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DIGISTEPS: MINI-STEPS TOWARDS MASTERING DIGITAL CITIZENSHIP

by
FARAH HASSAN HUTAYT

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by

FARAH HASSAN HUTAYT

Approved by:

Dr. Hoda Baytiyeh, Associate Professor Department of Education	First Reader
Dr. Saeed Raheel, Lecturer Department of Computer Science	Second Reader

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ABSTRACT
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As technology continues to infiltrate multiple aspects of our lives, individuals of all ages now find themselves belonging to the global, digital community. As digital citizens, the goal is to become "iCitizens" – a term coined in the iCitizen Project (Ribble, 2015) – who are not only digitally fluent, but are also empowered, personally responsible, participatory, and justice-oriented both online and offline (Kahne et al., 2006). In response, schools have begun integrating digital citizenship into their curricula; however, opportunities for structured and engaging practice remain limited.

This project aimed to design and develop DigiSteps, a web-based application tailored for students from kindergarten through grade 12. The application enables K–12 students to actively practice digital citizenship concepts through scenario-based learning. The application is aligned with Ribble's nine elements of digital citizenship in schools: digital etiquette, access, law, literacy, communication, commerce, rights and responsibilities, security, and health and wellness. It is intended for use as a digital hands-on tool within Social Emotional Learning (SEL) and Digital Citizenship classes. In essence, DigiSteps provides mini-steps towards mastering digital citizenship.

Grounded in the TPACK framework and informed by constructivist principles, the application was developed using a component-based architecture and a structured question bank. It incorporates gamified elements including differentiation, multiple difficulty levels, immediate feedback, progress bars, a scoring system and motivational messages. However, due to the scope of the project, pilot testing is yet to be conducted.

The outcome of the project is a functional and scalable platform that allows students to engage with key digital citizenship concepts in a low-stakes environment. DigiSteps supports the development of critical thinking, reflection, and responsible decision-making, while also providing educators with a flexible tool that complements existing curricula. Overall, the project demonstrates how thoughtfully designed educational technology can support the development of iCitizens through active, practice-based learning.

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ABBREVIATIONS

AI	Artificial Intelligence
BIA	Be Internet Awesome
CK	Content Knowledge
CSE	Common Sense Education
PCK	Pedagogical Content Knowledge
PK	Pedagogical Knowledge
SEL	Social Emotional Learning
TCK	Technological Content Knowledge
TK	Technological Knowledge
TPACK	Technological Pedagogical and Content Knowledge
TPK	Technological Pedagogical Knowledge
UTAUT	Unified Theory of Acceptance and Use of Technology
ZPD	Zone of Proximal Development

CHAPTER 1

INTRODUCTION

Problem Statement

In today's digital era, technology has become a central part of young people's lives, dominating their education, social interactions, and leisure time. Yet, a critical disconnect exists: while K–12 learners are hyper-connected, they often lack the structured education necessary to help them behave safely, ethically, and responsibly in online spaces. Educational systems, especially in K–12 settings, often fail to adequately integrate comprehensive digital citizenship into their curricula (Buchholz et al., 2020). While schools may present scattered concepts, children are left without opportunities to practice. Without such practice tools, students are vulnerable to a range of harms, including cyberbullying, exposure to misinformation, privacy violations, unfair digital commerce, and deteriorating digital well-being (Althibyani & Al-Zahrani, 2023; Zhu et al., 2022).

Empirical research highlights a concerning gap between *knowing* about safety and *acting* safely. For example, a recent cluster randomized controlled trial found that while school-based programs improved students' theoretical knowledge of online risks, critical behaviors – such as privacy protection and reporting unsafe interactions – remained largely unchanged (Jones et al., 2024). This indicates that traditional instruction is often insufficient to alter behavior. Conversely, research suggests that when students *do* possess high levels of digital citizenship competence, these skills act as protective factors, significantly correlating with a lower incidence of cybercrime and irresponsible behavior among young adults (Althibyani & Al-Zahrani, 2023).

Despite this evidence, schools struggle to implement age-appropriate digital citizenship curricula consistently. A comparative study of teacher practices in Germany and Hong Kong revealed that, while educators recognize the importance of digital citizenship, actual implementation varies widely. Most often it is limited by lack of resources, time, or structured content (Vajen et al., 2023). This challenge also exists in the Arab context, where the inclusion of digital citizenship in traditional curricula is often weak. Educators report a lack of structured frameworks, resources, and guidance, hindering their ability to teach these concepts effectively (Alenezi & Alfaleh, 2024).

These realities create a critical gap: without accessible and engaging tools to practice digital citizenship, many students remain unprepared for the complexities of the digital world. This gap highlights the pressing need for a practical, accessible and scalable solution – usable both inside and outside the classroom – that provides differentiated, interactive, and developmentally appropriate opportunities for students to internalize digital citizenship concepts through active practice.

Significance of the Project: Impact and Implications

Today, the need for structured, age-appropriate digital citizenship education has never been greater. However, many K–12 institutions lack consistent curricula, resources, or effective pedagogical frameworks to deliver this education (Ribble & Park, 2019; Vajen et al., 2023). The significance of DigiSteps lies in its potential to bridge the persistent gap between theoretical digital citizenship education and practical, student-centered application. It is a web-based digital citizenship application that provides accessible, scalable, and developmentally appropriate opportunities for students to build digital competence through practice, not just exposure to theory. DigiSteps has specific impacts across individual, institutional, and societal levels.

Impact 1: Promoting Student Safety and Well-being

At the individual level, the project directly promotes safer online behaviors and psychological well-being. Research demonstrates that higher levels of digital citizenship competency act as a protective factor, significantly reducing the likelihood of youth engaging in cybercrime or irresponsible online behavior (Althibyani & Al-Zahrani, 2023). By offering structured and scenario-based practice across Ribble's nine elements – such as security, rights and responsibilities, and etiquette – DigiSteps helps students internalize ethical norms, thereby minimizing their exposure to harms such as harassment, privacy breaches, and misinformation. This active practice is crucial for mitigating negative behaviors like cyberbullying and harassment, fostering instead a culture of empathy and respect (Zhu et al., 2022). Furthermore, this competence supports broader mental health: recent research identifies a positive correlation between digital literacy and psychological well-being, suggesting that equipping youth to navigate digital environments consciously reduces stress (Arkan & Bal, 2025).

Impact 2: Bridging the Equity Gap in Education

At the institutional level, DigiSteps aims to bridge gaps in accessibility to digital citizenship education, on a large scale. Many schools, particularly those in under-resourced areas, struggle to teach digital citizenship systematically due to a lack of training or curriculum time (Alenezi & Alfaleh, 2024). A web-based solution like DigiSteps has the advantages of being accessible (no sign-in or installation required), scalable (usable by many students across levels), and low-cost (requires minimal maintenance once built). It can be used as a supplemental tool by schools or parents, extending beyond traditional classroom limitations. It democratizes access, ensuring that students from all backgrounds can engage with vital digital citizenship resources.

Furthermore, because the project is designed with scalability and future expansion in mind, it serves as a foundational platform upon which further enhancements – such as progress tracking, personalized learning, teacher dashboards, and larger-scale implementation in schools – can be built. In the long run, this can contribute to institutional adoption of digital citizenship curricula.

