
	Digital Law, Rights, and Responsibilities	3.303	0.795
	Digital Footprint & Identity	2.889	0.623
Digital Participation and Agency	Digital Commerce	2.970	0.970
	Digital Access	3.021	0.825
	Digital Communication & Netiquette	3.551	0.773
Digital Emotional Intelligence	Self-Awareness, Regulation, Empathy, Interpersonal Skills	3.542	0.795
Digital Creativity and Innovation	Innovative Designer, and Creative Communicator, Literacy and Expression	3.428	0.676

emphasis on essential digital skills within the school curriculum. For instance, the teachers indicated agreement with the survey item, "Our school curriculum adequately covers the necessary digital skills for effective internet use" ($M = 3.475$, SD = 0.897).

Within the Digital Safety and Resilience domain, three sub-domains were analyzed: Digital Security, Privacy, and Health and Wellness; Digital Law, Rights, and Responsibilities; and Digital Footprint and Identity. The highest mean score was observed in the Digital security, Privacy, and Health and Wellness subdomain ($M = 3.504$, SD = 0.720), which was also the highest mean score across all the domains. This highlights a strong focus on teaching students about digital security measures and the importance of online safety protocols and personal data protection. For example, the item "My students understand the importance of digital security measures like passwords and online safety protocols" had a high mean score ($M = 3.832$, SD = 0.928), as highlighted in Table 5, reflecting high awareness in this area.

The subdomain of Digital Law, Rights, and Responsibilities scored ($M = 3.303$, SD = 0.795), suggesting that teachers have a moderate level of agreement on the emphasis placed on legal and ethical use of technology in the curriculum. The mean score also indicates that while teachers somewhat agree with the current emphasis on these topics as well as indicate some awareness among students regarding these issues, there is a need to further strengthen this aspect of digital citizenship education. These results also indicate that while students are relatively well-informed about digital security and the health

impacts of digital usage, there may be less emphasis or effectiveness in teaching digital law and rights.

On the other hand, the Digital Footprint and Identity element had the lowest mean score in the Digital Safety and Resilience domain ($M = 2.889$, SD = 0.623), also the lowest mean across the other subdomains, indicating a strong need for increased focus on educating students about the long-term impacts of their online activities. Notably, the item "My students know that they cannot completely delete their online posts" had the lowest score ($M = 2.505$, SD = 0.869), highlighting a potential gap in the curriculum regarding educating students about the permanence of online actions and the management of their digital identities.

Within the Digital Participation and Agency domain, the Digital Communication and Netiquette subdomain had a relatively high mean score ($M = 3.551$, SD = 0.773), suggesting that teachers agree to a significant extent that proper digital communication and etiquette and standards are well-integrated into the curriculum, implying that students are possibly adhering to appropriate communication standards online. Conversely, the mean score for the Digital Commerce subdomain was the lowest ($M = 2.970$, SD = 0.970), suggesting that students are not adequately taught about safe online purchasing practices. On the other hand, Digital Access scored ($M = 3.021$, SD = 0.826), indicating that current efforts to provide equitable access to digital technologies are moderately effective, with teachers neither strongly agreeing nor disagreeing on the adequacy and effectiveness of these efforts.

The Digital Emotional Intelligence domain had the highest overall mean score ($M = 3.542$, SD = 0.795), indicating a strong emphasis on teaching students about self-awareness, empathy, and interpersonal skills in the digital context. Notably, the survey item, "Teaching digital citizenship has helped improve my students' understanding of their online behavior and responsibilities" scored high ($M = 3.681$, SD = 0.966).

Additionally, the mean score for the Digital Creativity and Innovation domain was also relatively high ($M = 3.428$, SD = 0.676), reflecting that there is a significant focus on promoting creativity and innovation using digital tools. For instance, the item "My students can communicate grade and age-level appropriate ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models, or simulations" had a high mean score ($M = 3.656$, SD = 0.903). This suggests that students are being effectively taught to use digital tools creatively and responsibly to express themselves and engage in innovative activities.

In the qualitative interviews, 15 teachers were asked about the topics and aspects they focus on in digital citizenship education and highlighted several key areas. One common theme was addressing issues that directly influence students, such as hate speech and cyberbullying. A teacher remarked, "I find myself focusing a lot on cyberbullying and hate speech because these are the issues that my students encounter frequently online allowing them to learn how to tackle these and other challenges faced by students in their digital interactions."

Additionally, the specific needs of the school community played a significant role in shaping the digital citizenship curriculum. One teacher noted, "The needs of our community influence what we teach. For example, in our community, there is a high use of social media, so we emphasize safe and responsible use of these platforms." The teacher

TABLE 5 Summary of survey item scores.

