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The impact of blended learning environment on students' awareness of sustainable digital citizenship and intellectual security requirements in Saudi higher education

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ABSTRACT

This study investigated the impact of a sustainability-oriented blended learning course on fostering responsible digital personalities and enhancing intellectual security among Saudi university students. Utilizing a sequential explanatory mixed-methods approach, the research involved 540 undergraduates, divided into traditional (n = 274) and blended (n = 266) learning formats. Quantitative results demonstrated that students enrolled in the blended course significantly surpassed their traditional peers across all facets of sustainable digital citizenship and intellectual security, exhibiting substantial effect sizes for total sustainable digital citizenship (d = 1.96) and a considerable effect for intellectual security (d = 1.23). Correlation analyses showed a positive relationship between responsible digital personality and intellectual security, but mediation analyses indicated that the blended learning intervention influenced these outcomes independently rather than sequentially. Qualitative data from open-ended responses, reflective journals, and interviews with 12 selected students revealed four key themes: reconceptualizing responsible digital personality, perceiving the blended environment as a "safe simulator," redefining intellectual security as active resilience, and linking digital citizenship to social sustainability aligned with Vision 2030. Overall, the findings suggest that well-designed blended learning environments can enhance ethical digital behaviors and intellectual resilience, providing a scalable model for higher education in digitally evolving societies.

KEYWORDS: sustainable digital citizenship, blended learning, intellectual security, responsible digital personality, higher education, Saudi Arabia

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1. Introduction

Saudi higher education is undergoing rapid digital transformation in line with Vision 2030, with universities increasingly adopting blended formats that combine face-to-face instruction, learning management systems, and a wide spectrum of digital resources. Post-pandemic reforms have normalized hybrid and blended learning across Saudi institutions, particularly as policymakers seek to reconcile quality, flexibility, and inclusion in a digitally mediated knowledge economy (Aladsani et al., 2022; Almalki, 2011). Within this context, the notion of digital citizenship has gained prominence as a strategic competence for learners who are expected to participate productively, safely, and ethically in online environments (Jæger, 2021; Richardson & Milovidov, 2019).

Concurrently, Saudi policy discourse emphasizes intellectual security (al-amn al-fikrī) as a central educational goal, linked to protecting youth from extremism, rumors, and value erosion while fostering balanced identity, loyalty, and critical awareness. Intellectual security is increasingly framed as a digital challenge, given that university students' beliefs, attitudes, and forms of civic engagement are deeply shaped by social media and algorithmic platforms. Research in Arab and Muslim-majority contexts suggests that digital media may simultaneously function as a risk factor—by amplifying polarizing content and misinformation—and as a potential tool for promoting moderation and resilience, depending on how critically and responsibly it is used (Lewin, Niederhauser, Johnson, Saito, & Skouteris, 2021; Mitsea, Drigas, & Skianis, 2023).

On the global level, digital citizenship is now explicitly linked to sustainable development. Lomachinska and colleagues (2025) conceptualize "digital citizenship and knowledge management in education" as strategic pathways to sustainability, arguing that the ethical, critical and collaborative use of digital tools is indispensable for achieving long-term educational and societal goals (Lomachinska et al. , 2025). Similarly, work on "digitainability" underlines that digital competence must be tied to social, environmental, and economic sustainability if societies are to harness post-COVID digital transformations for the common good (Sá, Santos, Serpa, & Ferreira, 2021).

Frameworks such as DigComp 2.2 and the Digital Citizenship Education (DCE) Handbook conceptualize digital competence as an integrated set of knowledge, skills, and attitudes encompassing information literacy, communication and collaboration, digital content creation, safety, problem solving, and explicit dispositions of criticality, responsibility, and sustainability (Vuorikari, Kluzer, & Punie, 2022; Richardson & Milovidov, 2019). Empirical work on students' digital maturity shows that ethical and responsible use of technology, together with critical thinking, is positively associated with sustainable behavioral patterns and pro-environmental orientations (Awdziej, Jaciow, Lipowski, Tkaczyk, & Wolny, 2023). At the university level, targeted training can significantly enhance both digital citizenship skills and students' attitudes toward sustainable development (Almudara et al., 2024; Simon, 2025).

Despite this growing body of work, research in Saudi Arabia has largely focused on the effectiveness and challenges of blended learning in terms of satisfaction, achievement, infrastructure, and equity (Aladsani et al., 2022; Almalki, 2011), with relatively little attention to deeper outcomes such as sustainable digital citizenship, responsible digital personality, or intellectual security. Studies that do examine digital citizenship among Saudi students generally report moderate levels of competence but highlight weaknesses in critical resistance to harmful content and in ethically grounded, sustainability-oriented digital practices (Zhao, Sánchez Gómez, Pinto Llorente, & Sánchez, 2021; Saeed, 2020).

The present study responds to these gaps by examining, in a Saudi university context, whether and how a sustainability-oriented blended digital learning course can cultivate a "responsible digital personality" and, in turn, enhance intellectual security among Saudi university students. By integrating digital citizenship and sustainability frameworks with Saudi concerns about intellectual security, the study aims to contribute both theoretically and practically to ongoing debates about the future of digital higher education in the Kingdom.

2. Literature Review

2.1 Digital citizenship and sustainable development

Digital citizenship has gradually shifted from a narrow concern with online safety and technical skills to a multidimensional construct tied to democracy, ethics, and sustainability. Systematic reviews show that contemporary definitions are increasingly "maximalist," linking digital citizenship to civic engagement, social justice, and participation in complex information ecologies (Ceccarini, 2021; Jæger, 2021). The Council of Europe's *Digital Citizenship Education Handbook* conceptualizes digital citizenship across three domains—being online, well-being online, and rights online—each integrating knowledge, skills, attitudes, and values such as empathy, responsibility, and critical reflection (Richardson & Milovidov, 2019).

At the same time, global policy and governance debates frame digital citizenship within broader projects of sustainable digital development. Work on digital governance and smart cities emphasizes that advanced technologies must be embedded in accountable, equitable, and rights-respecting frameworks if they are to support public welfare and environmental sustainability (Calzada, 2021; Kitchin, 2016; Milakovich, 2021). In similar fashion, studies on smart and sustainable cities, digital twins, and platformized metaverse environments highlight the need for digital rights, transparency, and responsible participation to avoid deepening inequalities and surveillance risks (El-Agamy et al., 2024; Pellegrino, Wang, & Stasi, 2023; Qadir & Fatah, 2023; Scholz, 2016).

Within education, digital citizenship is now explicitly tied to sustainable development. Lomachinska, Dobrodum and Ishchuk (2025) argue that digital citizenship and knowledge management constitute strategic pathways to sustainability by enabling learners to access, evaluate, create, and share knowledge responsibly. Education 3.0 and 4.0 paradigms similarly

propose that young people need "sustainable digital development" capacities—critical use of technologies, ethical awareness, and agency in digital spaces—to participate in a "super smart Society 5.0" that integrates human, social, and technological innovation (Frau-Meigs & Hibbard, 2016; George & George, 2024; Hımmetoglu, Aydug, & Bayrak, 2020).

Digital literacy scholarship reinforces this orientation. Reviews from diverse regions underscore that ethics, responsibility, and security are now core attributes of digital literacy, not peripheral add-ons (Digital Literacy: South Pacific Review – Reddy, Sharma, & Chaudhary, 2022; Mohammadi, 2024). Digital information literacy, self-directed learning, and personal knowledge management are framed as interlocking processes that cultivate *habitual* critical reading and lifelong learning dispositions—features that are central to a sustainable, "responsible" digital personality (Mohammadi, 2024).

Empirical research links these constructs to sustainable behavior. Awdziej, Jaciow, Lipowski, Tkaczyk and Wolny (2023) show that students' digital maturity—encompassing ethical use, critical thinking, and responsible engagement—predicts sustainable consumption patterns. Shaan and Shah (2024) similarly argue that trust and prosocial orientations in digital environments underpin social welfare and green behavior, suggesting that civic and ethical traits in the digital sphere have material implications for sustainability. Digital citizenship training at the university level has been shown to improve attitudes toward sustainable development (Almudara, El-Gammal, Ali, & colleagues, 2024; Simon, 2025), while research from GCC countries underscores that 21st-century skills frameworks increasingly integrate sustainability, social responsibility, and digital competences (Alainati & Al-Hunaiyyan, 2024).

In sum, digital citizenship is now widely conceptualized as a sustainability-relevant competence that operates at the intersection of individual character, socio-technical infrastructures, and environmental concerns. This broader framing is directly relevant to the present study's focus on sustainable digital citizenship and responsible digital personality in Saudi higher education.