Impact 3: Fostering a Responsible Digital Society

Ultimately, the implications of this project extend beyond individual users to society as a whole. By nurturing a generation of digitally literate and responsible "iCitizens," the project aligns with broader societal goals: promoting ethical online behavior, protecting individuals from cyber-risks (such as fraud, harassment, cybercrime), safeguarding privacy, and fostering respectful, inclusive online communities. Safer online environments, reduced cybercrime rates, enhanced trust in digital spaces, and more informed responsible digital participation, will all lead to social cohesion, strengthened public safety, and sustainable digital growth.

Project Objectives and Expected Outcomes

The primary goal of DigiSteps is to bridge the gap between digital citizenship theory and practice. The project's goal is summarized through four core objectives:

1. Develop a functional, browser-based web application that enables K–12 students to actively practice digital citizenship skills in a low-stakes environment.
2. Provide high-quality, differentiated (level-appropriate) digital citizenship content aligned with Ribble's nine elements, ensuring relevance for all developmental stages.
3. Create an engaging, intuitive, and age-appropriate user experience that lowers the barrier to entry for young learners.

4. Build a scalable structure that supports immediate deployment while laying the groundwork for future expansion

Upon completion, the project will deliver a fully functioning, browser-based self-contained practice web application that allows K–12 students to independently engage with digital citizenship scenarios and practice questions, so that they can build, scaffold, and solidify their knowledge in various topics. The application will enable students to select their grade band, choose from the nine categories of digital citizenship, and practice with randomized sets of questions fetched from an extensive question bank, easily and without the need for sign-ins. A smooth navigation flow will guide learners from level to category selection, to category descriptions, practice questions, scoring, and retry options, ensuring a complete and robust user experience.

To support differentiated learning, a major outcome of this project is the development of a comprehensive, differentiated question bank consisting of thousands of questions tailored to four distinct grade bands: Grades K to 2, Grades 3 to 5, Grades 6 to 8, and Grades 9 to 12. Additionally, each element of digital citizenship will include level-appropriate descriptions, questions, and feedback on answers. This tailored content ensures that information is not just consumed but understood. This content will be stored in a structured and maintainable format to ensure ease of filtering, scalability, and long-term usability.

To ensure ease-of-use and adoption, the project will deliver a visually engaging interface designed specifically for K–12 cognitive levels. Featuring clean aesthetics, friendly iconography, a “one-click-per-page” navigation philosophy, and motivational messaging on the score page, the UI will minimize cognitive load to keep students focused on learning. Insights gathered through technical and pilot testing will guide

refinement, resulting in an interface that supports student focus, clarity, and meaningful learning.

Finally, the project will have a scalable design to allow for future growth. The initial version will be built with modular architecture so that features such as user accounts, progress tracking dashboards, analytics, updated question banks, and additional content can be added without restructuring the system. Documentation and structured data design will ensure that DigiSteps can evolve from a standalone tool into a robust and comprehensive digital citizenship learning platform in the future.

CHAPTER 2

LITERATURE REVIEW

Digital citizenship has become an essential component of K–12 education as students increasingly interact, learn, and socialize in online spaces. This chapter adopts a funneled approach that guides the logical narrative flow of the literature review. Starting with a broad overview of digital citizenship in K–12 education, the review then examines gamification in K–12 learning, highlighting why gamified learning approaches are effective and their associated benefits. The review then explores existing gamified platforms across various educational contexts as a proof of concept that gamification does indeed work. Finally, it examines current digital citizenship platforms and tools, with particular attention to recent efforts to incorporate gamification into digital citizenship education. After clearly identifying the need for a gamified tool to support digital citizenship, the chapter concludes by presenting the conceptual frameworks that inform the development of an effective, student-centered web application like DigiSteps.

Overview of Digital Citizenship in K–12 Education

Digital citizenship is commonly defined as the "norms of appropriate, responsible behavior with regard to technology use" (Ribble, 2015, p. 15). It encompasses a broad set of competencies that help young people navigate digital environments and contribute positively to their digital communities (ISTE, 2016). Ribble's widely referenced framework organizes digital citizenship into nine domains: digital etiquette, digital access, digital law, digital literacy, digital communication, digital commerce, digital rights and responsibilities, digital security, and digital health

and wellness. This framework reflects the diverse knowledge and behavioral skills needed for students to participate effectively in a connected world. As schools adopt more technology-rich learning environments, the need for explicit, developmentally appropriate instruction in these nine areas has grown significantly.

The importance of digital citizenship education is closely tied to current challenges in the digital landscape. Students encounter issues such as misinformation, cyberbullying, privacy risks, online commercial manipulation, and unhealthy media habits at increasingly younger ages. Research shows that while children are highly active users of technology, their understanding of safe and ethical online behavior often lags behind their actual participation online (Choi et al., 2017).

Despite this urgency, teachers report difficulties implementing digital citizenship curricula due to limited time, insufficient training, and a lack of structured guidance or age-appropriate instructional materials. Recent research highlights low teacher preparedness – specifically limited digital citizenship self-efficacy and insufficient professional development – as major barriers to implementation (Alenezi & Alfaleh, 2024; Sleem & Nicolas, 2025). For instance, in Lebanon, Sleem and Nicolas (2025) found that teachers had confidence in only some digital citizenship elements, and faced significant infrastructural and resource constraints preventing them from implementing digital citizenship successfully. Similarly, in Saudi Arabia, Alenezi and Alfaleh (2024) reported that elementary teachers face a lack of structured guidance, training, institutional support, and an absence of age-appropriate materials. These findings collectively demonstrate that insufficient teacher training and unclear curriculum expectations result in inconsistent digital citizenship delivery across grade levels.

These challenges make it necessary to explore innovative and engaging approaches to strengthen students' digital citizenship competencies. Gamification and active-based learning can pave the way forward.

Gamification in K–12 Learning

In educational contexts, gamification refers to the application of game-design elements – such as points, badges, levels, challenges, and leaderboards – to learning activities with the goal of enhancing student motivation, engagement, and learning outcomes (Dichev & Dicheva, 2017). Unlike traditional instruction, gamification introduces rewards, progress tracking, and goal-oriented challenges. These mechanics encourage learners to actively participate, persist through difficulties, and monitor their own development (Hamari et al., 2016). By providing a structured environment for repeated practice, gamification supports the principles of mastery learning and promotes learner autonomy (Mekler et al., 2017).

Research consistently shows that gamification increases both intrinsic and extrinsic motivation. Students in gamified environments exhibit higher levels of engagement and persistence because game elements make the learning process more enjoyable and goal-directed (Hamari et al., 2016; Sailer & Homner, 2020). By fulfilling psychological needs for competence and autonomy, these environments encourage sustained participation and a deeper investment in learning tasks.

Beyond motivation, a critical advantage of gamification is its ability to provide immediate, actionable feedback. Through progress indicators, levels, and points, learners can instantly monitor their growth, reflect on their performance, and adjust their strategies to achieve mastery. This feedback loop supports skill acquisition by

reinforcing correct behavior and highlighting areas that need improvement (Mekler et al., 2017).

Empirical studies further indicate that these mechanisms enhance retention, knowledge acquisition, and self-directed learning. Longitudinal studies in both classroom and online settings have demonstrated that gamified activities improve academic performance compared to non-gamified instruction (Sailer & Homner, 2020).

However, success depends on thoughtful design. Poorly implemented game elements can result in superficial engagement, increased cognitive load, or unequal benefits across diverse learners. Consequently, studies emphasize the importance of aligning gamification elements with specific learning objectives and scaffolding content to maximize educational benefits (Dichev & Dicheva, 2017; Mekler et al., 2017).