DCE element	Survey item	Mean	Std. deviation
Digital literacy	1. There is sufficient emphasis on teaching students to critically evaluate online resources and content as well as adequate time committed to teaching students how to use the technology tools in the classroom.	3.44	0.843
	2. Our school curriculum adequately covers the necessary digital skills for effective internet use.	3.475	0.897
Digital security, privacy, and health and wellness	3. My students understand the importance of digital security measures like passwords and online safety protocols, know how to protect their passwords for online accounts, and know not to share their passwords with a friend	3.832	0.928
	4. My students know that it is important to have proof when they tell you that he/she has been cyberbullied	3.781	0.942
	5. I teach my students about the physical and mental health impacts of excessive digital device usage	2.922	1.182
	6. I regularly discuss the consequences of cyberbullying, flaming, inflammatory language, and so forth in my classes.	3.578	0.879
	7. My students certainly know not to follow or add a stranger as a friend online or allow a stranger to follow them online	3.241	0.876
	8. My students know how to create a password for their online account that is difficult for others to guess and know how to edit their security settings for online accounts	3.58	0.982
	9. My students know very well not to click on a link from a stranger's email	3.593	0.901
Digital law, rights, and responsibilities	10. Students are aware of their rights and responsibilities when participating in digital environments.	3.606	0.924
	11. I teach my students to respect the digital work of others by not plagiarizing or using content without permission.	3.508	0.985
	12. My students are aware of the legal ramifications of their actions in digital spaces, including legal responsibility for what they post, copyright infringement, or digital privacy laws.	2.796	0.997
Digital footprint & identity	13. My students know that they cannot completely delete their online posts.	2.505	0.869
	14. My students understand the consequences of sharing personal information online	3.181	1.117
	15. My students know that a person's digital identity can be different from their face-to-face identity	2.922	1.112
	16. The students clearly know that their online activities can also impact their face-to-face identity.	2.749	0.779
	17. My students know that what others post, share, or reshare about them adds to their digital footprint.	3.088	1.207
Digital commerce	18. Students are adequately taught about safe online purchasing practices through our curriculum.	2.97	0.97
Digital access	19. All students in my school have equal opportunities to access digital technologies.	3.193	0.95
	20. My school actively works towards reducing the digital divide among students.	2.849	0.961
Digital communication & netiquette	21. Students are taught to use digital communication technologies such as social networking sites to support classroom activities.	3.653	0.861
	22. I believe my students adhere to appropriate digital communication standards (e.g., email etiquette, social media interactions) such as understanding that liking/sharing a mean comment/post is also mean	3.45	0.87
Self-awareness, regulation, empathy, interpersonal skills	23. Students realize how their use of technology affects others and are taught how to use technology in ways that minimize the negative effects on others.	3.327	0.911
	24. My students know that posting or saying something online could be seen as rude, mean, or unfair to others of a different race or gender.	3.445	0.884
	25. Teaching digital citizenship has helped improve my students' understanding of their online behavior and responsibilities.	3.681	0.966
	26. Students demonstrate a better understanding of the impact of their actions online after going through digital citizenship lessons.	3.693	0.958
	27. I believe students who are taught digital citizenship exhibit more responsible behavior online.	3.563	0.981
Innovative designer, and creative communicator, literacy and expression	28. My students can choose the right and age-appropriate digital platforms and tools to achieve their communication goals.	3.015	0.568
	29. Students in my class can select the task and age-appropriate digital tools for different creative tasks.	3.515	0.877
	30. My students are aware of how to create original works or responsibly repurpose or remix digital resources into new creations for their classroom projects.	3.525	0.919
	31. My students can communicate grade and age-level-appropriate ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models, or simulations.	3.656	0.903

argued that such an approach helped ensure that the education provided was relevant to the students' environment and experiences. This approach reflects an adaptive use of Pedagogical Content Knowledge (PCK), where teachers tailor their instruction to meet the contextual needs of their students (Mishra and Koehler, 2006).

Emerging topics and current trends within the community also significantly influenced the digital citizenship lessons. A teacher shared, *"We sometimes adjust our focus based on what is trending or emerging in our community. For instance, if there are reports of online scams targeting students, we will address that in our lessons."* The teacher added that such a proactive approach helps prepare students to navigate new and evolving digital challenges effectively. Addressing online scams relates to the Digital Security and Digital Law, Rights, and Responsibilities tenet, which emphasizes the importance of educating students about digital threats and legal implications (Ribble, 2015).

The provided materials and the existing curriculum were also mentioned as guiding factors. One participant stated, *"The topics covered in the materials we receive from the school administration guide what we teach. If the curriculum emphasizes digital security, that becomes our focus."* This indicates that while teachers strive to address immediate and relevant issues, their teaching is also shaped by the curriculum and resources available to them. This reliance on available resources reflects potential limitations in teachers' Technological Content Knowledge (TCK), where they may depend heavily on provided materials due to a lack of confidence or knowledge in adapting or creating new content (Koehler et al., 2013). It highlights the need for more comprehensive training and resources to enhance teachers' TPACK, enabling them to integrate all aspects of digital citizenship effectively.

3.3 RQ2: What are the perceived challenges and barriers that educators face in effectively teaching digital citizenship in Saudi Arabian elementary schools?

The qualitative interviews with teachers revealed several significant challenges in effectively teaching digital citizenship in Saudi Arabian elementary schools. A prevalent issue, cited by the majority of teachers ($n = 9$ out of 15) was the lack of structured guidance to guide DCE effectively. One participant mentioned, *"We do not have a clear guideline or framework to follow. We have approached the administration on multiple occasions to point out a way for us, but they have always said they would escalate the issue to the district level. This makes it difficult to ensure we cover all necessary aspects of digital citizenship."* This lack of structured guidance is corroborated by the survey result for the item *"There is a structured curriculum guiding the teaching of digital citizenship,"* which had a low means score of ($M = 2.53$, $SD = 1.130$), indicating a significant challenge with the participants showing dissatisfaction with the existing curriculum structure in guiding DCE education in their schools. This lack of structured guidance reflects a gap in the existing TPACK framework, specifically in the integration of technological knowledge with pedagogical and content knowledge (Mishra and Koehler, 2006). Without clear frameworks, teachers struggle to align their instructional strategies with the content and technological tools necessary for comprehensive DCE.

Additionally, the majority of the teachers expressed a need for more professional development opportunities related to digital citizenship. One respondent emphasized, *"We need training on how to teach some of these concepts effectively."* This sentiment was supported by survey findings, where the item *"I feel adequately trained to teach digital citizenship in my classroom per the existing curriculum"* scored ($M = 3.26$, $SD = 0.952$), indicating ambivalence as teachers neither agreed nor disagreed with the adequacy of their training. This aligns with the findings of Almazroa and Alotaibi (2023), who highlight the importance of ongoing professional development and mandatory pre-service training to enhance teachers' 21st century skill adeptness such as in TPACK. Insufficient TPACK related training hinders teachers' ability to develop the necessary technological knowledge and technological pedagogical knowledge required to integrate digital tools effectively into their teaching.