2.2 Blended learning and digital citizenship

Blended learning—variously termed hybrid, mixed-mode, or technology-enhanced learning—has become a central paradigm in school and university systems. Foundational work describes blended learning not merely as adding online components but as re-designing learning environments to integrate the strengths of face-to-face and digital modalities, ideally enhancing interaction, access, and depth of learning (Cleveland-Innes & Wilton, 2018; Ossiannilsson, 2018).

A significant body of research associates blended learning with greater learner responsibility and self-regulation. Studies converting large lecture courses into active blended formats indicate that frequent low-stakes assessments, immediate feedback, and online discussion tools can gradually shift responsibility for learning from the teacher to the student, fostering more sustained engagement and participation (Godlewska et al., 2019; Holland & Piper, 2016). Masic (2008) argues that e-learning and blended approaches can play a central role in modern medical education by supporting self-paced study and continual updating, though he warns about equity and sustainability of infrastructure.

Popa et al. (2020), using mixed methods during COVID-19, show that in emergency and post-emergency blended contexts, autonomy, resilience, and critical reflection become key personality characteristics that help students navigate uncertainty and fragmented learning conditions. Their findings suggest that well-designed blended environments, coupled with responsive feedback, can help students feel more responsible for their work and more engaged with the learning process. Similarly, Ossiannilsson (2022) develops the notion of "resilient agile education" for lifelong learning, arguing that post-pandemic blended and hybrid systems must empower learners to take control of their learning and align with the United Nations Sustainable Development Goals.

In K–12 and teacher education contexts, blended learning is often explicitly connected to character education and digital citizenship. Satori, Komariah and Suryana (2019) report that blended approaches can support ethical, responsible and caring dispositions among secondary students when character values are intentionally embedded in digital tasks. Beggs, Shields, Telfer and Bernard (2015) similarly illustrate how integrating digital citizenship concepts into blended classroom projects can foster self-regulation, collaboration, and long-term digital responsibility. Studies in primary and elementary contexts show that blended environments, when combined with explicit digital citizenship instruction, improve pupils' awareness of online safety, etiquette and responsible behavior (Erol, 2025; Romdhoni & Anam, 2025).

Within higher education, blended learning has been widely adopted as part of digital transformation strategies. Horizon reports project blended learning as a long-term structural feature of schooling and higher education, tied to flexible access, personalization and the development of digital citizenship (Freeman, Becker, & Cummins, 2017; S. Adams Becker et al., 2017). Bonfield et al. (2020) emphasize that Education 4.0 in universities requires rethinking teaching and learning practices in ways that both leverage digital tools and preserve deep human relationships, positioning blended learning as a key site for transformation rather than mere technological substitution.

In the Saudi and wider MENA context, empirical work confirms both the promise and tensions of blended learning. Almalki (2011) documents mixed experiences at Umm Al-Qura University, with students appreciating flexibility and increased resources but also reporting technical and pedagogical challenges. Aladsani, Al-Abdullatif, Almuhanna and Gameil (2022) show how pandemic-driven distance education in Saudi Arabia catalyzed longer-term plans for blended schooling, though questions of equity, teacher preparedness, and long-term sustainability remain. Studies in other regions of the Global South similarly highlight readiness issues, digital divides and mixed attitudes among teachers and students (Bariham, Ondigi, & Kiio, 2021; Hoang, 2015; Kovalchuk et al., 2022).

Importantly, several contributions argue that blended learning is uniquely situated to connect digital competence, character, and sustainability. Education 4.0 scholarship proposes that blended environments can nurture "learning how to learn," continuous development, and digital ethics (Hımmetoglu et al., 2020; Bonfield et al., 2020). Studies of innovative, digitally based elementary schools suggest that blended, gamified and adaptive designs prepare pupils for responsible digital citizenship and critical engagement with technology, thereby contributing to the long-term sustainability of digital education ecosystems (Romdhoni & Anam, 2025). In this sense, blended learning is not only a technical solution but also a pedagogical arena in which a responsible digital personality can be cultivated.

2.3 Responsible digital personality, digital competence, and character

The construct of "responsible digital personality" proposed in this study lies at the intersection of digital competence frameworks, digital citizenship research, and contemporary debates on character and Education 4.0.

As noted earlier, DigComp 2.2 conceptualizes digital competence across five domains and foregrounds attitudes such as critical thinking, responsibility, and awareness of environmental impact (Vuorikari, Kluzer, & Punie, 2022). The Council of Europe's digital citizenship framework positions these competences within a broader rights-based, democratic and well-being-focused agenda (Richardson & Milovidov, 2019). Education 4.0 literature extends these ideas by emphasizing "learning how to learn," sustainability, and continuous development as essential attributes for both students and educators in a rapidly changing digital landscape (Bonfield et al., 2020; Hımmetoglu et al., 2020).

Character education in the digital era adds further nuance. Satori et al. (2019) stress that high schools must intentionally foster ethical, responsible and caring young people, and argue that blended learning can serve as a vehicle for integrating character values into technologically rich classrooms. Swanzen (2018) highlights the challenges of parenting and teaching "digital native" generations Y and Z, noting that concepts such as digital nativeness and character qualities require educators to design blended environments that scaffold long-term sustainable citizenship rather than short-term compliance. Ohler (2010) similarly frames "digital community, digital citizen" as a form of character education for networked societies, insisting that schools must help students become wise, caring and reflective participants in digital communities.

Recent work explicitly connects responsibility and digital competence. Bondarchuk et al. (2022) investigate responsibility among future socionomic professionals as an indicator of digital competence, suggesting that a responsible orientation toward digital technologies is part of the human capital and intellectual potential of a country. Androniceanu, Sabie and Georgescu (2023) show that personality traits, organizational context and digital transformation jointly shape the digital competences of human resources, with implications for sustainability and public administration quality. In the education sector, Yan and Yang (2021) describe "Education Informatization 2.0" in China, emphasizing reflective ability and a "bottom-line character" as guarantees that students will become qualified digital citizens capable of using technology responsibly.

From a psychological and lifelong-learning perspective, interest, habit formation and self-directed learning are also crucial. Mohammadi (2024), drawing on IDC theory, argues that digital information literacy, self-directed learning and personal knowledge management work together to create lasting habits of critical reading and knowledge construction. Digital parenting research echoes this by showing that parents' practices significantly influence children's responsible, safe, and balanced use of digital media (Tosun & Mihci, 2020).

Taken together, these strands support conceptualizing responsible digital personality as a relatively stable, education-sensitive configuration of knowledge, skills, values and habits that govern digital behavior. It comprises at least three interrelated dimensions:

1. **Ethical–legal responsibility online** (non-harm, respect, compliance with laws and institutional norms);
2. **Critical and reflective engagement** (evaluating information, resisting manipulation, questioning deviant or extremist content);
3. **Sustainability-oriented digital practices** (privacy protection, mindful data and resource use, contribution to community and environmental well-being).

This conceptualization is consistent with calls to view digital citizenship not only as a set of technical skills but as a moral and civic orientation in the era of digital transformation, Society 5.0 and Education 4.0 (Bonfield et al., 2020; George & George, 2024; Rachmad, 2025).

The broader literature on digital citizenship and character education provides further grounding. Ohler (2010) describes "digital community, digital citizen" as a project of character education in digital spaces, emphasizing the need to cultivate empathy, integrity, and long-term responsibility. Berardi (2015) shows that sustained digital citizenship education can support behavioral change and deepen teachers' sense of ethical responsibility. Taken together, these strands support conceptualizing "responsible digital personality" as a relatively stable configuration of knowledge, skills, values, and habits that governs how individuals behave in digital environments—ethically, critically, and with a sustainability-oriented mindset.

2.4 Intellectual security and digital media

Although intellectual security has a particularly strong resonance in Saudi educational and policy discourse, it overlaps with global concerns about cyber-wellness, digital resilience and protection from harmful online influences. Lewin et al. (2021) define "safe and responsible internet use" as a multidimensional construct encompassing cognitive, emotional and

social competences; their review shows that interventions aimed at cultivating resilience to cyberbullying, radicalization and manipulative content often combine digital skills with social–emotional learning and values education.

Chadwick (2014) emphasizes the importance of building social and emotional resilience to counter cyberbullying and harm, noting that digital environments can either strengthen or damage relationships depending on how they are navigated. Studies of digital parenting similarly underscore that parents and caregivers have an "inevitable responsibility" to guide children's and adolescents' engagement with digital media, helping them manage risks and develop balanced, critical habits (Tosun & Mihci, 2020).

From a sustainability perspective, the notion of intellectual security can be linked to the capacity to maintain a coherent, ethically grounded worldview in the face of accelerated digital change. Ossiannilsson (2022) proposes "resilient agile education" as an approach to lifelong learning that supports personal development, human dignity and the strengthening of personality in digitally rich environments. Tripon, Gonța and Bulgac (2023) show that educational interactions addressing responsibility, ethics and sustainability can enhance student well-being and assessment outcomes, suggesting that intellectual security is tied to a sense of meaning and agency.