Existing Gamified Learning Platforms

A substantial body of research confirms that gamified digital platforms are effective across various K–12 disciplines, consistently demonstrating positive effects on motivation, engagement, and learning outcomes. These platforms succeed by leveraging interactive designs that allow for personalized practice and rapid feedback.

In language learning, *Duolingo* utilizes points, streaks, levels, and adaptive sequencing to maintain student engagement. Multiple program evaluations report significant gains in vocabulary, listening, and reading outcomes when the application supplements classroom instruction (Ouyang et al., 2024; Jiang et al., 2021). In mathematics and science, several platforms illustrate the value of mastery-based learning. *Khan Academy* integrates badges, hints, and real-time feedback, supporting measurable achievement gains when paired with teacher instruction (Kelly & Rutherford, 2017). Similarly, *IXL* offers skill-based practice with adaptive difficulty.

Evaluations indicate that consistent usage correlates with improved skill confidence and achievement (Liu & Wu, 2021; IXL Learning, 2024). Even simpler, lightweight tools like *Hit-the-Button* effectively support mathematics fact fluency through gamified repetition. For science, *PhET Interactive Simulations* use inquiry-based tasks and exploratory mechanics to deepen conceptual understanding (Rayan et al., 2023; PhET Research Team, 2024). In literacy, platforms such as *Reading Plus* incorporate adaptive comprehension tasks, leveled texts, and progress tracking. Studies indicate that students who complete recommended usage "doses" show marked improvements in reading fluency and comprehension (Reading Plus, 2019).

Despite the availability of these successful platforms across core subjects, there is currently no equivalent practice-oriented system tailored specifically to digital citizenship. The demonstrated effectiveness of adaptive, feedback-driven designs in language, math, and literacy suggests that gamification is a pedagogically powerful tool in K–12 education. This underscores a significant opportunity to apply these proven principles to digital citizenship through a tool such as DigiSteps.

Existing Digital Citizenship Platforms, Tools, and Applications

Full-Curriculum Programs

Over the past decade, several curriculum-based initiatives have emerged to teach digital citizenship in K–12 settings. Two of the most prominent are *Google's Be Internet Awesome (BIA)* and *Common Sense Education (CSE)*. Both have been widely disseminated and evaluated, offering critical insights about what works – and what remains missing – in current practice.

Google's BIA is designed for elementary school students and integrates both lessons and a game called Interland, which teaches core digital citizenship skills such as

safe sharing, privacy protection, and evaluating online content. CSE offers a broader scope, spanning kindergarten through grade 12. It covers topics ranging from digital etiquette to cyberbullying prevention, providing teachers with structured lesson plans, videos, and activities.

Rigorous evaluations indicate that while these programs improve students' knowledge and self-efficacy for particular online skills, their impact on long-term behavior is mixed. For instance, a randomized controlled trial of BIA showed measurable gains in knowledge and attitudes among elementary students, but limited changes in complex behaviors like privacy management (Jones et al., 2024). Similarly, evaluations of CSE report improvements in conceptual understanding but highlight that without ongoing reinforcement and situated practice, behavioral change is often inconsistent (Brandau, 2022). This highlights the need for complementary tools that emphasize repeated practice and situated scenario-based learning (Jones et al., 2024; Brandau, 2022).

Focused Interventions and Shorter Programs

Beyond full-curriculum packages, peer-reviewed research has examined shorter interventions targeting only specific competencies, such as media literacy, privacy, and cyberbullying prevention. For example, the *Screenshots* program offers a nine-lesson curriculum for middle schoolers focused on mental health and digital wellness. The quasi-experimental study by Bickham et al. (2021) reports a gain in digital citizenship knowledge when the program components were implemented as intended, but the authors emphasized that knowledge gains did not always translate automatically into improved online behaviors without reinforcement and practice. This suggests that while

classroom lessons are necessary, they are often insufficient on their own to produce lasting behavioral change.

Limitations of Current Tools

Current digital citizenship resources face two primary limitations. First, from a technological perspective, most are designed as lesson repositories or static interactive modules rather than lightweight, practice-oriented applications. This limits opportunities for the repeated, low-stakes practice and rapid feedback loops that are central to skill acquisition (Milenkova et al., 2021). In addition, while some platforms include assessments, few offer the large volume of differentiated exercises needed for regular practice without repetition.

Second, equity and accessibility remain significant concerns. Schools with fewer resources or less trained staff are less likely to adopt comprehensive programs, risking a widening gap in students' digital competence (Opria & Momanu, 2023; Alenezi & Alfaleh, 2024). Consequently, there is a clear need for solutions that are low-cost, easy to deploy, and require minimal teacher preparation while delivering scaffolded, level-appropriate practice.

Gamification in Digital Citizenship

Recently, there have been several efforts to use gamification to enhance digital citizenship learning. The studies demonstrate the varied approaches on how to integrate gamification and game-based learning into digital citizenship education.

Panjaburee et al. (2024) implemented a personalized, two-dimensional role-playing game designed to teach digital citizenship to eighth-grade students. The game presents realistic digital scenarios requiring decisions about privacy, safe sharing, and online ethics. The system uses fuzzy logic to adapt scenarios to individual decision

patterns and provide tailored feedback. The study found that students in the "personalized game" group achieved significantly higher scores on digital citizenship knowledge tests and reported more positive attitudes than the control group. Eye-tracking data further revealed that the gamified environment increased visual attention and engagement. This study highlights the effectiveness of adaptive, personalized gamification in fostering both conceptual understanding and active participation, demonstrating that responsive feedback can enhance engagement beyond traditional instruction.

Adding to this evidence, Liu et al. (2025) examined the effects of a digital citizenship educational game on teenagers' achievement and cognitive load. Their study revealed that the gamified approach not only significantly improved learning achievement and motivation but also maintained an optimal level of cognitive load. Furthermore, analysis of behavioral patterns showed that students in the game-based group exhibited more sustained and focused engagement compared to those in traditional learning settings.

In a different approach, Hill (2015) examined the use of *Minecraft* as a constructionist tool. In this study, fifth-grade students collaboratively built a 3D virtual library to teach digital citizenship concepts – including respectful sharing, digital footprint awareness, and ethical online behavior – to younger peers. By negotiating norms of ownership and privacy within their shared virtual world, students actively practiced the very ethical behaviors they were learning, and were teaching to the younger learners. Although small-scale and non-experimental, this study demonstrated that game design – not just gameplay – can cultivate deep reflective thinking.

More recently, Zheng et al. (2024) conducted a quasi-experimental study comparing traditional instruction against a game-based learning intervention that focuses on one core component of digital citizenship: digital etiquette. The results were clear: students in the game-based group showed significantly greater improvements in digital etiquette knowledge, as well as higher motivation and engagement.

Collectively, these studies highlight the transformative potential of gamification in digital citizenship education. By offering active, contextualized practice, gamified environments allow students to navigate realistic simulations – ranging from role-playing scenarios to virtual world-building – that mirror the complexities of the digital landscape (Panjaburee et al., 2024; Hill, 2015). Furthermore, the integration of personalized, immediate feedback supports self-regulated learning, enabling students to understand the consequences of their actions in a safe, low-stakes setting (Zheng et al., 2024). Ultimately, these interactive approaches do not merely increase engagement; they foster the participatory and reflective skills necessary for students to evolve from passive users into empowered "iCitizens" capable of ethical decision-making in online communities.