Moreover, there was a consensus on the lack of adequate resources, particularly age-appropriate teaching materials and digital tools for younger students with one teacher stating *"Having more resources tailored to our students' age group would greatly help, we are often having to choose the material ourselves but there are hardly any materials relevant for my Grade 2 class."* This aligns with the survey result for the item *"There are enough resources at my disposal to effectively teach digital citizenship,"* which had a mean score of ($M = 3.10$, $SD = 0.956$), reflecting moderate and ambivalence in agreement. This challenge indicates a deficiency in technological content knowledge, where teachers lack access to appropriate technological resources that align with the content they need to teach (Koehler et al., 2013). The absence of suitable materials hinders their ability to deliver effective DCE aligned with both curriculum standards and students' developmental levels. Another teacher acknowledged that though the school administration is supportive, there was a need for more tangible resources. Another teacher also argued that access to a repository of digital citizenship resources and lesson plans on DCE would be immensely helpful for them.

Several teachers also highlighted the challenge of engaging parents in supporting digital citizenship education at home. One teacher observed, *"Parents need to be involved and educated about digital citizenship to reinforce what we teach at school."* This issue was reflected in the survey item *"Parents are actively involved and supportive in reinforcing Digital Citizenship Education (DCE) concepts taught at school,"* which had a low mean score ($M = 2.86$, $SD = 0.924$), indicating that teachers generally perceive a lack of adequate parental engagement and support in reinforcing DCE concepts outside the classroom. Another parent argued, *"Parents are not always aware of what digital citizenship entails, so they cannot reinforce these concepts at home."* When asked if there are efforts to engage parents in DCE, one teacher mentioned, *"It is challenging to get parents involved and ensure they understand the importance of digital citizenship."* This was further emphasized by the survey item, *"I am satisfied with the level of parental involvement in our digital citizenship education"* which scored a very low mean ($M = 2.56$, $SD = 1.079$) indicating teachers' dissatisfaction with the level of parental involvement in digital education. According to Hollandsworth et al. (2011), effective digital citizenship education requires a multi-stakeholder approach, where schools, parents, media specialists, and the community work together to promote responsible digital behavior among students. They emphasize that parental involvement is crucial for reinforcing digital citizenship concepts outside the classroom, as it helps create a

consistent message and supports students in applying what they learn in school to their online activities at home.

The absence of clear policies also emerged as a barrier. The item "To what extent do you agree that there are clear policies supporting digital citizenship education at your school?" scored ($M = 3.41$, SD = 0.917). This suggests that teachers generally agree that policies exist but may not be comprehensive or well-communicated. Additionally, a teacher in the qualitative interviews mentioned, "*While we have some guidelines from the district board and at the school level, they are not always clear or sufficient to guide us in covering all aspects of digital citizenship.*" Such a lack of policy clarity impacts teachers' pedagogical knowledge and their ability to plan and deliver comprehensive DCE lessons effectively (Mishra and Koehler, 2006). Clear policies and guidelines are essential for providing a structured framework within which teachers can operate.

These qualitative findings coincide with the survey results highlighted in Table 6.

3.4 RQ3: To what extent do teachers' demographic characteristics and school contexts influence their perceptions and practices of digital citizenship education in Saudi Arabian elementary schools?

A multivariate analysis of variance (MANOVA) was conducted to examine the impact of teachers' demographic characteristics (age, gender) and school contexts (teaching experience in DCE, school type, region) on various dimensions of digital citizenship education. The dimensions considered included Digital Literacy, Digital Security and Privacy, Digital Law and Rights, Digital Footprint and Identity, Digital Commerce, Digital Access, Digital Communication and Netiquette, Digital Self-Awareness, Regulation and Empathy, and Digital Innovation and Creative Communication.

The multivariate tests showed significant effects for the intercept, indicating substantial overall model fit (Pillai's Trace = 0.907, F (9, 299) = 325.010, $p < 0.001$, $\eta^2 = 0.907$). However, the main effects of age group, gender, years of experience teaching DCE, school type, and region were not found to be significant for the elements of digital citizenship. This lack of significant findings suggests that individually, these demographic and contextual factors do not independently exert significant influences on the perceptions and practices of digital citizenship education.

Additionally, no significant interaction effects were observed when examining the combined effect of the teachers' age group and gender as well as for the combination of Age Group and Years of Experience teaching DCE, highlighting that these factors do not combine to influence digital citizenship outcomes significantly. Moreover, no significant interaction effects for the elements of digital citizenship were reported when testing for the combined effect of the teachers' age and school region.

However, significant effects were observed in the interaction between the teachers' age group and school type on Digital Literacy (F (3, 307) = 3.75, $p = 0.019$, $\eta^2 = 0.032$); Digital Security, Privacy, and Health and Wellness (F (3, 307) = 3.75, $p = 0.023$, $\eta^2 = 0.031$), and Digital Access (F (3, 307) = 3.41, $p = 0.036$, $\eta^2 = 0.027$). These findings indicate that the interplay between these factors influences digital citizenship education outcomes. Notably, the combined influence of

age group and school type is more pronounced, potentially reflecting different educational needs and technology integration levels across age groups and school types. Practically, this may indicate that younger teachers in certain school types (such as private vs. public schools) are more proficient or place greater emphasis on integrating digital literacy and security topics into their teaching. This could be due to differences in access to resources, training opportunities, or varying institutional priorities across different school types. Nonetheless, the effect sizes for these interactions were small to moderate.