In the Gulf and Saudi context, intellectual security is often explicitly associated with resistance to extremist ideologies, destructive rumors and attacks on religious or national values, with digital media playing an increasingly central role in both risk and protection. Studies on digital nationalism, online religious discourse and social media campaigns in the region indicate that young people's attitudes can be shaped by targeted digital narratives, making critical and responsible engagement with online content essential for intellectual security. When combined with digital citizenship and sustainability education, blended learning environments have the potential to become protective spaces where students can practice critical appraisal, dialogue and reflective judgment in a supported setting.

2.5 Summary and research gap

The literature reviewed suggests several points of convergence:

- Digital citizenship and digital competence are increasingly conceptualized as strategic levers for sustainable development, requiring integration of ethical, critical, and environmentally aware attitudes alongside technical skills (Ghosn-Chelala, 2019; Lomachinska et al., 2025; Sá et al., 2021; Vuorikari et al., 2022).
- Blended learning is now a central feature of higher education, including in Saudi Arabia, yet its potential to cultivate sustainable digital citizenship and intellectual security remains underexplored (Aladsani et al., 2022; Almalki, 2011; Cleveland-Innes & Wilton, 2018).
- Emerging frameworks and empirical studies support the notion of a responsible digital personality, built from digital competence, digital citizenship, and character dimensions, and linked to sustainable behaviors and well-being (Awdziej et al., 2023; González-Pérez & Ramírez-Montoya, 2022; Ohler, 2010; Zhao et al., 2021).
- Intellectual security, while conceptually prominent in Saudi policy, has not yet been systematically examined through the lens of digital citizenship and blended learning in higher education.

Consequently, there is a clear gap in empirical, theory-driven work that (a) designs a sustainability-oriented blended digital citizenship course for Saudi university students, (b) operationalizes a responsible digital personality construct grounded in contemporary digital competence and citizenship frameworks, and (c) tests its impact on intellectual security using robust mixed-methods designs.

2.6 Theoretical Framework

The theoretical framework for this study integrates four main components as shown in Figure 1:

Figure 2: Conceptual Model of the Study

Figure 1. Hypothesized Conceptual Model of the Study Illustrating the Proposed Mediating Role of Responsible Digital Personality between the Blended Digital Citizenship Course and Intellectual Security

1. **Digital competence and digital citizenship frameworks**

   The **DigComp 2.2** framework conceptualizes digital competence across five areas and explicitly incorporates critical thinking, responsibility, and environmental awareness (Vuorikari et al., 2022). The *Digital Citizenship Education Handbook* translates these competences into educational aims organized around being online, well-being online, and rights online, providing a curricular structure for designing courses that address ethics, participation, and rights–responsibilities balances (Richardson & Milovidov, 2019). These frameworks guide the design of the blended course and the operationalization of responsible digital personality.

2. **Education 4.0 and character/sustainability**

   Education 4.0 frameworks stress that future-oriented education must cultivate not only cognitive and technical skills but also character, meta-learning, and responsibility (González-Pérez & Ramírez-Montoya, 2022). Active, technology-rich pedagogies such as project-based learning, flipped classrooms, and hybrid STEAM environments are presented as means to nurture critical, creative, and ethically grounded learners (Deák & Kumar, 2024; Grimus, 2020). This strand supports the use of blended learning not merely as a delivery modality but as a transformative environment for shaping sustainable digital dispositions.

3. **Digital maturity and responsible digital personality**

   Building on Awdziej et al. (2023), the study conceptualizes responsible digital personality as a latent construct comprising:

- **Ethical–legal responsibility online** (respect for others, avoidance of harm, adherence to laws and institutional policies);
- **Critical and reflective engagement** (evaluation of information, resistance to manipulation, critical stance toward extremist or misleading content);
- **Sustainability-oriented digital practices** (privacy protection, mindful data use, contribution to personal and collective well-being, pro-social engagement).

These dimensions reflect an integration of DigComp, digital citizenship, and character-education insights (Ohler, 2010; Richardson & Milovidov, 2019; Zhao et al., 2021).

4. **Intellectual security in digitally mediated environments**

   Intellectual security is modeled as a multi-component outcome encompassing:

- **Cognitive resilience** (capacity to recognize and reject extremist, conspiratorial, or manipulative digital content);
- **Value alignment and balanced identity** (sense of belonging, moderation, and commitment to constructive civic and religious values);
- **Safe digital engagement** (avoidance of risky networks, irresponsible rumor-sharing, and ethically problematic practices).

This conceptualization draws on research on safe and responsible internet use, cyber-wellness, and sustainability-oriented education (Lewin et al., 2021; Mitsea et al., 2023; Tripon et al., 2023), while being attuned to Saudi understandings of intellectual security.

2.7 Conceptual model

The resulting conceptual model posits that:

- Participation in a sustainability-oriented blended digital citizenship course (independent variable) will enhance students' responsible digital personality (mediator), by engaging them in structured, reflective, and practice-oriented activities aligned with DigComp, DCE, and Education 4.0 principles.
- Enhanced responsible digital personality will, in turn, lead to higher levels of intellectual security (dependent variable), particularly in digital contexts where students are exposed to potentially harmful content.

Baseline digital maturity, gender, and previous exposure to digital citizenship training may function as moderators that influence the strength of these relationships.

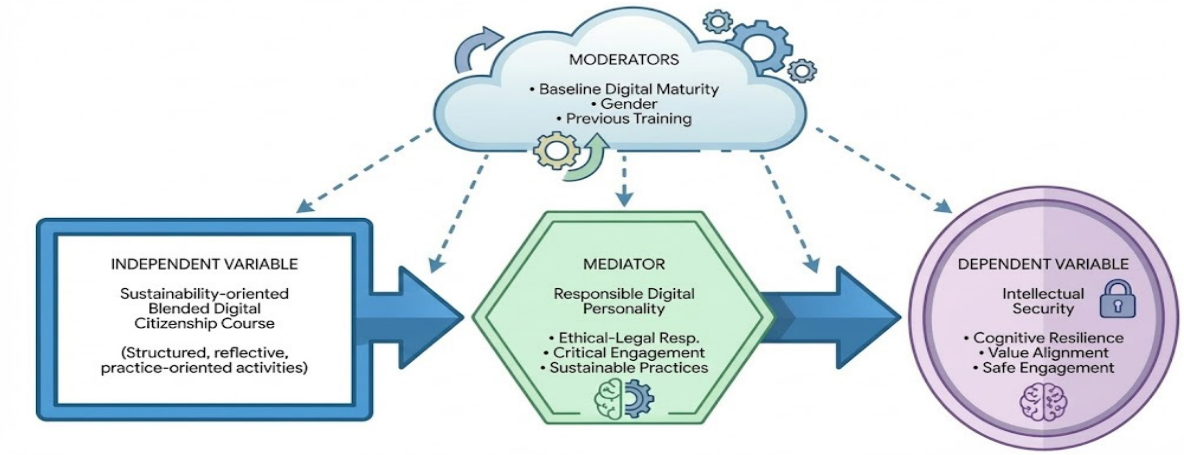

Figure 2. Conceptual Framework Illustrating the Hypothesized Relationships between Variables

This framework shown in Figure 2 justifies the use of a quasi-experimental mixed-methods design, in which quantitative measures of responsible digital personality and intellectual security are complemented by qualitative data capturing students' lived experiences of the blended course.

3. Research Questions

1. What are the baseline levels of sustainable digital citizenship (responsible digital personality) and intellectual security among Saudi university students enrolled in general education courses?
2. To what extent do students who complete a sustainability-oriented blended digital citizenship course differ in their post-test responsible digital personality scores from students in a control group receiving traditional instruction?
3. To what extent do students in the blended digital citizenship course obtain higher post-test intellectual security scores than students in the control group?
4. Does responsible digital personality mediate the relationship between exposure to the blended digital citizenship course and intellectual security outcomes?
5. How do Saudi university students describe the ways in which blended digital learning experiences support—or fail to support—the development of a responsible digital personality and their sense of intellectual security?

4. Hypotheses

1. Students who complete the sustainability-oriented blended digital citizenship course will obtain significantly higher post-test scores on the Responsible Digital Personality Scale (overall and across its sub-dimensions) than students in the control group receiving traditional instruction.
2. Students in the experimental group will obtain significantly higher post-test scores on the Intellectual Security Scale than students in the control group.
3. Responsible digital personality will partially mediate the relationship between participation in the blended digital citizenship course and intellectual security.
4. Levels of responsible digital personality will be positively correlated with levels of intellectual security across the sample.