The Need for DigiSteps

Traditional instruction often relies on one-time lessons rather than sustained, practice-based learning that helps students transfer knowledge to real-life digital contexts. Recent studies emphasize the need for interactive, scaffolded, and context-rich experiences that allow students to practice evaluating digital situations rather than merely passively receiving instruction. Furthermore, although existing digital citizenship programs are valuable, they often lack differentiation across grade levels or

sufficient opportunities for students to apply concepts through repeated, formative practice.

Taken together, the literature indicates that while existing digital citizenship curricula (such as Be Internet Awesome and Common Sense Education) are valuable for introducing concepts and raising awareness, they leave critical gaps in the pedagogical landscape. Specifically, current tools often fall short in three key areas:

1. Repeated, scenario-based practice to help students apply what they learn.
2. Easy integration for teachers with limited time or resources.
3. Adaptive, age-appropriate practice exercises that keep students engaged.

DigiSteps is designed to fill this niche. Unlike existing programs, it offers a lightweight, gamified platform focused on practice. By providing scaffolded challenges, immediate feedback, and differentiation from kindergarten through grade 12, the application allows students to build competence progressively. It serves as a vital practical application tool to complement existing curricula, ensuring that students do not just learn about digital citizenship, but actively practice becoming responsible iCitizens.

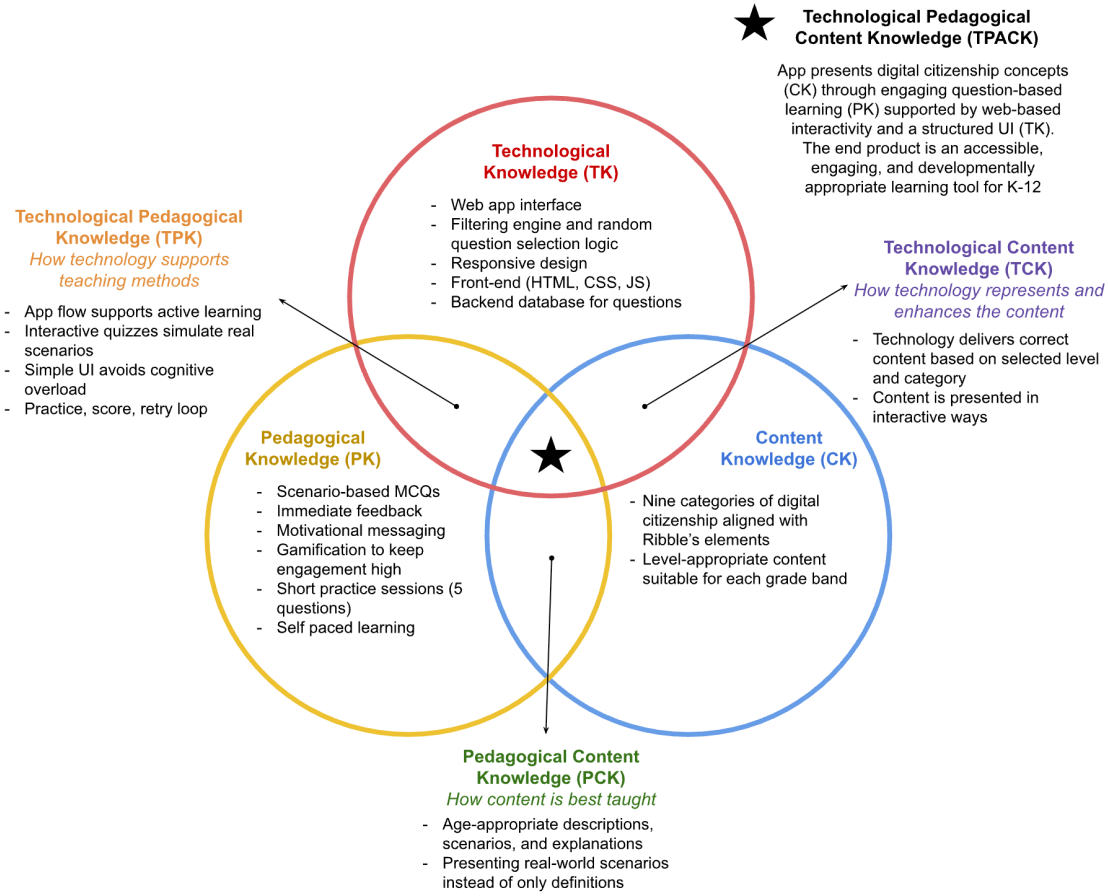
Theoretical Frameworks

Instructional Design: TPACK

The design of the DigiSteps web application is grounded in the TPACK (Technological Pedagogical Content Knowledge) framework. Developed by Mishra and Koehler (2006), this framework emphasizes that effective educational technology integration requires the thoughtful intersection of technology, pedagogy, and content to enhance digital learning. Figure 1 demonstrates how the different components of TPACK apply to DigiSteps.

Figure 1

How the TPACK Framework Applies to the Design of DigiSteps



For this project, *Content Knowledge (CK)* is represented by the nine elements of digital citizenship, each aligned with developmentally appropriate knowledge for different grade bands. This classification aligns with the study by Valtonen et al. (2017), which argues that the TPACK framework must encompass 21st-century skills, explicitly positioning digital competencies as essential "Content Knowledge" rather than just side skills. *Pedagogical Knowledge (PK)* shapes how these concepts are taught through scenario-based questions, immediate feedback, and level-appropriate explanations that support active and self-paced learning. *Technological Knowledge (TK)* is reflected in

the web application structure itself: its front-end development, question-filtering engine, and user-friendly intuitive interface that makes learning accessible without requiring logins. By integrating these three knowledge areas, the TPACK framework ensures that DigiSteps is not merely a digital version of instructional content, but a pedagogically meaningful, technologically robust, and content-aligned learning experience. This alignment strengthens the educational value of the tool, supporting students' ability to practice digital citizenship skills in ways that are engaging, developmentally appropriate, and authentically connected to real-world digital contexts. Grounding the design in TPACK supports effective digital citizenship learning, consistent with findings that technology-integrated pedagogy significantly enhances student engagement and conceptual understanding (Mishra & Koehler, 2006).

Constructivism

While TPACK outlines the necessary integration of knowledge components, Constructivist learning theory provides the specific pedagogical foundation for how students will acquire digital citizenship skills within DigiSteps. At its core, constructivism suggests that learners do not passively absorb information; they actively construct knowledge by connecting new ideas to their existing experiences and mental models. It calls for students to solve problems and actively engage in inquiry (Draper, 2002). In the context of digital citizenship education, constructivism supports instructional designs where students interpret scenarios, think about questions, make decisions, and reflect on outcomes. These processes promote deeper understanding of responsible digital behavior.