Additionally, combining gender and the teacher's years of experience in DCE indicated significant interaction effects on multiple digital citizenship elements with small to moderate effect sizes, indicating subtle differences based on gender and professional experience. These included: Digital Literacy (F (3, 307) = 3.68, $p = 0.026$, $\eta^2 = 0.030$); Digital Security, Privacy, and Health and Wellness (F (3, 307) = 4.12, $p = 0.006$, $\eta^2 = 0.040$); Digital Law, Rights and Responsibilities (F (3, 307) = 3.59, $p = 0.028$, $\eta^2 = 0.029$); Digital Access (F (3, 307) = 4.19, $p = 0.008$, $\eta^2 = 0.037$); Digital Communication and Netiquette (F (3, 307) = 4.17, $p = 0.009$, $\eta^2 = 0.037$); Digital Self-Awareness, Regulation and Empathy (F (3, 307) = 3.248, $p = 0.022$, $\eta^2 = 0.031$); and Digital Innovation and Creative Communication (F (3, 307) = 4.774, $p = 0.003$, $\eta^2 = 0.045$). These findings highlight possible influences of both gender and teaching experience in DCE when examining digital citizenship education. The findings may be an indicator that male and female teachers with differing levels of experience approach digital citizenship topics differently, possibly due to variations in professional development experiences, comfort with technology, or cultural expectations influencing teaching practices. On the other hand, no significant interaction effects were observed upon combining: Gender and School Type, Gender and Region, Years of Experience teaching DCE and School Type, Years of Experience and Region, as well as School Type and Region.

Additionally, testing for higher-order interaction indicated only one significant three-way interaction among age group, gender, and years of experience for Digital Literacy (F (3, 307) = 3.52, $p = 0.034$, $\eta^2 = 0.015$) and Digital Security, Privacy, and Health and Wellness (F (3, 307) = 3.44, $p = 0.042$, $\eta^2 = 0.013$), with relatively low effect sizes. No significant interaction effects were observed for the four-way interactions involving age group, gender, years of experience, school type, and region.

Ultimately, the multivariate analysis indicated that while the main effects of age group, gender, years of experience, school type, and region were not significant individually for most digital citizenship elements, certain interaction effects (especially involving gender and years of experience teaching DCE) revealed significant influences on various aspects of digital citizenship education with effect sizes indicating that gender and years of experience have moderate impacts on various aspects of digital citizenship education (η^2 ranging from 0.029 to 0.045). These findings highlight the possible complexity and interplay of multiple factors in shaping digital citizenship education outcomes. Understanding these interactions can help in designing targeted interventions that consider the specific needs and strengths of different teacher groups.

However, while MANOVA is a robust statistical technique for examining multiple dependent variables and their relationships with independent variables, it does not indicate causality but rather associations between variables (Tabachnick and Fidell, 2013).

TABLE 6 Teacher's perceptions of challenges and opportunities.

Item	Mean	Std. Deviation
32. I feel adequately trained to teach digital citizenship in my classroom per the existing curriculum.	3.26	0.952
33. There are enough resources at my disposal to effectively teach digital citizenship.	3.10	0.956
34. My school provides ongoing support and training for teaching digital citizenship.	3.35	0.885
35. There is a structured curriculum guiding the teaching of digital citizenship.	2.53	1.130
36. Parents are actively involved and supportive in reinforcing Digital Citizenship Education (DCE) concepts taught at school.	2.86	1.021
37. To what extent do you agree that there are clear policies supporting digital citizenship education at your school?	3.41	0.917
38. Do you agree that you are sufficiently supported by your school administration in implementing digital citizenship education?	3.49	0.949
39. I am satisfied with the level of parental involvement in our digital citizenship education.	2.56	1.079

Therefore, while significant interactions were found between demographic factors and elements of digital citizenship education, these results indicate patterns of association that are valuable for understanding the interplay of these factors. Establishing causality would require longitudinal or experimental studies. Nonetheless, the observed associations provide meaningful insights that can inform educational policies and professional development programs. Recognizing these associations helps in identifying specific groups of teachers who may benefit from targeted interventions to enhance digital citizenship education. For instance, professional development initiatives can be designed to address the specific needs of teachers based on their age group, gender, and years of experience.

3.5 RQ4: What pedagogical strategies, activities, and resources are perceived as effective by teachers in facilitating digital citizenship education?

The 15 teachers engaged in the semi-structured interviews shared various strategies they found effective in teaching digital citizenship. Interactive activities, such as role-playing and simulations, were particularly noted for their effectiveness in teaching concepts like online safety and digital etiquette. One teacher shared, "*My students are always enjoying the lesson and really engage when I use scenarios that they can relate to.*" Another added, "*Interactive games that focus on online safety and etiquette are highly engaging for students. I have recommended these to my colleagues because they really help in making the lessons stick.*" These methods allow students to experience real-world scenarios in a controlled environment, helping them to understand the consequences of their actions and to practice appropriate responses. For example, a teacher mentioned, "*We used a simulation where students had to navigate a series of online interactions, making choices about how to respond to cyberbullying. It was eye-opening for them.*"

Collaborative projects were also highlighted as a successful strategy. These projects were reported as effective in encouraging students to work together and practice digital citizenship skills. One teacher noted, "*Group projects that involve online research and presentations help students understand the importance of digital responsibility.*" Another commented, "*Encouraging students to work on digital presentations promotes both creativity and understanding of digital tools.*" Another teacher added, "*Group projects where students create digital content together help them learn about collaboration and*

respect online." These projects promote teamwork and collective problem-solving, essential skills in digital environments. A teacher elaborated, "*We had a project where students had to undertake a project and presentation together. They learned not just about the topic, but also how to communicate effectively and responsibly online.*"

The use of educational digital tools and games was another effective method mentioned. A participant highlighted, "*There are some great apps and games that teach students about online safety in a fun way.*" In the effort of incorporating these tools, teachers demonstrate their technological knowledge and their ability to select appropriate technological resources that align with pedagogical goals and content needs. These tools make learning about digital citizenship engaging and enjoyable for students. For example, teachers cited the use of platforms like Google Classroom and educational games like "Interland" by Google, which teaches kids about internet safety through interactive gameplay. Another teacher added, "*Apps that gamify the learning experience make the concepts more relatable and easier to understand for younger students.*"