5. Methodology

5.1 Research Design

The study employed a quasi-experimental, sequential explanatory mixed-methods design to investigate how a blended course on sustainable digital citizenship influenced Saudi university students' responsible digital personality and intellectual security. Quantitatively, a pre-test–post-test non-equivalent groups design was used, with one experimental group exposed to a redesigned blended course and one comparison group following the conventional version of the same course. Qualitatively, reflective journals and semi-structured interviews were used to elaborate and explain the statistical patterns that emerged from the quantitative phase. The mixed-methods design was sequential explanatory in character: quantitative data were collected and analyzed first, followed by qualitative data collection and analysis, and finally an integrated interpretation of both strands in the discussion. This sequencing allowed the qualitative findings to clarify the mechanisms behind any observed quantitative changes in responsible digital personality and intellectual security.

5.2 Context and Setting

The research took place at a large public university in Saudi Arabia that had institutionalized blended learning as part of its post-COVID digital transformation and alignment with Vision 2030. The intervention was embedded in a credit-bearing undergraduate course on digital literacy and citizenship that was offered as a university requirement across several colleges.
In the experimental sections, the course was redesigned as a blended learning environment combining face-to-face sessions and online activities. The face-to-face component focused on ethical case discussions, simulations, and structured debates, while the online component, delivered via the university's learning management system, included short video lectures, moderated discussion forums, scenario-based quizzes, and digital projects explicitly oriented toward responsible, sustainable digital citizenship and intellectual security. The comparison sections covered similar core content but relied mainly on traditional lecture-based delivery with limited online interaction and without explicit emphasis on sustainability, digital responsibility, or structured reflection.

5.3 Participants

5.3.1 Population and Sample Size

The target population consisted of undergraduate students enrolled at the participating university. For the main quantitative analyses, complete data were available for **540 students**, of whom **274** were enrolled in traditionally delivered courses (comparison group) and **266** in the sustainability-oriented blended digital citizenship course (experimental group).

This sample size exceeds conventional a priori power recommendations for between-groups designs aiming to detect at least medium effects (e.g., $d \approx 0.50$ or $f \approx 0.25$) at $\alpha = .05$ with statistical power of .80. It was therefore considered more than adequate for the planned independent-samples t tests and correlational analyses, and it also permitted exploratory subgroup comparisons (e.g., by gender) without compromising statistical robustness.

5.3.2 Inclusion and Exclusion Criteria

All participants were full-time undergraduates enrolled in one of the selected course sections during the study semester. Students were included if they consented to participate and completed both the pre- and post-test questionnaires. Students who had previously completed a specialized semester-long course in digital citizenship or digital ethics were excluded to reduce potential confounding effects. Cases with incomplete pre- or post-test data were removed at the analysis stage.

5.3.3 Qualitative Subsample

Within the experimental (blended-learning) group ($n = 266$), a qualitative subsample was selected purposively after examining pre-test scores and demographic profiles. The subsample was constructed to maximize variation in gender, college affiliation (e.g., Education versus Science or Engineering), and initial levels of sustainable digital citizenship and intellectual security. On this basis, 25 students were invited to participate in the qualitative phase. As part of the course requirements, reflective journals were ultimately collected from all students in the experimental group, while 12 students from the invited pool agreed to take part in semi-structured interviews, providing in-depth accounts of their experiences in the blended course and their perceived changes in digital citizenship and intellectual security.

5.4 Instruments

5.4.1 Sustainable Digital Citizenship through Blended Learning Questionnaire

The primary quantitative instrument was the Sustainable Digital Citizenship through Blended Learning Questionnaire, which was developed and validated for the purposes of this study. The instrument comprised several sections.

The first section collected demographic and background information, including gender, age, college, year of study, previous training in digital citizenship or digital ethics, and average daily time spent online.

The second section measured digital maturity through six Likert-type items that assessed students' perceived ability to search for, evaluate, and manage digital information, protect their devices and accounts, configure privacy settings, use new tools confidently, and produce digital content tailored to specific audiences. For the purposes of analysis, these items formed the "Digital Competence" subscale within the broader Sustainable Digital Citizenship construct.

Responsible digital personality was assessed through fifteen items grouped into three subdimensions: ethical–legal responsibility online, critical–reflective engagement, and sustainability-oriented digital practices. These items captured behaviors such as avoiding harmful posts, respecting copyright and privacy, aligning online conduct with Saudi cultural and religious values, questioning provocative or extreme content, avoiding the spread of unverified information, reflecting on how algorithms shape one's digital environment, and considering the long-term societal and intergenerational consequences of digital behavior.

Intellectual security in digital environments was measured through an additional fifteen items organized into three subdimensions: cognitive resilience to harmful content, value alignment and balanced identity, and safe digital engagement. The items addressed students' perceived ability to recognize manipulative content, resist social pressure, maintain core values while engaging with new ideas, behave consistently even under anonymity, avoid dangerous online spaces, and use reporting or blocking tools to safeguard themselves and others.

A final section, administered only to the experimental group at post-test, captured perceived impact of the blended course on students' awareness, behaviors, and understanding of sustainability and intellectual security.

All items used a five-point Likert response scale ranging from "strongly disagree" to "strongly agree." The instrument was piloted with a small cohort not included in the main sample to check clarity, face validity, and preliminary reliability. Minor wording adjustments were made based on pilot feedback. In the main study, internal consistency was assessed for each subscale using Cronbach's alpha and, where appropriate, McDonald's omega. The dimensional structure of the scales was explored using factor analytic techniques prior to testing the study hypotheses.

5.4.2 Reflective Journals

Three structured reflective journal tasks were integrated into the experimental course over the semester. Early in the course, students were asked to describe recent online situations in which they had to decide whether to share, like, or comment on content, and to reflect on how the course had begun to influence such decisions. Mid-semester, a second reflection focused on encounters with challenging or disturbing online content and prompted students to narrate how they responded and how the blended activities had helped them interpret or manage these situations. A final reflection near the end of the course invited students to articulate their current understanding of their "digital personality," their perceived intellectual security, and the course elements they felt had contributed to any changes. Reflections were submitted through the learning management system, counted for participation rather than content, and later anonymized for analysis.

5.4.3 Semi-Structured Interview Protocol

Semi-structured interviews were conducted with the qualitative subsample from the experimental group after completion of the post-test. The interview guide contained open-ended questions that probed students' experiences of the blended course, their evolving understanding of responsible digital personality, their strategies for dealing with manipulative or extremist content, and their perceptions of how digital citizenship intersected with sustainability and the future of Saudi society. Interviews

typically lasted between 30 and 45 minutes, were held either face-to-face or online depending on availability, and were audio-recorded with explicit consent. Recordings were transcribed verbatim and all identifying information was removed.

5.5 Procedures

Data collection followed a clear temporal sequence across the semester. In the first two weeks, the pre-test version of the questionnaire was administered to both the experimental and comparison groups under comparable classroom conditions, after informed consent had been obtained from all participants.

Over the next ten to twelve weeks, the experimental group engaged in the blended course, which combined classroom-based ethical case work, collaborative discussions, and simulations with online activities such as forums, digital assignments, and scenario-based quizzes. The comparison group, by contrast, received the conventional form of instruction in which content was delivered primarily through lectures with limited structured online engagement and no explicit focus on sustainable digital citizenship or intellectual security. The three reflective journal tasks were scheduled at early, middle, and late points in the semester for the experimental group.

In the final two weeks of the semester, the post-test questionnaire was administered to both groups. The experimental group also completed the perceived-impact section of the instrument at this stage. Shortly after the post-test, interviews were scheduled and conducted with the selected students from the experimental group.

5.6 Data Analysis

5.6.1 Quantitative Data Analysis

Quantitative data were entered into a statistical software package and screened for missing values, outliers, and assumptions related to normality and homoscedasticity. Cases with incomplete pre- or post-test data were removed. Descriptive statistics, including means and standard deviations, were computed for all main variables. Reliability estimates were calculated for each subscale.

Group equivalence at baseline was examined by comparing experimental and comparison groups on pre-test measures of digital maturity, responsible digital personality, and intellectual security through independent-samples t tests and, where appropriate, multivariate analyses. To evaluate the effects of the intervention, between-group differences at post-test were analyzed using independent-samples t tests for each sustainable digital citizenship and intellectual security outcome (subscales and total scores).

Effect sizes, such as Cohen's d, were reported to support interpretation of the practical importance of significant results. Zero-order Pearson correlations were computed to examine the associations between sustainable digital citizenship and intellectual security, and a regression-based mediation model was estimated to test whether responsible digital personality statistically mediated the relationship between teaching mode and intellectual security. Exploratory analyses considered whether gender, college, or prior exposure to digital ethics training moderated the observed intervention effects.