Piaget (1972) emphasized that learners make meaning by connecting new information to what they already know, adjusting their mental models as they encounter

new situations. “Piaget’s theory gives a rough guide to when students become able to think in various ways” (Sternberg & Williams, 2010, p. 45). In terms of content, teachers must teach concepts that are just above the reach of students. This disequilibrium between what they already know and what they are exposed to will trigger equilibration, and students will be able to construct new knowledge (new schemas) using the processes of assimilation or accommodation. In the context of DigiSteps, this means students learn digital citizenship best with questions at multiple difficulty levels, instead of a “one size fits all” approach (Sternberg & Williams, 2010, p. 45)

Vygotsky (1978) emphasized learning through guided practice within the learner’s Zone of Proximal Development (ZPD), which focuses on the space between what learners can do independently and what they can achieve with support. To trigger learning, educators must create incongruity by introducing cognitive conflict at a reasonable level (Schunk, 2009). Paris et al. (2006) mention the idea of low-hanging fruit and interventional research. Interventions should not be far beyond the children’s ability, nor be given to children who have already acquired the skills. Rather, interventions on certain skills and knowledge should be given to children who are “ripe for learning the target skills” (Paris, 2006, p. 71). If the learning is within the child’s ZPD, then the child will have the prerequisite knowledge and skills to take advantage of the learning opportunity. Learners learn best when they receive scaffolding, in the form of prompts, explanations and feedback, which helps them build on their current knowledge and move towards knowledge that is just beyond their reach. This aligns with DigiSteps’ level-appropriate scenarios and immediate feedback with explanations.

By grounding DigiSteps in constructivist principles, the project supports active learning experiences where students are encouraged to think, question, and make sense of digital dilemmas, and not simply memorize concepts. This approach helps students build a deeper understanding of what it means to act responsibly and thoughtfully in digital spaces.

Chapter Summary

This chapter critically examined the literature underpinning the development of the DigiSteps web application, focusing on digital citizenship education in K–12 contexts, gamified learning approaches, and existing tools and interventions. While digital citizenship is widely acknowledged as essential, the literature reveals gaps between conceptual understandings of digital citizenship and students' actual behaviors in online spaces. Traditional approaches often rely on passive instruction, which may fail to promote meaningful skill development that translate into real-life actions.

Research on gamified learning highlights the value of active engagement and low-stakes practice, supporting the need for interactive, practice-oriented tools like DigiSteps. In fact, research shows that actively involving students in learning contributes to long-term retention (Slavin, 2009). The review reveals that although several digital platforms address aspects of digital citizenship, few integrate gamified elements in a structured and pedagogically grounded manner.

Furthermore, the literature indicates that while gamification and interactivity can enhance motivation and engagement, their effectiveness depends on alignment with clear pedagogical goals. In addition, studies on usability and accessibility suggest that complex or resource-heavy applications requiring subscriptions may lower adoption and

limit access. This highlights the importance of designing solutions that are not only engaging, but also intuitive, lightweight and scalable.

Overall, the literature underscores the need for tools that bridge the gap between theory and practice by integrating content, interactivity, and accessibility. Insights from this review directly inform the methodological and design decisions presented in the following chapter, ensuring that DigiSteps is both pedagogically sound and practically implementable. Accordingly, the next chapter outlines the methodology adopted to design and develop the DigiSteps application in alignment with these theoretical and practical considerations.

CHAPTER 3

METHODOLOGY

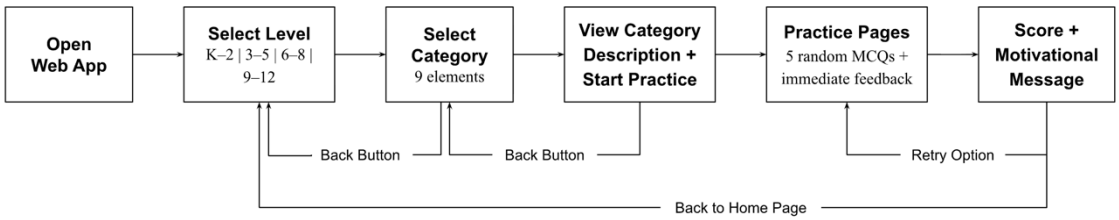
This chapter outlines the methodology adopted for the design and development of the DigiSteps web application. It describes the project design (both technical and pedagogical), the project context, implementation procedures, and the tools and resources used throughout the development process, along with the justification for design decisions. The chapter also explains the strategies followed to ensure that the project objectives are achieved, resulting in an application that is pedagogically sound, technically functional, and user-friendly.

Technical Design

The conceptual model or flow diagram below illustrates how data flows from one page to the next in the web application and serves as the project's blueprint. It illustrates the user journey through the pages of the application, showing how interactions on each page trigger the underlying logic and update the interface dynamically. The visual blueprint is followed by a detailed overview of the content of each page, and the logic flow between pages.

Figure 2

Conceptual Model of DigiSteps Outlining the Content of Each Page and the Flow Between Pages



Page 1: Level Selection

Students choose one of four levels, each of which corresponds to a grade level band. Each level represents a user persona, with Level 1 representing "The Explorer," Level 2 "The Learner," Level 3 "The Citizen," and Level 4 "The Leader."

Page 2: Category Selection

Students choose one of the nine elements of digital citizenship defined by Ribble. The elements with their descriptions are outlined in Table 1.

Table 1

Descriptions of Ribble's Nine Elements of Digital Citizenship

Element No.	Category Name	Brief Description	Context
1	Digital Etiquette	Do's & Don't of Proper Online Behavior	Proper behavior online, respectful communication, professionalism online, avoiding harmful actions, and considering your digital footprint and reputation
2	Digital Access	Equal Access to Technology for Everyone	Equal opportunities for all users to participate online; solving digital divide issues
3	Digital Law	Legal Responsibilities & Violations	Legal responsibilities: cyberbullying, copyright, plagiarism, hacking, illegal downloads, acceptable use
4	Digital Literacy	Fake News & Fact Checking	Ability to find, evaluate, and use information online; understanding media and technology
5	Digital Communication	The How, When & What of Proper Communication	Proper and effective use of messaging, email, social media, and online collaboration tools. To communicate properly, learn how to use digital communication methods, when to use what, and what content to send. Apply STEP – Stop, Think, Empathize, and Post – before posting
6	Digital Commerce	Safe Buying & Downloading	Safe and responsible buying/selling online; identifying scams, fraud, or risky financial behaviors

7	Digital Rights & Responsibilities	Fair Use, Ethics & Copyright	Users' rights (access, privacy, freedom of expression) and responsibilities (ethical use, reporting abuse)
8	Digital Safety & Security	Passwords, Privacy & Scams	Protecting devices, accounts, personal data; passwords, phishing avoidance, cybersecurity basics
9	Digital Health & Wellness	Screen Time & Balance	Physical and mental well-being online: screen time balance, ergonomics, cyberbullying stress

Page 3: Category Info Display

A short category description and explanation of the chosen element is displayed based on the selected level, followed by a *Start Practicing!* Button, and a *Back* button should the student change their mind.

Page 4: Practice Session

The question selection logic pulls five random questions from the pre-loaded question bank filtered by level and category. The multiple-choice questions (MCQ) are displayed one at a time. The student selects an answer. The application evaluates each answer internally and gives instant feedback on each question with a brief explanation of the correct answer. The *Next* button moves the user to the following question page. A progress bar at the top of the page shows user progress through the practice session giving a sense of completion, along with a running score of correct answers.

Page 5: Scoring Page with Retry and New Session Options

After all five questions are completed, the tool calculates and displays a score out of 5. The application also displays a motivational message based on the score. The student can either choose to practice another set of five questions on the same topic (*Keep Practicing* button), or can choose to begin a new session by going back to the beginning and selecting another level-category (*Back to Home Page* button).

Pedagogical Design

DigiSteps is designed around core learning principles that boost engagement and improve learning outcomes. Table 2 shows how each principle is put into practice and outlines the pedagogical rationale behind each design choice.