Inviting guest speakers and organizing workshops were also cited as impactful strategies. One teacher recounted, "*We invited a cybersecurity expert to talk to students about online safety. Hearing from a professional really made the importance of the topic hit home for them.*" These sessions provide students with expert insights and real-world applications of digital citizenship principles. Another teacher noted, "*Workshops where students can engage hands-on with digital tools and see demonstrations of good practices are very effective.*"

Additionally, blended learning approaches that integrate digital citizenship concepts into other subjects were also praised. One teacher explained, "*I integrate some of the digital citizenship topics into our social studies and language arts classes. This helps students see the relevance of these skills in different contexts.*" Embedding digital citizenship education across various subjects, allows students to see its applicability in multiple areas of their lives. Another teacher highlighted, "*Using a cross-curricular approach makes the lessons more meaningful and helps reinforce the concepts.*" This cross-curricular integration demonstrates teachers' technological pedagogical content knowledge, as they incorporate digital citizenship content into various subject areas using appropriate pedagogical strategies and technologies.

Teachers also emphasized the importance of assessing students' understanding and providing feedback. One teacher shared, "*We use quizzes and reflective essays to assess students' grasp of digital citizenship concepts. The feedback helps them improve and understand their strengths and areas for growth.*" Regular assessment ensures that students are internalizing the lessons and can apply them effectively.

Another teacher added, "*Interactive assessments like online quizzes not only test knowledge but also engage students in a fun way.*"

3.6 RQ5: How can curriculum and instruction design be enhanced to better support the development of digital citizenship skills among elementary school students in Saudi Arabia, considering international best practices and local contextual factors?

When asked to provide recommendations for improving DCE within their schools, teachers provided several recommendations for improving digital citizenship education. Among these recommendations, integrating digital citizenship lessons into existing subjects rather than teaching them as standalone topics was a common suggestion. One teacher proposed, "*We can integrate these lessons into subjects like social studies and language arts to make them more relevant.*" Another emphasized the need for an age-appropriate curriculum, stating, "*Ensuring that the curriculum is age-appropriate and progressively builds on previous knowledge is essential.*"

There was also a strong advocacy for continuous professional development and training for teachers. "*Regular workshops and training sessions on the latest trends and best practices in digital citizenship would be beneficial by helping us stay updated and more confident in our teaching,*" recommended one participant. The survey results further support these findings. The item "My school provides ongoing support and training for teaching digital citizenship" had a mean score of ($M = 3.35$, SD = 0.885), indicating moderate agreement that schools offer ongoing support and training.

Additionally, involving parents in digital citizenship education was perceived to be crucial. Teachers advocated for programs that engage parents and provide them with the necessary knowledge and tools to support digital citizenship education at home. One teacher remarked, "*Workshops and resources for parents would help them understand and support what we teach their children.*" This sentiment was supported by another teacher who said, "*Engaging parents through workshops and informational sessions would help in reinforcing these concepts at home.*"

The need for clear policies and robust resources also emerged as a critical theme among educators. Teachers consistently emphasized that the lack of structured guidelines and readily accessible teaching materials hindered their ability to effectively integrate digital citizenship education (DCE) into their classrooms. One teacher articulated, "*Having clear policies and a repository of digital citizenship resources and lesson plans would be immensely helpful.*" This sentiment was echoed by several others who stressed that well-defined policies provide a framework that ensures consistency and comprehensiveness in teaching DCE. These sentiments coincide with the findings from the survey based on the item, "To what extent do you agree that there are clear policies supporting digital citizenship education at your school?" which scored ($M = 3.41$, SD = 0.917) indicating uncertainty with the clarity of existing policies. Without clear policies, teachers reported they often feel directionless and uncertain about the scope and depth of the topics they should cover. Another teacher remarked, "*We sometimes receive contradictory messages about what should be prioritized in digital citizenship. Clear policies would provide a*

unified direction and help avoid confusion." This highlights the necessity for school administrations to develop and communicate clear, consistent policies regarding DCE, ensuring that all educators are aligned in their approach.

Moreover, resources tailored to the specific needs of different grade levels were identified as another crucial requirement. A teacher commented, "*The materials we have are often too generic and not suitable for younger students. We need age-appropriate resources that are engaging and relatable for elementary students,*" reflecting a common issue where resources are either too advanced or too simplistic, failing to effectively engage students at their respective developmental stages. This need is reinforced by the majority's consensus on the lack of adequate resources, particularly age-appropriate teaching materials and digital tools for younger students. One teacher shared an example of the challenge, stating, "*I often have to spend extra time creating or adapting materials because the provided resources do not fit my students' needs. If we had a well-organized repository of resources, it would save time and ensure consistency with existing needs.*" This underscores the need for a centralized repository where educators can access a variety of vetted, age-appropriate materials, including lesson plans, interactive activities, and digital tools designed to teach various aspects of digital citizenship.

Teachers also highlighted the role of school administrations in providing the necessary support for DCE. The survey item "How supported do you feel by your school administration in implementing digital citizenship education?" scored a mean of ($M = 3.49$, SD = 0.949), indicating that teachers feel somewhat supported by their administration. However, there is still a need for more robust support. In the qualitative interviews, one teacher mentioned, "*The administration is supportive in principle, but we need more tangible support in terms of resources and clear guidelines.*"

4 Discussion

The findings of this study illuminate the current landscape of Digital Citizenship Education (DCE) in Saudi Arabian elementary schools, highlighting both its strengths and areas needing enhancement. The emphasis on Digital Emotional Intelligence reflects a commendable focus on promoting self-awareness, empathy, and interpersonal skills in digital interactions, aligning with the broader literature that emphasizes emotional intelligence as critical for navigating digital environments (Leeuw and Joseph, 2023; Ertiö et al., 2024). This focus is particularly relevant given the high rates of social media usage among Saudi youth (Hammad and Awed, 2022; Kemp, 2023), and the potential psychological impacts associated with digital immersion (Liu et al., 2016; Booker et al., 2018). From the perspective of the TPACK framework (Mishra and Koehler, 2006), this suggests that teachers possess the necessary content knowledge and pedagogical knowledge to address emotional aspects of digital citizenship, integrating them effectively into their teaching practices.