5.6.2 Qualitative Data Analysis

Qualitative data from reflective journals and interview transcripts were imported into qualitative analysis software and analyzed using thematic analysis. The process involved repeated reading of the texts, initial open coding of segments related to digital responsibility, intellectual security, blended learning experiences, and sustainability, and progressive grouping of codes into broader categories and themes. Particular attention was given to trajectories of change across the three reflective points and to how students described the influence of specific blended activities on their identities and practices as digital citizens.

Themes were refined through constant comparison across cases, and the credibility of the analysis was enhanced through peer debriefing with a second researcher who reviewed a subset of data and the emerging coding schemes. Discrepancies in interpretation were discussed until a shared understanding was reached.

5.6.3 Integration of Quantitative and Qualitative Findings

Integration of the quantitative and qualitative strands occurred at the interpretation stage. Quantitative patterns, such as changes in responsible digital personality or intellectual security scores, were juxtaposed with qualitative themes that illuminated the processes and experiences behind those patterns. Points of convergence and divergence between the two strands were identified and discussed, and joint displays were constructed aligning statistical trends with illustrative qualitative excerpts. This integrative analysis allowed more comprehensive conclusions to be drawn about how and why the blended sustainable digital citizenship course influenced students' digital identities and intellectual security.

5.7 Ethical Considerations

Throughout the study, ethical standards were rigorously observed. Ethical approval had been obtained from the university's research ethics committee prior to data collection. Participation was voluntary, and students were informed that their decision to participate or withdraw at any stage would not affect their academic standing or course grades.

Informed consent forms explained the aims of the study, procedures, potential risks and benefits, and the measures adopted to ensure confidentiality. Questionnaire responses were collected anonymously or under numeric codes, while interview recordings and transcripts were stored securely on password-protected devices and servers accessible only to the

research team. In all publications and presentations, data were reported in aggregate form or via anonymized quotations. These safeguards ensured that participants' identities and privacy were fully protected and that the study complied with institutional and national ethical requirements.

6. Results

6.1 Quantitative Findings

6.1.1 Preliminary analyses and descriptive statistics (RQ1)

The analytic sample comprised 540 students, of whom 274 were enrolled in traditionally delivered courses and 266 in the sustainability-oriented blended digital citizenship course. Females (61.1%, n = 330) were somewhat overrepresented relative to males (38.9%, n = 210). Most participants were between 18 and 23 years of age and reported using the internet between 3 and 8 hours per day.

Across the whole sample, students reported moderate-to-high levels of sustainable digital citizenship and intellectual security. As shown in Table 1, mean scores on the four sustainable digital citizenship subscales clustered around the upper-middle of the possible range, with total Sustainable Digital Citizenship (SDC) averaging M = 66.59, SD = 5.75. Intellectual security scores were similarly moderate-to-high (M = 47.20, SD = 4.13), suggesting that, overall, students perceived themselves as reasonably competent, ethically responsible, and secure in their digital practices (see Table 1).

When examined by teaching mode, students in the blended course consistently scored higher on all digital citizenship subscales and on intellectual security than those in traditionally taught sections. For instance, blended-learning students reported higher digital competence (M = 20.15, SD = 2.27) than traditional students (M = 18.00, SD = 1.97), and higher total intellectual security (M = 49.39, SD = 3.89 vs. M = 45.07, SD = 3.11). These descriptive patterns already point to a substantial advantage for the sustainability-oriented blended course.

Gender differences were statistically significant but small in magnitude. Females scored slightly higher than males on total sustainable digital citizenship (M = 67.15, SD = 5.67 vs. M = 65.70, SD = 5.78), $t(\approx 538) = -2.88$, $p = .004$, $d = 0.25$, and on total intellectual security (M = 47.57, SD = 4.32 vs. M = 46.62, SD = 3.74), $t(\approx 538) = -2.70$, $p = .007$, $d = 0.23$. These effect sizes indicate that female students reported slightly higher levels of responsible digital behaviour and perceived intellectual security, but the differences are modest. No statistically significant differences emerged in sustainable digital citizenship or intellectual security as a function of age group or daily online hours (all $p > .17$), and associated effect sizes were negligible ($\eta^2 \leq .01$), suggesting that these background variables did not meaningfully differentiate students' scores.

Table 1

Descriptive Statistics for Sustainable Digital Citizenship and Intellectual Security by Teaching Mode

Variable	Overall M (SD)	Traditional M (SD)	Blended M (SD)
Digital competence	19.06 (2.38)	18.00 (1.97)	20.15 (2.27)
Ethical–legal responsibility	15.90 (2.18)	14.98 (1.79)	16.86 (2.12)
Critical–reflective engagement	15.83 (2.24)	14.79 (1.83)	16.89 (2.12)
Sustainability-oriented practices	15.79 (2.17)	14.85 (1.84)	16.77 (2.05)
Total sustainable digital citizenship	66.59 (5.75)	62.62 (3.77)	70.67 (4.43)
Cognitive resilience (CRHC)	15.68 (2.13)	15.07 (1.89)	16.31 (2.17)
Value alignment (VABI)	15.78 (2.12)	14.93 (1.72)	16.65 (2.14)
Safe digital engagement (SDE)	15.74 (2.07)	15.08 (1.93)	16.43 (1.99)
Total intellectual security	47.20 (4.13)	45.07 (3.11)	49.39 (3.89)

Note. N = 540 (traditional: n = 274; blended: n = 266). Higher scores indicate higher levels of the corresponding construct.

6.1.2 Impact of the blended course on sustainable digital citizenship (RQ2 / H1)

To test the hypothesized effect of the sustainability-oriented blended course on responsible digital personality, independent-samples t tests compared traditional and blended groups on each sustainable digital citizenship subscale and on the total SDC score (Table 2).

The pattern was highly consistent: across all four subscales, students in the blended course reported significantly higher scores than those in traditional sections, and the differences were large in practical terms. For digital competence, blended-learning students reported substantially higher levels (M = 20.15, SD = 2.27) than their peers in the traditional condition (M = 18.00, SD = 1.97), $t(522) = -11.74$, $p < .001$, $d = 1.01$. This reflects roughly a one–standard deviation advantage in students' perceived ability to locate, evaluate, and manage digital information and tools.

A similar pattern emerged for ethical–legal responsibility. Students in the blended course reported higher adherence to ethical and legal norms online (M = 16.86, SD = 2.12) compared with those in traditional classes (M = 14.98, SD = 1.79), $t(518) = -11.09$, $p < .001$, $d = 0.96$. In other words, exposure to the blended environment was associated with noticeably stronger commitment to respecting copyright, protecting privacy, and complying with national cyber regulations.

The intervention also appeared to foster deeper critical–reflective engagement with digital content. Blended students

scored higher on this dimension (M = 16.89, SD = 2.12) than students in the traditional condition (M = 14.79, SD = 1.83), $t(522) = -12.33$, $p < .001$, $d = 1.06$. This indicates that students who experienced the blended course were more likely to question the reliability of online information, resist rumors and extreme content, and reflect on their own digital identities.

Finally, students in the blended course reported more sustainability-oriented digital practices (M = 16.77, SD = 2.05) than those in the traditional group (M = 14.85, SD = 1.84), $t(528) = -11.41$, $p < .001$, $d = 0.98$. This suggests that blended learning was associated with more conscious management of digital footprints, more responsible time use, and stronger engagement with positive, future-oriented digital initiatives.

These subscale differences converged in the total sustainable digital citizenship score, where the effect was particularly striking. Blended students achieved M = 70.67 (SD = 4.43) compared to M = 62.62 (SD = 3.77) in the traditional group, $t(520) = -22.70$, $p < .001$, $d = 1.96$. An effect of nearly two pooled standard deviations indicates that the vast majority of students in the blended condition outperformed their counterparts in traditional classes on the composite indicator of responsible digital personality. Taken together, these findings provide strong support for H1, suggesting that the redesigned blended learning environment substantially enhanced students' sustainable digital citizenship across all measured dimensions.

Table 2

Independent-Samples t Tests Comparing Traditional and Blended Teaching Modes on Key Outcomes

Variable	Traditional M (SD)	Blended M (SD)	t(df)	p	d
Digital competence	18.00 (1.97)	20.15 (2.27)	–11.74 (522)	< .001	1.01
Ethical–legal responsibility	14.98 (1.79)	16.86 (2.12)	–11.09 (518)	< .001	0.96
Critical–reflective engagement	14.79 (1.83)	16.89 (2.12)	–12.33 (522)	< .001	1.06
Sustainability-oriented practices	14.85 (1.84)	16.77 (2.05)	–11.41 (528)	< .001	0.98
Total sustainable digital citizenship	62.62 (3.77)	70.67 (4.43)	–22.70 (520)	< .001	1.96
Cognitive resilience (CRHC)	15.07 (1.89)	16.31 (2.17)	–7.10 (523)	< .001	0.61
Value alignment (VABI)	14.93 (1.72)	16.65 (2.14)	–10.29 (508)	< .001	0.89
Safe digital engagement (SDE)	15.08 (1.93)	16.43 (1.99)	–8.00 (536)	< .001	0.69
Total intellectual security	45.07 (3.11)	49.39 (3.89)	–14.23 (506)	< .001	1.23

Note. Welch's t tests are reported with their approximate degrees of freedom. Cohen's d is calculated using the pooled standard deviation (positive values indicate higher scores for the blended group).