Table 2

The Various Learning Principles and How They Apply to DigiSteps

Educational Principle	Implementation in App
Active Practice/Learning	Students engage with real-life scenarios instead of passively reading
Immediate Feedback	Total score gives a sense of performance, and correct and incorrect explanations help internalize concepts
Differentiated Learning	Levels allow content to be age-appropriate
Experiential Learning	Scenario-based practice simulates real digital situations
Self-Directed Learning	Students control their learning by choosing their level and category
Iterative Learning	Formative assessments through scoring, coupled with the retry option reinforce learning through continual practice
Cognitive Load Theory (John Sweller)	Following a “one-click-per-page” design with a clean and clear interface avoids cognitive overload and reduces extraneous load

Context of the Project

The DigiSteps web application is designed specifically for K–12 students to promote responsible digital citizenship skills. While digital literacy and responsible online behavior are universally important and apply to individuals of all ages, younger learners often face unique challenges in navigating online spaces safely and ethically. This project focuses on providing age-appropriate, level-differentiated content that

aligns with the developmental needs of students across different grade bands. The target population includes students from early primary to high school levels, grouped into four grade bands for tailored content delivery. Each grade band encounters scenarios and questions that are relevant to their developmental stage, ensuring that the material is meaningful and engaging. Teachers and educators are secondary stakeholders, as the platform also provides a tool they can use to reinforce digital citizenship practices in their classrooms. Parents are also stakeholders should they choose to use this tool at home.

The project is implemented in an online learning environment, making it suitable for both in-person and remote educational contexts. This flexibility allows the web application to be integrated into different curricular settings, whether as part of classroom instruction, digital citizenship workshops, supplementary learning activities, or in home-learning scenarios. The content is structured around Ribble's nine elements of digital citizenship, providing a framework that is both comprehensive and adaptable to a variety of educational standards and common guidelines.

In terms of geographical context, the application is developed to be universally accessible, with potential usage in any region where K–12 education is delivered in English. While the initial testing and pilot implementation will focus on students in Riyadh, Saudi Arabia, particularly those attending international schools that offer some form of digital citizenship curriculum or lessons, the tool's design allows for scalability and adaptation to other educational settings. Future versions will support other languages, starting with Arabic, thereby increasing the scope of potential users.

Finally, the technological context of the project is important, as DigiSteps is designed as a web-based application using a structured question bank and interactive

features. This allows students to practice digital citizenship in a simple and low-pressure environment. The tools and technologies used were selected to ensure the application is easy to access, user-friendly, and scalable, allowing it to be improved and expanded over time.

Design Decision: Equitable Access

While the DigiSteps web application is designed to be widely accessible, certain limitations related to internet connectivity and device availability may affect its use. Not all students have consistent access to high-speed internet or personal devices, particularly outside the school environment. To address this, the application is designed as a lightweight, web-based platform that loads efficiently and functions across a range of devices, including mobiles, laptops, tablets, and standard school computers. Its simple interface and minimalistic design reduce data usage and ensure smooth performance even on lower-bandwidth connections.

One key design decision that ensures equitable access is the choice between developing an extensive question bank versus relying on AI-generated questions on the spot. The design of DigiSteps considers internet accessibility by ensuring that the application functions as a self-contained system. In version developed, all questions are stored within a structured extensive question bank, from which they are retrieved during use, eliminating the need for continuous internet-dependent content generation. This approach ensures that the application remains accessible to all users with a device, without requiring subscriptions or access to external generative AI platforms such as ChatGPT or Gemini. While future versions may incorporate AI functionalities to generate questions dynamically, this design decision is intentionally avoided in the current version to promote equitable access and ease of access across different contexts.

Project Implementation Procedures

The implementation plan consisted of an outline of the steps required to develop the DigiSteps application and successfully generate the intended product. The development of DigiSteps followed a structured, iterative process to ensure the tool was pedagogically sound, technically functional, and user-friendly. The steps carried out during the design and development of the practical application are as follows:

- Wireframing: The first stage involved creating detailed wireframes for all key screens, including the landing page with level selection, the category selection page, question pages, and the scoring/results page. These wireframes guided the design layout, user flow, and placement of interactive elements.
- Prototype Creation: Using the wireframes, a functional prototype of the application was developed to validate core concepts and usability before full development.
- Backend Preparation: The backend infrastructure was prepared, which included generating differentiated category descriptions for each of the four levels (grade bands) and constructing a comprehensive question bank containing 100 questions per category per level, totaling 3,600 questions.
- Frontend Development: Following the backend preparation, the frontend was built using React, ensuring a clean, responsive, and intuitive user experience.
- Initial Deployment: An initial version was deployed and hosted on Vercel to pave the way for the testing phase.
- Technical and Pilot Testing: Once the initial build was complete, systematic testing was to be conducted in two phases. Technical testing focused on functionality, responsiveness, and performance across devices and browsers.

Pilot testing was then planned to be conducted at a future date with students and teachers to gather feedback on usability, clarity, and engagement.

- Final Deployment: After refinements, the final version was deployed. Moving forward, continuous monitoring after deployment – through usage analytics, feedback forms, and observations – will help further enhance and sustain the tool's effectiveness.
- Extensions: Potential extensions include developing a mobile app version to complement the web-based platform, as well as integrating additional features into the tool.

Required Resources, Platforms, and Tools

The development of DigiSteps utilized the following resources and tools, suitable for rapid prototyping and web application development. The backend relied on structured .json files to store leveled questions and feedback data, providing a simple yet flexible database solution. The frontend was built using React to ensure a clean, responsive user interface.

As the web application is not static and includes levels, logic, and user interactions, React was chosen over HTML, CSS, and JavaScript because it made it easier to build a more organized, scalable, and interactive application using reusable components and efficiently managing dynamic content.

Integrated AI tools, namely Google AI Studio, supported development by assisting with code generation, prototyping, and debugging. The generative AI tool, Gemini, helped in the creation of high-quality educational content. VS Code and GitHub were used for development, while Vercel was employed for hosting and

deploying the application. These tools collectively allowed for an efficient, scalable, and maintainable development workflow.

Strategies for Achieving Objectives

The overarching goal of the project can be summarized into four core objectives. To achieve each objective, a series of strategies and actionable steps were followed.

Objective 1: Develop a functional web app that enables K–12 students to actively practice digital citizenship skills in a low-stakes environment.

To achieve this objective, the project followed a structured development process beginning with wireframing and prototype creation to define the application's core flow. The frontend interface was built using React, incorporating essential features such as level selection, category selection, question delivery, and score pages. Backend data structures were prepared to house category descriptions and the full question bank. The application then underwent technical testing to ensure that it operated reliably, loaded efficiently, and delivered accurate practice sessions. This systematic approach resulted in a fully functional tool that supports skill practice across all grade bands.

Objective 2: Provide high-quality, differentiated (level-appropriate) digital citizenship content aligned with Ribble's nine elements, ensuring relevance for all developmental stages. This objective was met by developing a comprehensive question bank of level-appropriate material structured across the four grade bands. Differentiated category descriptions were defined for each level. A total of 3,600 questions – 100 per category per level – were generated, reviewed, and organized into a structured data format (.json). This approach ensures that each learner receives developmentally appropriate content, aligned to Ribble's nine categories, supporting meaningful skill-building and consistent practice.