However, significant gaps persist, particularly in the domains of Digital Participation and Agency and Digital Footprint and Identity. The low mean scores for Digital Footprint and Identity ($M = 2.889$, SD = 0.623) and Digital Participation and Agency ($M = 3.223$, SD = 0.698) suggest that topics such as digital commerce, access, communication, and the long-term impacts of online activities are not

adequately covered. According to Ribble's Digital Citizenship Model (Ribble, 2015), these areas correspond to essential elements like Digital Communication, Digital Literacy, and Digital Commerce. The deficiencies in these areas indicate a gap in teachers' content knowledge regarding these specific digital citizenship concepts, as well as potential limitations in their technological knowledge to effectively integrate these topics into the curriculum.

These low scores emphasize the need to enhance teacher training in these areas to improve student understanding as well as curriculum enhancements to promote active digital engagement. Within the TPACK framework, this calls for a strengthening of the intersection between technological knowledge, pedagogical knowledge, and content knowledge related to digital citizenship (Koehler et al., 2013). Teachers need to develop an understanding of digital citizenship content as well as the pedagogical strategies and technological proficiency required to effectively teach these concepts. This aligns with the findings and recommendations of recent studies that emphasize the importance of teacher training in digital citizenship education (Öztürk, 2021; Simões et al., 2024).

These findings also echo concerns in existing research that highlight the necessity of comprehensive education in all facets of digital citizenship to prepare students effectively for the digital world (Ribble, 2015; ISTE, 2023). The gap and underdevelopment in Digital Participation and Agency may be attributable to limited access to digital platforms in schools and a lack of emphasis on collaborative online learning activities due to infrastructural constraints (Pettersson, 2021; Timotheou et al., 2023). Additionally, cultural factors may influence the cautious approach towards open digital participation (Lewis, 2019; Alqirnas, 2022; Wahid, 2024). For instance, the conservative nature of Saudi society, guided by Islamic principles and traditions, influences attitudes towards digital interaction and content consumption (Lewis, 2019; Almekhled and Petrie, 2024). This suggests that the technological context in which teachers operate affects their ability to integrate certain digital citizenship elements, highlighting the importance of considering external factors when designing interventions.

Moreover, the lower scored elements such as digital commerce ($M = 2.970$, SD = 0.970) and access ($M = 3.021$, SD = 0.825) indicate a need for further integration aligned with recommendations from international frameworks that stress the importance of these competencies for empowering students to engage effectively in the digital economy and civic life (UNESCO, 2016; ISTE, 2023; UNESCO, 2024). On the other hand, as highlighted by Yurinova et al. (2022), the low awareness of Digital Footprint and Identity could be attributed to insufficient teacher training on these topics, resulting in minimal coverage within the curriculum, highlighting the need to enhance teachers' content knowledge and technological knowledge in these specific areas.

The qualitative data reveals significant challenges, including the lack of clear guidelines and structured frameworks, insufficient professional development opportunities for teachers, and inadequate resources tailored to younger students, findings that were corroborated with teachers' perceptions shared through the survey. Per the TPACK framework, these challenges point to gaps in technological pedagogical knowledge and technological content knowledge, where teachers may lack the skills to select and use appropriate technologies for teaching digital citizenship content effectively (Mishra and Koehler, 2006). Ongoing professional development and training allow for continuous

upskilling enabling teachers to stay abreast of evolving digital challenges and best practices (Almazroa and Alotaibi, 2023; Öztürk, 2021).

The results from the multivariate analysis of variance (MANOVA) highlight significant insights into the factors influencing DCE in Saudi Arabian elementary schools. While the main effects of demographic variables such as age group, gender, years of experience, school type, and region were not individually significant for most digital citizenship elements, significant interaction effects were observed in certain combinations, particularly involving the teachers' age group, school type, and gender combined with years of experience, revealing significant influences. Significant interaction effects were found between teachers' age group and school type for Digital Literacy, Digital Security, Privacy, and Health and Wellness, and Digital Access. These findings suggest that younger teachers in certain school types might be more adept at integrating digital citizenship elements into their teaching. This aligns with findings from recent research, which indicate that younger teachers generally have stronger digital information skills (Saikkonen and Kaarakainen, 2021). This generational gap in digital competency also highlights the need for targeted professional development programs for older or less adept teachers (Tomczyk et al., 2022). Tailoring training initiatives can enhance overall DCE effectiveness and improve consistency across educators.

Combining gender and years of experience also showed significant interaction effects across multiple elements of digital citizenship, implying that male and female teachers with varying years of experience may approach digital citizenship education differently. However, previous studies, such as Cantú-Ballesteros et al. (2017), found no significant differences between male and female teachers' use of ICT, suggesting that other factors might be at play here. Additionally, higher-order interaction effects involving age group, gender, and years of experience were significant for Digital Literacy and Digital Security, Privacy, and Health and Wellness. This indicates a complex interplay of these demographic factors in influencing certain aspects of digital citizenship education.

Moreover, the implementation of DCE in Saudi Arabia could be influenced by the interplay of existing socio-political factors and cultural norms such as those emphasizing traditional, religious, and cautious engagement with digital content (Gökhan, 2019; Nisa, 2021; Alkouatli et al., 2023). Future interventions should emphasize the necessity for DCE to address digital skills gaps aligned with the cultural preservation preferences and ethical considerations specific to the Saudi context. Existing cultural sensitivities related to familial privacy, gender, and Islamic principles may lead educators to place greater emphasis on Digital Emotional Intelligence and Digital Security over Digital Participation, aiming to protect students while promoting responsible online behavior. Therefore, DCE in Saudi Arabia must balance the promotion of global digital citizenship competencies with respect for local cultural and religious norms. Understanding these dynamics is essential for developing effective DCE strategies that are globally informed as well as locally relevant with respect for local cultural and religious norms.