6.1.3 Impact of the blended course on intellectual security (RQ3 / H2)

The second set of analyses examined whether participation in the blended course also improved students' sense of intellectual security in digital environments. Independent-samples t tests again compared traditional and blended groups on each intellectual security dimension and on the composite score (Table 2).

On cognitive resilience to harmful content, students in the blended course reported significantly higher scores (M = 16.31, SD = 2.17) than those in traditional sections (M = 15.07, SD = 1.89), $t(523) = -7.10$, $p < .001$, $d = 0.61$. This indicates that blended-learning students felt more capable of recognizing manipulative or extremist content and resisting social pressure to endorse or share it.

The blended course also appeared to strengthen value alignment and balanced identity. Students in the blended condition reported higher alignment between their online behaviour and their religious–cultural values (M = 16.65, SD = 2.14) than those taught traditionally (M = 14.93, SD = 1.72), $t(508) = -10.29$, $p < .001$, $d = 0.89$. In practical terms, this suggests that the blended environment supported students in maintaining a sense of belonging and ethical integrity while engaging with diverse digital content.

Regarding safe digital engagement, blended-learning students again scored higher (M = 16.43, SD = 1.99) than traditional students (M = 15.08, SD = 1.93), $t(536) = -8.00$, $p < .001$, $d = 0.69$. Students exposed to the blended intervention thus reported being more selective about the communities they joined, more aware of blocking/reporting mechanisms, and more confident in navigating digital spaces without jeopardizing their intellectual or moral stability.

At the composite level, total intellectual security was markedly higher among blended-learning students (M = 49.39, SD = 3.89) than among their peers in the traditional condition (M = 45.07, SD = 3.11), $t(506) = -14.23$, $p < .001$, $d = 1.23$. This represents a large overall effect, indicating that the blended course had a robust, positive association with students' perceived intellectual security in digital environments.

Importantly, the effects of teaching mode on both sustainable digital citizenship and intellectual security remained robust when controlling for gender in supplementary analyses (not tabulated), suggesting that the observed advantages of the blended condition cannot be explained by gender composition alone. Collectively, these findings confirm H2 and indicate that the sustainability-oriented blended course not only strengthened digital citizenship dispositions but also enhanced students' resilience and stability in the face of potentially harmful online content.

6.1.4 Associations between sustainable digital citizenship and intellectual security

Zero-order Pearson correlations were computed to examine the association between responsible digital personality and intellectual security across the full sample (Table 3). As expected, higher sustainable digital citizenship was positively associated with greater intellectual security. The correlation between total Sustainable Digital Citizenship and total Intellectual Security was $r = .29$, $p < .001$, indicating a modest but statistically reliable relationship.

All four sustainable digital citizenship subscales were positively related to intellectual security, with correlations ranging from $r = .13$ ($p < .01$) for ethical–legal responsibility to $r = .22$ ($p < .001$) for digital competence and for critical–reflective engagement (see Table 3). These patterns support H4 at the level of overall association: students who perceive themselves as more competent, ethically responsible, reflective, and sustainability-oriented in their digital practices also tend to report stronger cognitive resilience, value alignment, and safe engagement in digital environments.

To test the mediation hypothesis (H3), a regression-based analysis was conducted following Baron and Kenny's steps.

1. **Path c (X Y):** The teaching mode significantly predicted Total Intellectual Security (), confirming the main effect.
2. **Path a (X M):** The teaching mode significantly predicted Total Sustainable Digital Citizenship ().
3. **Path b (M Y):** When examining the correlation within the experimental group alone, the relationship between Digital Citizenship and Intellectual Security was significant but **negative** (), while in the control group it was non-significant ().
4.

When both Teaching Mode and Digital Citizenship were entered into the regression to predict Intellectual Security, the Teaching Mode remained the dominant predictor. The Digital Citizenship variable did not function as a positive mediator; rather, the intervention improved both outcomes in parallel. Consequently, Hypothesis 3 was rejected.

Table 3

Zero-Order Correlations Among Sustainable Digital Citizenship and Intellectual Security Variables

Variable	1	2	3	4	5	6
1. Total sustainable digital citizenship	—					
2. Digital competence	0.67***	—				
3. Ethical–legal responsibility	0.61***	0.20***	—			
4. Critical–reflective engagement	0.66***	0.28***	0.19***	—		
5. Sustainability-oriented practices	0.62***	0.18***	0.21***	0.23***	—	
6. Total intellectual security	0.29***	0.22***	0.13**	0.22***	0.17***	—

Note. $N = 540$. Values below the diagonal are Pearson correlation coefficients. $^{*}p < .01$. $^{**}p < .001$.

As shown in Table 3, the four subdimensions of sustainable digital citizenship are strongly and positively interrelated (rs = .61–.67 with the total SDC score), indicating that digital competence, ethical–legal responsibility, critical–reflective engagement, and sustainability-oriented practices tend to co-occur as a coherent dispositional profile. The correlations between each subscale and total intellectual security are more modest but consistently positive (rs = .13–.22, $p < .01$ or better), suggesting that students who report higher levels of responsible digital behaviour also tend to feel more intellectually secure online. The association between the composite indices of sustainable digital citizenship and intellectual security ($r = .29$, $p < .001$) further confirms that the two constructs are related but not redundant, leaving room for meaningful differentiation between ethical–behavioural dispositions and cognitive–ideological resilience.

Considered together, the quantitative analyses show that the sustainability-oriented blended course not only elevated students' scores on both constructs, but also preserved a clear conceptual distinction between responsible digital personality and intellectual security while linking them in a moderate, theoretically meaningful way. What these statistics cannot fully capture, however, is how students understood these constructs in their own terms and which features of the blended environment they perceived as most transformative. To address these questions and to deepen the interpretation of the numerical trends, the next section turns to the qualitative strand, drawing on open-ended responses, reflective journals, and semi-structured interviews from students in the experimental group.

6.2 Qualitative Findings

To explain the statistical improvements observed in sustainable digital citizenship and intellectual security (RQ5), qualitative data were analyzed from three sources within the experimental (blended-learning) group: (a) open-ended post-test responses to four questions (OE1–OE4; $n = 266$), (b) structured reflective journals collected at three time points across the semester (Reflections 1–3; $n = 266$), and (c) semi-structured interviews with a purposively selected, maximum-variation subsample of 12 students.

Using a reflexive thematic analysis approach, the researcher iteratively coded the data, grouped codes into candidate

themes, and then refined these themes through comparison across data sources and participants. The final analytic framework comprised four overarching themes that illuminate how and why the blended course produced the quantitative gains observed on the Sustainable Digital Citizenship and Intellectual Security scales:

1. Re-conceptualizing responsible digital personality from passive to agentic.
2. Experiencing the blended environment as a "safe simulator" for ethical and critical practice.
3. Reframing intellectual security as active resilience rather than withdrawal.
4. Positioning digital citizenship as a pillar of social sustainability and national vision.
   Each theme is discussed below with illustrative extracts and explicit links to the quantitative findings.

6.2.1 Theme 1: Re-conceptualizing "responsible digital personality"

Across open-ended responses (OE1–OE2) and final reflective journals (Reflection 3), students described a marked shift in how they understood their "digital personality." At the beginning of the course, many participants portrayed their online presence as fragmented or "less serious" than their offline identity—"just for fun," "not real," or "separate from my reputation." By the end of the semester, however, students increasingly defined a responsible digital personality as a coherent extension of the self, where ethics, reputation, and long-term impact are integrated.

In their end-of-course reflections, students frequently used terms such as "integrity," "consistency," "imprint," and "accountability" to describe this new understanding. One interviewee captured the shift succinctly:

"Before this course, I had two personalities: the respectful student in real life and the anonymous commenter online. Now, I realize that a 'responsible digital personality' means these two must match. What I type is a permanent part of who I am." (Interviewee 4, Female, Education)

This re-definition helps to explain the large quantitative difference between the blended and traditional groups on the Ethical–Legal Responsibility subscale and the total Sustainable Digital Citizenship score. Students were no longer framing rules (e.g., copyright, privacy, cybercrime laws) as external constraints imposed from outside; instead, they described them as internalized character traits and markers of personal integrity.