Objective 3: Create an engaging, intuitive, and age-appropriate user experience that lowers the barrier to entry for young learners. To meet this objective, the project prioritized strong user-experience design from the early stages. Wireframes, prototypes, and visual layouts were developed with clarity, simplicity, and age-appropriateness in mind. The design aimed for one click per page for simplicity. Design elements were refined through iterative testing. Once conducted, pilot testing with students and teachers will further highlight usability needs, ensuring that the application is visually appealing, easy to navigate, and fully accessible to learners across grade levels.

Objective 4: Build a scalable structure that supports immediate deployment while laying the groundwork for future expansion. This objective was supported by designing the app with a modular and flexible architecture from the beginning. Data structures, content formats, and front-end logic were created to allow new features – such as user accounts, progress dashboards, analytical tools, expanded grade levels, and an extended question bank – to be added without restructuring the system. Additional features may include support for multiple languages through immersive translation services and the incorporation of an immersive reader for young learners. Testing and documentation helped ensure long-term maintainability, setting the application up for sustainable growth and adaptability to future educational needs and enhancements.

Timeline and Achievement Indicators

The design and development of the DigiSteps WebApp followed a structured 10-week timeline shown in Table 3. In Week 1, the focus was on wireframing and defining the user experience. All major screens were mapped out, and the user journey was validated to ensure a simple and intuitive flow. Screenshots of wireframes are

shown in Figure 3. In Week 2, the visual design was developed and converted into a working prototype, allowing early feedback on the look and feel of the app. During Weeks 3 and 4, the backend content foundation was prepared, including writing differentiated category descriptions for each grade band and building the full question bank of 3,600 scenario-based items. These were then structured into a .json format for efficient access. Core development occurred in Weeks 5 and 6, during which the frontend was built using React. All interface pages were developed, and full functionality was implemented, including the category description selection logic, the random question selection logic, a five-question practice engine, and score reporting. In Weeks 7 & 8, the application underwent technical testing to identify and correct issues related to navigation, data filtering, performance, and interface behavior. Pilot testing was scheduled for Week 8, to test the product with students and teachers, in order to gather real-world usability feedback. Pilot testing was rescheduled for a future date, and its outputs will be incorporated in future versions of DigiSteps. Based on the testing phase feedback, Week 9 was dedicated to iterative improvements that enhanced the user experience, content clarity, performance, and overall functionality. Finally, in Week 10, the refined application was deployed to a hosting platform, ensuring accessibility across devices, and all documentation and considerations for future development were finalized. These steps ensured that the DigiSteps web application is fully functional, user-friendly, and aligned with its intended pedagogical objectives.

Figure 3

Wireframes of the Major Pages of DigiSteps

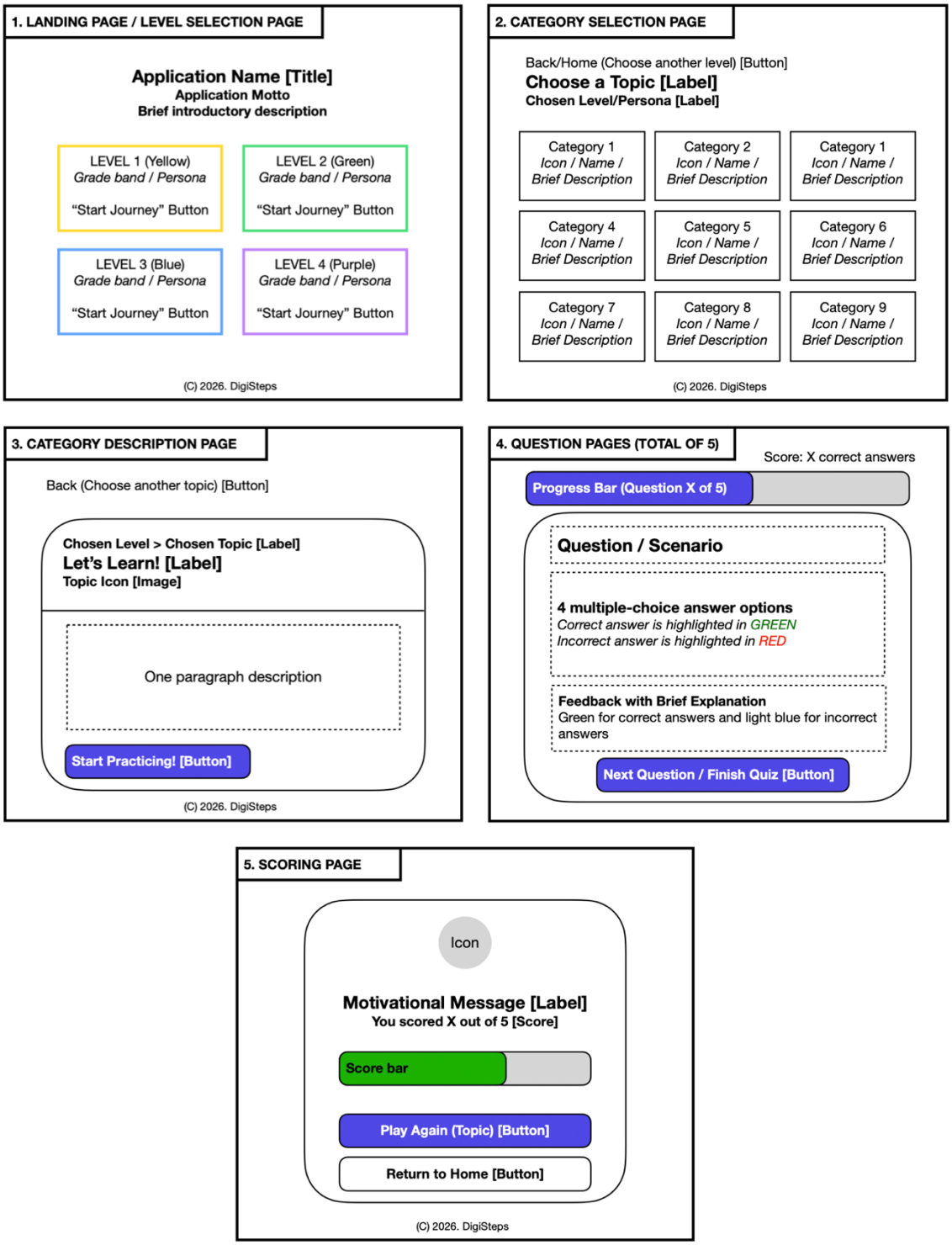


Table 3

Summary of the Project Timeline, Detailing Each Phase, the Key Activities That Constitute Each Phase, and the Achievement Indicators After Each Phase

Timeline (Weeks)	Phase/Step	Key Activities	Deliverables (Achievement Indicators)
Week 1	Wireframing & UX Structure	Create wireframes for all pages Determine layout of elements (buttons, icons, navigation, text areas) Validate the user flow (Level → Category → Practice → Score)	Complete wireframe set Confirmed user journey map
Week 2	Prototype Design	Design the visual look for each page Build a working clickable prototype Gather initial internal feedback	Working prototype showing all screens (without a backend)
Weeks 3 & 4	Backend Preparation (data)	Write differentiated category descriptions for each level (9 categories x 4 grade bands) for a total of 36 category descriptions Structure the descriptions into a JSON file Prepare the question bank (9 categories × 4 grade bands × 100 questions each) with a total of 3,600 questions Structure the questions into a JSON file	Category description dataset Complete structured question bank (3600 questions) Functioning question data structure ready for frontend use
Weeks 5 & 6	WebApp Development (Frontend)	Build UI pages using React Implement the full flow: - Level selection - Category selection - Category description - 5-question practice session engine - Score page with motivational feedback Add logic for: random question selection (filtering logic based on level and category selected), and for displaying the category description (filtering logic based on level and category selected)	Fully functioning frontend connected to question data bank All pages interactive and responsive
Weeks 7 & 8	Technical Testing	Test entire app for: navigation issues, filtering accuracy, speed/performance, broken logic or UI glitches Fix bugs	Functional version of the app Testing report
Week 8	Pilot Testing with Users	Test with students or teachers	Pilot feedback summary