Nonetheless, the effect sizes though statistically significant, were small, indicating that these interactions have modest or small to moderate impacts but meaningful influence on DCE perceptions. This emphasizes the importance of considering multiple factors in shaping

digital citizenship education outcomes. These findings also underscore the complexity and interplay of multiple factors, which can provide valuable insights for educational policymakers and curriculum developers aiming to address specific gaps or leverage strengths identified through these factors. Practically, these modest but meaningful effect sizes suggest that while demographics play a role, other factors such as institutional policies, resource availability, and teachers' TPACK may have a greater impact. Further analysis of these and other factors in future research would provide deeper insights into how these variables interact to influence digital citizenship education, aiding in the development of more tailored educational strategies. Recent studies highlight more significant determinants, including teachers' beliefs, available resources, training opportunities, and school policies (Saikkonen and Kaarakainen, 2021; Hatos et al., 2022). Effective professional development and training, highlighted by Öztürk (2021) and Simões et al. (2024), are crucial for building digital competencies among teachers, suggesting that targeted interventions in these areas could mitigate the variability introduced by demographic factors and enhance teachers' TPACK.

4.1 Implications and recommendations

4.1.1 Managerial implications

The findings of this study have significant implications for school administrators responsible for implementing digital citizenship education. Firstly, the effectiveness of DCE is significantly dependent on teachers' knowledge and awareness, highlighting the need for ongoing professional development programs. Thus, schools should invest in training initiatives that enhance teachers' technological knowledge, pedagogical knowledge, and content knowledge, as well as their ability to integrate the different domains of DCE effectively, as per the TPACK framework s (Mishra and Koehler, 2006). These programs should aim to develop teachers' TK, PK, and CK, as well as their ability to integrate these domains effectively. Such initiatives could include mandatory training programs, workshops, online courses, and collaborative learning communities to facilitate continuous professional development, enabling teachers to stay abreast of evolving digital challenges, international digital citizenship standards, digital competencies, and effective pedagogical strategies for DCE. Moreover, implementing structured training programs using resources such as "Be Internet Awesome" by Google and the Microsoft Digital Literacy Curriculum can reinforce and enhance the effectiveness of training initiatives. Additionally, aligned with insights from recent studies, conducting workshops and seminars in collaboration with experts such as in digital literacy and cybersecurity can help keep teachers updated on the latest trends and tools in digital citizenship education (Öztürk, 2021; Simões et al., 2024). Moreover, establishing collaborative learning communities where teachers can share experiences, challenges, and successful practices in teaching digital citizenship can help in building a supportive network and encouraging innovation in teaching methods (Saikkonen and Kaarakainen, 2021).

Additionally, integrating age-appropriate digital citizenship activities can help students understand and practice digital citizenship concepts effectively. Thus, teachers need to apply their TPACK to design and implement learning activities that are pedagogically sound, technologically appropriate, and content-rich. Activities that involve collaboration, creativity, and critical thinking can make learning more meaningful and enjoyable. For instance, engaging students in activities such as creating class rules for online behavior, storytelling, and role-playing scenarios can help students understand the importance of responsible behavior online and take ownership of their learning as well as make learning more enjoyable. These efforts can be enhanced by combining them with interactive tools and games like "Digital Passport" by Common Sense Education and "Cyber Choices" by MediaSmarts which provide hands-on experiences that promote safe online behavior and critical thinking skills.

Moreover, identifying and addressing the challenges educators face in teaching digital citizenship, such as lack of sufficient resources and structured guidelines is essential for improving curriculum integration. School managers should ensure that adequate support and age-appropriate resources are available and accessible for teachers to help them effectively teach digital citizenship. Developing a repository of digital citizenship resources, including lesson plans and digital tools, can support teachers in integrating all elements of digital citizenship into their teaching (Simões et al., 2024). Additionally, clear communication of school policies regarding DCE and providing support from the administration can enhance teachers' confidence and effectiveness in teaching these concepts. Schools should also partner with the Ministry of education as well as private sector stakeholders such as those with interests in edtech to source and allocate funding for technological infrastructure and age-appropriate digital tools within schools to ensure equitable access and engagement.

Similarly, engaging parents and the broader community is vital for effectively reinforcing digital citizenship principles both inside and outside the classroom. Research emphasizes the significance of a multi-stakeholder approach in digital citizenship education, where collaboration between schools, families, and the community enhances the learning experience and promotes consistent reinforcement of responsible digital behavior (Hollandsworth et al., 2011; Imran et al., 2023). Initiatives such as organizing workshops to educate parents about digital citizenship and online safety, developing community programs that promote digital literacy, and providing parental engagement tools can empower parents to support their children's learning and understand the importance of digital citizenship. These collaborative efforts can help bridge the knowledge gap between digitally savvy students and their parents as well as align educational practices with cultural values and societal expectations, particularly in contexts like Saudi Arabia where cultural factors significantly influence attitudes toward digital technology (Lewis, 2019; Alqirnas, 2022). Thus, involving parents and the immediate community can help schools extend the impact of digital citizenship education beyond the classroom, promoting a supportive ecosystem that nurtures students' development as responsible digital citizens and contribute to a digitally literate and resilient society.

Teaching students to critically assess online information is also essential in today's digital age. Developing these skills early on helps students become discerning consumers of digital content and prevents the spread of misinformation. Guiding students through evaluating websites based on author credentials, factual accuracy, and presentation quality helps them differentiate between reliable and unreliable sources. Activities like "Real or Photoshop" available on Adobe's website can teach students about the impact of digital manipulation and the importance of verifying information before accepting it as true.