Open-ended responses to OE2 ("one concrete change") showed that students operationalized this new conceptualization through specific micro-practices in their daily digital habits. A recurring example was the adoption of a "pause" or "check" routine before posting or sharing. One student wrote:

"I used to retweet anything that looked exciting or shocking. The concrete change I made is the 'three-second rule' we learned: stop, check the source, think about the impact. I have deleted several drafts this semester because they didn't pass this test." (Open-ended response, Male, Business)

Another participant described going back through old posts and cleaning up content that no longer fit their new sense of responsibility:

"After the unit on digital footprint, I went back and deleted some old jokes and comments. They were not illegal, but they did not represent me now. I felt I was 'repairing' my digital personality." (Reflection 3, Female, Arts)

These accounts mirror the high scores on sustainability-oriented practices and critical–reflective engagement found quantitatively. Students were not only endorsing responsible digital personality at an attitudinal level; they were also taking visible, sometimes effortful steps to align their online behaviours with their ethical standards and future self-image.

6.2.2 Theme 2: The blended environment as a "safe simulator" for ethical and critical practice

A second major theme concerned how students experienced the structure of the blended course itself. Across OE4, mid-semester reflections (Reflection 2), and interview questions about course design, participants emphasized the interplay between face-to-face sessions and online components as crucial to their development.

Students described in-class debates, case-based discussions, and group activities as providing immediate exposure to controversial or emotionally charged digital scenarios (e.g., cyber-bullying, hate speech, fake news, polarizing hashtags). In contrast, the Learning Management System (LMS) forums, online scenarios, and journals offered a "psychological pause"—time and space to think carefully before responding.

One interviewee compared this structure to a simulator:

"In the lecture hall, we discussed controversial hashtags, and it was sometimes heated. But when I went home to write my journal or post on the forum, I had time to cool down and think critically. The blended format forced me to slow down. The online scenarios were like a flight simulator—we could practice handling dangerous content without getting hurt." (Interviewee 9, Male, Computer Science)

Students consistently reported that this "slow-thinking" space allowed them to experiment with different responses, "try out" ethical decisions, and watch how others reasoned through similar dilemmas. In Reflection 2, one student wrote:

"During the forum about rumor spreading, my first reaction was emotional. But when I saw my classmates' posts and the instructor's questions, I realized I was focusing only on my feelings. I rewrote my post two times to base it more on evidence and less on anger." (Reflection 2, Female, Education)

This theme provides a qualitative explanation for the large effects on the Critical–Reflective Engagement subscale. The

blended design did not only transmit information about responsible behaviour; it rehearsed it through a cycle of exposure → reflection → feedback. Students explicitly contrasted this experience with traditional lecture-based courses:
"In other courses, we only hear 'don't do this' or 'this is illegal,' but we never practice decisions. Here, the LMS and in-class discussions made us face real examples, write about them, and see the consequences. This is what changed me." (Interviewee 1, Male, Engineering)

Thus, the qualitative evidence suggests that the pedagogical affordances of the blended environment—especially the iterative movement between fast, social debate and slower, reflective writing—are central to the observed quantitative gains in digital competence, ethical–legal responsibility, and reflective engagement.

6.2.3 Theme 3: Intellectual security as active resilience rather than withdrawal

The third theme adds nuance to the construct of intellectual security. Early reflections and initial open-ended responses indicated that many students initially interpreted "security" in technical terms: passwords, antivirus software, privacy settings, and platform filters. Over the semester, however, their language shifted toward cognitive and ideological resilience.
When responding to OE3 ("how the course influenced your sense of intellectual security") and to interview questions about harmful content, students described moving from a stance of fear and avoidance to one of informed confidence. One interviewee contrasted her earlier reaction to extremist or offensive content with her current approach:

"I used to feel scared when I saw extremist ideas or rumors attacking our community values on Twitter. I felt like I had to hide. Now, my sense of intellectual security comes from knowledge. I know how to analyze their rhetoric, I know their tricks. I don't just block; I understand why they are wrong. That makes me feel secure." (Interviewee 2, Female, Arts)

This development resonates strongly with the quantitative increase on the Cognitive Resilience to Harmful Content subscale. Students described learning to recognize framing devices, emotional manipulation, and argumentative fallacies in online texts. Several participants referred to course activities where they had to "dissect" viral posts or videos looking for exaggeration, bias, or missing evidence.

The metaphor of "filter versus wall" appeared in several journals. One student wrote at the end of the course:
"Intellectual security is not a wall; it is a filter in my mind. The wall means I just avoid everything, but the filter means I let in what is correct and stop what is harmful. The course taught me how to build this filter." (Reflection 3, Male, Science)

Students also linked intellectual security with a balanced identity rather than rigid defensiveness. In interviews, they emphasized that engaging with global content did not necessarily threaten their values; instead, it gave them opportunities to justify and articulate those values more clearly:

"At first, I feared that seeing too many different opinions online would weaken my beliefs. Now I feel that discussing them in this course made my beliefs stronger and more mature, not weaker." (Interviewee 6, Female, Education)

These accounts shed light on the high scores on the Value Alignment and Balanced Identity and Safe Digital Engagement subscales in the blended group. Qualitative evidence suggests that intellectual security in this context is experienced not as staying away from the digital world, but as engaging critically and confidently—knowing when to report, block, or challenge harmful content while continuing to participate constructively in online spaces.

6.2.4 Theme 4: Digital citizenship as social sustainability and national vision

The final theme connects students' personal transformations to wider notions of sustainability and national development. In responses to OE4 and in end-of-course reflections (Reflection 3), students frequently linked their individual digital practices to the social and cultural dimensions of Vision 2030.

Initially, many participants associated "sustainability" primarily with environmental issues (e.g., energy, water). Over time, they began to talk about "digital hygiene" and a "clean digital environment" as essential for a healthy society. One interviewee explained:

"We talk about green energy for the future, but we also need a 'clean' digital society. If we are all toxic and spread lies, society breaks down. Being a sustainable digital citizen means I contribute to a healthy digital environment that helps Saudi Arabia grow, not one that tears it down." (Interviewee 7, Male, Engineering)

Students used strong ecological metaphors—"pollution," "toxins," "waste"—to describe misinformation, hate speech, and rumor-spreading. This metaphorical mapping reflects and deepens the quantitative link between the Sustainability-Oriented Practices subscale and total intellectual security. From the students' perspective, every act of responsible sharing, respectful commenting, or rumor-checking is not only self-protection but also community care.
Several participants explicitly framed their digital behaviour as a form of national service:

"When I avoid sharing rumors or when I correct false information about Saudi Arabia, I feel I am doing something small for my country. It is like keeping our digital image clean for the world and for the next generation." (Open-ended response, Female, Business)

Others pointed to the role of higher education in this process, describing the course as a "training ground for future citizens":
"University is not only to prepare us for jobs. It should also prepare us for our role as digital citizens. This course showed me that my tweets and posts can either support Vision 2030 or work against it." (Interviewee 10, Male, Science)
This theme helps explain why sustainable digital citizenship and intellectual security were not experienced as individualistic

constructs only, but as embedded in social sustainability and national identity. The blended course appears to have helped students connect personal responsibility with broader narratives about Saudi Arabia's future.

6.5 Summary of qualitative findings

The qualitative strand confirms and deepens the quantitative results. The large statistical differences between blended and traditional groups on sustainable digital citizenship are illuminated by students' accounts of:

- Re-defining their digital personality as a unified, ethical identity (Theme 1).
- Rehearsing ethical and critical decisions in a blended "safe simulator" that slows down impulsive responses and encourages reflection (Theme 2).

  Likewise, the higher intellectual security scores among blended-learning students are explained by:
- A shift from fear and avoidance of harmful content toward informed, critical resilience (Theme 3).
- An expanded understanding of security that integrates value alignment, safe engagement, and active participation.

Finally, the observed association between digital citizenship and intellectual security is made intelligible by students' conceptualization of digital behaviour as social sustainability and national contribution (Theme 4). Rather than viewing responsible digital behaviour as a set of isolated rules, participants described it as a long-term commitment to preserving a healthy digital ecosystem that supports individual well-being, community cohesion, and the goals of Vision 2030.

Collectively, these qualitative insights show that the sustainability-oriented blended course did more than increase scores on scales: it reconfigured how students think, feel, and act as digital citizens in ways that align closely with the quantitative patterns documented in the preceding section.

7. Discussion

This study examined the effectiveness of a sustainability-oriented blended learning course in cultivating a "responsible digital personality" and strengthening "intellectual security" among Saudi university students. Through aligning the DigComp 2.2 framework with national priorities surrounding intellectual security, the research sought to provide empirical evidence for the role of higher education in shaping digital citizenship in the context of Vision 2030. Drawing on a sequential explanatory mixed-methods design, the findings strongly indicate that when blended environments are deliberately structured for reflection, ethical engagement, and sustainability, they yield markedly better outcomes than traditional lecture-based instruction.

7.1 Cultivating a Responsible Digital Personality

The quantitative results confirmed Hypothesis 1: students in the blended course scored significantly higher on all dimensions of sustainable digital citizenship than their peers in traditional sections, with a very large effect size on the total SDC score (d = 1.96). This pattern is consistent with recent work arguing that digital citizenship education requires interactive, participatory pedagogies rather than purely transmissive approaches (Almudara et al., 2024; Simon, 2025).

The particularly large between-group differences in Critical–Reflective Engagement and Ethical–Legal Responsibility are noteworthy. Earlier studies in Saudi contexts have highlighted a familiar paradox: students often possess moderate technical skills but display weaker ethical application and critical filtering of online content (Zhao et al., 2021). The present intervention appears to narrow this gap. The qualitative findings—especially Themes 1 and 2—clarify how this occurred. Students described the blended course as a kind of "safe simulator" in which they could experiment with digital decisions, receive feedback, and revise their responses before they "went live." This is congruent with Cleveland-Innes and Wilton's (2018) and Popa et al.'s (2020) contention that blended designs can create the cognitive and emotional space required for learners to move from impulsive reactions toward more reflective, ethically grounded choices.

Moreover, participants reported a shift from viewing their online and offline selves as separate to understanding a "responsible digital personality" as a unified, enduring identity. This resonates with Mohammadi's (2024) argument that genuine digital literacy involves stable critical–ethical dispositions rather than isolated skills. The robust increase in Sustainability-Oriented Practices further supports the study's theoretical integration of "digitainability" (Sá et al., 2021). Students did not describe digital hygiene merely as compliance with cyber-laws, but as a contribution to the long-term health of the Saudi digital ecosystem. This is in line with Lomachinska et al. (2025), who conceptualize digital citizenship as a strategic pathway towards broader sustainable development goals.

7.2 Enhancing Intellectual Security through Blended Learning

The findings also provide strong support for Hypothesis 2: participation in the blended course was associated with significantly higher levels of intellectual security, with a large effect on the composite measure (d = 1.23). This offers important empirical backing for Saudi policy discourses that foreground intellectual security as central to protecting youth from extremism, misinformation, and value erosion (Aladsani et al., 2022).

In particular, improvement on the Cognitive Resilience to Harmful Content subscale suggests that the course functioned as a form of "inoculation" against manipulative or extremist discourse. Qualitative Theme 3 showed that students increasingly understood intellectual security not as withdrawal from digital spaces but as active resilience—shifting from a

"wall" to a "filter" metaphor. This reframing is consistent with Lewin et al.'s (2021) conceptualization of cyber-wellness, which emphasizes competence and agency over simple restriction.

By analyzing controversial scenarios, deconstructing viral content, and debating sensitive topics within a supported environment, students developed the kind of resilient and agile mindset advocated by Ossiannilsson (2022). They reported feeling more capable of recognizing rhetorical strategies, challenging distortions, and safeguarding their beliefs without disengaging from global information flows. The gains on Value Alignment and Balanced Identity and Safe Digital Engagement are thus not simply defensive; they reflect a more confident, articulated relationship between national/religious values and participation in diverse digital publics.

7.3 The Relationship between Digital Personality and Intellectual Security

At the relational level, the results supported what was formulated as Hypothesis 4: there was a positive, statistically significant correlation between responsible digital personality and intellectual security ($r = .29$). Students who reported higher sustainable digital citizenship also tended to report higher intellectual security, and the qualitative data corroborated this link. Participants often described responsible digital behaviour and intellectual stability as mutually reinforcing.

However, the mediation analysis **did not support Hypothesis 3**. While the blended course increased both outcomes, high levels of digital citizenship within the experimental group were associated with a slight decrease in perceived intellectual security ().

This "critical awareness paradox" suggests that as students become more digitally responsible and literate (higher SDC), they become more acutely aware of digital risks and vulnerabilities, leading to a more cautious or critical self-assessment of their security (lower IS scores compared to their naïve baseline). The intervention appears to operate via a dual-track mechanism: it builds ethical character (Track A) and cognitive resilience (Track B) simultaneously, but the former does not directly cause the latter.

The qualitative findings support a dual-track interpretation. Students framed some elements of the course (e.g., explicit discussion of laws, ethics, and digital footprint) as primarily shaping their character and sense of responsibility, while they described other elements (e.g., critical analysis of posts, exposure to challenging content) as directly building cognitive resilience and intellectual security. These tracks clearly interact but are not reducible to one another. This refines the conceptual model (Figure 2) and suggests that educational interventions should target both tracks explicitly—character formation (RDP) and cognitive resilience (IS)—rather than assuming that strengthening one will automatically and fully generate the other.

7.4 Theoretical and Practical Implications

Theoretically, this study demonstrates the value of integrating Education 4.0 principles (Bonfield et al., 2020) with character-oriented digital citizenship (Ohler, 2010). The findings support "responsible digital personality" as a viable, measurable construct that bridges the gap between technical competence (as captured in DigComp) and value-based citizenship. It also advances the notion of intellectual security as an inherently cognitive–ethical construct rather than a purely technical or legal one.

Practically, several implications emerge for Saudi higher education and the realization of Vision 2030:

1. **Curriculum design.** Universities should move beyond purely informational lectures on cybercrime and online ethics. To foster both digital responsibility and intellectual security, curricula need blended formats that incorporate scenario-based practice, structured reflection, and deliberate "slow thinking." The present course design illustrates how face-to-face debates, online forums, and reflective journals can be orchestrated to achieve this.
2. **Social sustainability.** Embedding sustainability concepts within digital literacy courses encourages students to perceive their digital behaviour as part of a wider project of social and cultural sustainability (Theme 4). This reframes digital citizenship from a defensive stance (avoiding harm) to a proactive civic duty, where students see rumor-checking, respectful engagement, and content curation as contributions to national development and societal cohesion.
3. **Instructor preparation.** The findings highlight that effective digital citizenship education is not simply a matter of providing an LMS; it requires educators who can facilitate sensitive, ethically charged discussions, scaffold critical analysis of real digital content, and manage potential tensions in a way that builds resilience rather than fear. Professional development for faculty should therefore address pedagogical strategies for blended ethical and critical engagement, not just technical skills.
4. **Policy alignment.** At the policy level, the results offer a model for operationalizing intellectual security goals within mainstream university curricula. Rather than treating intellectual security as a separate, security-driven agenda, it can be integrated into ordinary digital literacy and general education requirements through carefully designed blended courses.

7.5 Limitations

Several limitations should be acknowledged. First, the study relied on self-report measures, which are vulnerable to social desirability effects—particularly in domains such as ethics and security. The incorporation of reflective journals and interviews provides some methodological triangulation, but future work could complement self-reports with behavioural or digital trace data. Second, the sample was drawn from a single Saudi university. Although the sample size was substantial and included

students from different colleges, caution is warranted in generalizing findings to all Saudi or GCC institutions, especially those with different technological infrastructures or student demographics. Third, the design focused on pre- and post-intervention comparisons within one semester. Consequently, the study cannot determine the long-term durability of the observed changes in responsible digital personality and intellectual security. Longitudinal follow-up—tracking students into later semesters or into the workplace—would help clarify whether these dispositions remain stable and how they manifest in professional and civic contexts.

8. Conclusion

In its entirety, the study reveals that a sustainability-oriented blended learning environment can act as a powerful driver of change in how university students understand and perform their roles as digital citizens. The course did more than raise scores on standardized measures; it reshaped students' perceptions of their digital identities, their responsibilities toward others online, and their capacity to withstand ideological and informational pressures. Within this environment, students encountered authentic digital dilemmas, engaged in guided debate, and then revisited these experiences through structured reflection. This cycle of exposure, dialogue, and reflection enabled them to internalize ethical principles, adopt more deliberate and evidence-based online behaviours, and reframe intellectual security as a form of confident, critical engagement rather than simple avoidance.

The findings also highlight the broader societal significance of such interventions. Students increasingly linked their personal digital choices to the health of the wider information ecosystem and to the social dimensions of sustainability. Responsible sharing, respectful participation, and resistance to harmful content emerged not only as private virtues but as contributions to national cohesion and the aspirations of Vision 2030.

In this sense, the blended course offers more than an instructional innovation; it outlines a practical model for universities that seek to translate abstract policy goals on digital transformation and intellectual security into everyday classroom practice. Educational programs that adopt similar principles can help prepare a generation that enters the digital public sphere with solid technical skills, a coherent and ethical digital personality, and a well-developed sense of intellectual security anchored in critical literacy and civic responsibility.

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Conflicts of Interest:

The authors declare no conflict of interest.

Authorship and Level of Contribution

All authors contributed to the literature research, data collection, analysis, and interpretation of the collected data.

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