Educating students about the permanence and impact of their digital footprints is also crucial for promoting responsible online behavior. Projects that encourage reflection on their digital presence can help students manage their online identities effectively. Educators can create projects where students reflect on their digital footprints by examining their social media profiles or blogs and discussing ways to improve their online presence to represent themselves positively. Inviting guest speakers, such as network security experts and social media managers, can also provide students with real-world insights into the implications of digital footprints and responsible online behavior.

4.1.2 Policy implications

At the policy level, the Ministry of Education should develop clear policies and guidelines that support DCE implementation (Hammad and Awed, 2022), and a standardized DCE curriculum aligned with international standards such as ISTE and UNESCO frameworks and tailored to the Saudi context (UNESCO, 2016; ISTE, 2023). This curriculum should gain insight from or adopt frameworks like Singapore's Cyber Wellness Framework and incorporate them into the local context to ensure comprehensive digital citizenship education (UNESCO, 2016). Additionally, this DCE curriculum should be comprehensive, integrating digital citizenship across various subjects and grade levels to provide students with a holistic understanding of their rights and responsibilities in the digital world. Incorporating digital citizenship lessons into existing subjects such as language arts, social studies, and science using multimedia resources, including instructional videos, animated stories, and interactive presentations can make learning engaging and relatable for young students. Additionally, implementing collaborative projects where students can work together on tasks related to digital citizenship, such as creating digital safety posters or developing a class blog on digital responsibility topics can enhance engagement and relevance. Emphasis should also be made on the identified gaps, including Digital Footprint, Identity, and Participation. Resources like the Common Sense Education digital citizenship curriculum offer age-appropriate lessons that cover topics such as media balance, privacy and security, and cyberbullying (UNESCO, 2016).

Recent studies also highlight the importance of developing clear and robust policies and guidelines to support the implementation of digital citizenship education at the school and district levels (Saikkonen and Kaarakainen, 2021). Schools should establish clear policies that support DCE, including guidelines for digital resource usage, ethical online behavior, and collaboration with parents to reinforce learning at home. Moreover, policies should mandate and support professional development programs focusing on digital competencies and effective pedagogical strategies for DCE. Policies aimed at allocating funding and resources for teacher training ISTE, 2023 can also substantially enhance the overall quality of digital citizenship education (Almazroa and Alotaibi, 2023). Clear policies aimed at facilitating the integration of digital technologies in schools, ensuring equitable access and reducing the digital divide among students should also be prioritized (Pettersson, 2021).

Lastly, engaging multiple stakeholders, including parents, teachers, and the broader community, is crucial for the effective implementation of digital citizenship education. Policies should encourage schools to collaborate with parents to reinforce learning at home and promote awareness of digital citizenship principles. Such

policies should also mandate the direct involvement of parents and community leaders in the development DCE initiatives to reinforce and address cultural concerns about digital interactions (Imran et al., 2023). Additionally, developing clear guidelines for parental involvement and community partnerships can enhance the cultural relevance and effectiveness of DCE initiatives. Moreover, establishing partnerships with local organizations, law enforcement, and technology experts in policy development can provide diverse perspectives and expertise in digital citizenship education policies (UNESCO, 2016). Through such recommendations, Saudi Arabian elementary schools can enhance their digital citizenship education, better preparing students to navigate the digital landscape safely, responsibly, and ethically.

5 Limitations

The study's findings should be considered in light of several limitations. The self-reporting nature of the survey used for data collection may have introduced biases, such as recall bias and social desirability bias, which could affect the accuracy of the responses. Participants might have provided responses they perceived as favorable, misinterpreted questions, or failed to recall information accurately. Additionally, not all participants responded to every question, potentially due to the inability to obtain necessary information or reluctance to divulge certain details, which could affect the comprehensiveness of the data. However, the incomplete survey questionnaires were excluded to determine the final sample size.

Another challenge is that variations in the implementation of digital citizenship education programs across different schools, with respect to the timing of lessons and instructors' professional backgrounds. These inconsistencies might have complicated the evaluation of the program and shape teachers' perceptions of its overall effectiveness, making it difficult to draw uniform conclusions across the board. Moreover, the lack of a common understanding among respondents regarding key concepts such as digital citizenship and cyber wellness might have affected the validity of the responses. Terms like "policy" were used broadly to cover various actions, which may have led to confusion and inconsistency in responses. The study's scope was also limited to formal education systems, excluding non-formal education settings. As a result, the findings cannot be extrapolated to other educational contexts, such as informal learning environments. These limitations highlight the need for follow-up studies to verify and expand upon the findings presented here.

To address these limitations and enhance the robustness of future research, scholars should explore the perspectives of other stakeholders, such as parents, school administrators, and policy-makers, to enrich the insights into effective digital citizenship education. Additionally, future research should investigate the impact of specific training programs and resources on teachers' ability to integrate DCE into their curricula effectively. Longitudinal studies should also be conducted to assess the long-term impact of digital citizenship education interventions on students' behavior and competencies. Future research should also examine more items under each element of DCE.

6 Conclusion

This study provides valuable insights into the current state of digital citizenship education in Saudi Arabian elementary schools, highlighting strengths in areas like Digital Emotional Intelligence and Digital Security while highlighting significant gaps in Digital Participation and Digital Footprint awareness. The findings highlight the influence of teacher demographics on DCE perceptions and practices, suggesting the critical need for and importance of ongoing targeted professional development and training for teachers, integrating age-appropriate digital citizenship activities, and developing clear policies and robust resources to support educators. With insight from the findings, the study offers actionable recommendations for curriculum development, teacher training, and policy implementation. These contributions advance the understanding of DCE in Saudi Arabia and provide a foundation for enhancing digital citizenship Saudi Arabian elementary school students, better-preparing them to traverse the digital landscape safely, responsibly, and ethically.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Deanship of Scientific Research of the Northern Border University. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

NA: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Writing – original draft, Writing – review & editing. MA: Formal analysis, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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