	(this is *to be conducted* in the future)	Gather real feedback on: clarity, difficulty level, usability, speed, question relevance Identify improvements	List of improvement actions
Week 9	Iterative Improvements	Implement changes based on feedback Improve UX, visuals, performance, clarity Refine questions, explanations, or layouts if needed	Release the improved version
Week 10	Final Deployment	Deploy app to a hosting platform (Vercel, GitHub) Ensure accessibility and browser/device compatibility Prepare documentation	Fully deployed web app Documentation and future extensions

CHAPTER 4

FINDINGS AND DISCUSSION

Beyond the design phase, this chapter focuses on the outcomes of the project. It presents the development of the product, outlines the technical implementation outcomes as deliverables, and examines the educational outcomes through a discussion of the project's impact on various stakeholders. The chapter also briefly addresses the testing phase and highlights potential extensions for future development.

Development of the Product

The DigiSteps application is composed of multiple interconnected components, where data flows through the system and user interactions drive the application logic. The system integrates structured data at the backend, application logic, and a user interface to deliver a seamless and interactive experience. Figure 4 illustrates the overall architecture of the application, highlighting the key components and their interactions.

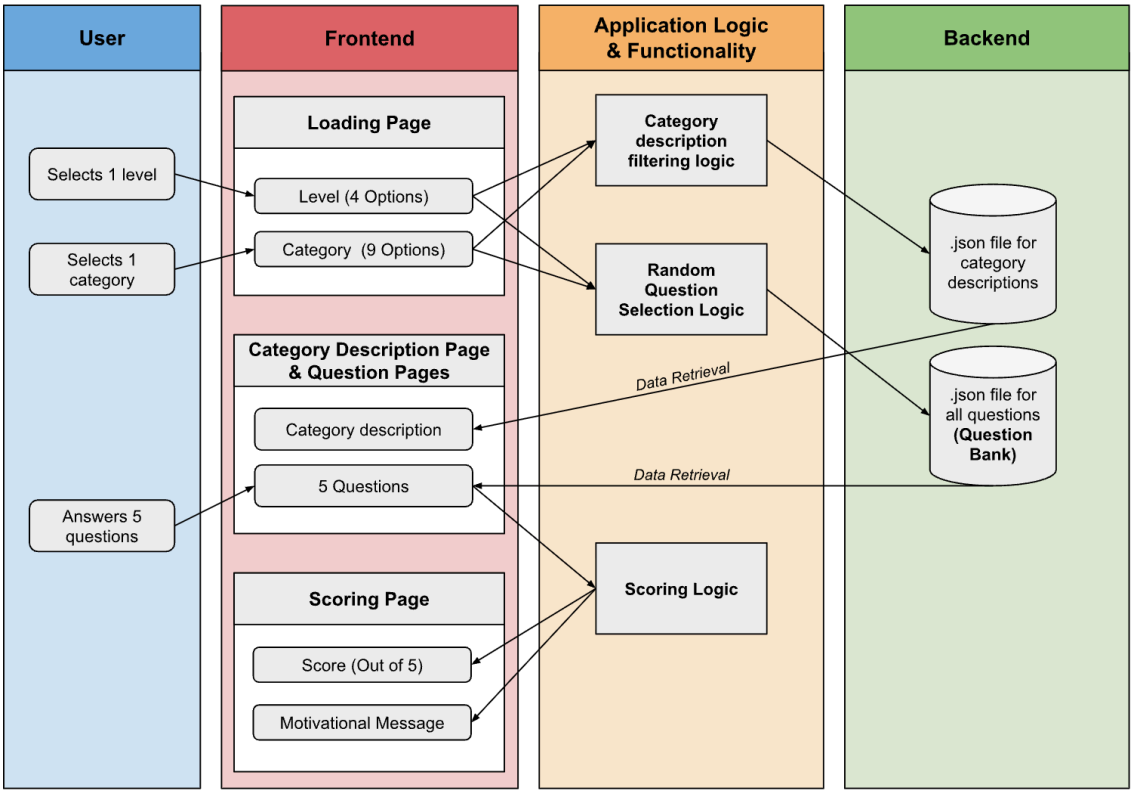
The following sections explain the development of the major components of the system in detail, starting with the backend (the development of the question bank and the data structuring of the .json files), the application logic (the "brains" of the system), and the frontend development (the user experience).

Development of the Question Bank

The development of the question bank forms a core component of the DigiSteps web application, as it provides the content through which users engage with digital citizenship concepts. The question bank was designed to be comprehensive, structured, and developmentally appropriate, ensuring alignment with both pedagogical standards and Ribble's framework.

Figure 4

Overall Architecture of the Application With the Key Components and Their Interactions



A total of 3,600 scenario-based questions were developed and organized across four levels, corresponding to different grade bands within the K–12 range. Each level contains nine categories aligned with Ribble's nine elements of digital citizenship, ensuring full coverage of key concepts such as digital access, communication, literacy, and safety. Within each category, 100 questions were created per level, resulting in a balanced and extensive dataset that supports repeated practice without immediate repetition.

The decision to include 100 questions per category at each level was made to ensure sufficient variety while maintaining a manageable and efficient data structure. When a user selects a specific level and category, the application logic filters the

question bank accordingly, resulting in 100 questions. It then randomly selects five unique questions, representing 5% of the available pool. This approach minimizes repetition and ensures that users are exposed to a wide range of scenarios across multiple attempts. From a probabilistic perspective, the number of possible combinations of five unique questions selected from a pool of 100 is considerably large, making it highly unlikely for users to encounter the same set of questions across repeated sessions. Even when individual questions are repeated, this is not detrimental, as it reinforces learning through repeated exposure. This design reflects a balance between expanding the size of the question bank to maximize variation and maintaining a manageable dataset in terms of storage and performance.

DigiSteps Question Bank Generator: A Supporting Tool

The creation of such an extensive question bank requires a considerable investment of time and effort. To support this process, generative AI was leveraged through carefully designed prompts to assist in the creation of high-quality database questions. A supporting tool, referred to as the DigiSteps Question Bank Generator, was developed for this purpose (see Figure 5).

The Question Bank Generator produces 25 questions per batch and exports them as a downloadable .json file (refer to Figure 6 and Figure 7 to see the generator in action). Each question follows a standardized structure consisting of a unique question identifier (question ID), a scenario-based prompt, four multiple-choice answer options, a correct response, and corresponding feedback (the detailed structure of the .json files is discussed in the following section). The developer selects the desired level and category combination, specifies a starting ID sequence, and generates questions in

batches. These batches are later merged into a single .json file to form the complete dataset for each level-category combination.

Figure 5

DigiSteps Question Bank Generator as a Supporting Tool

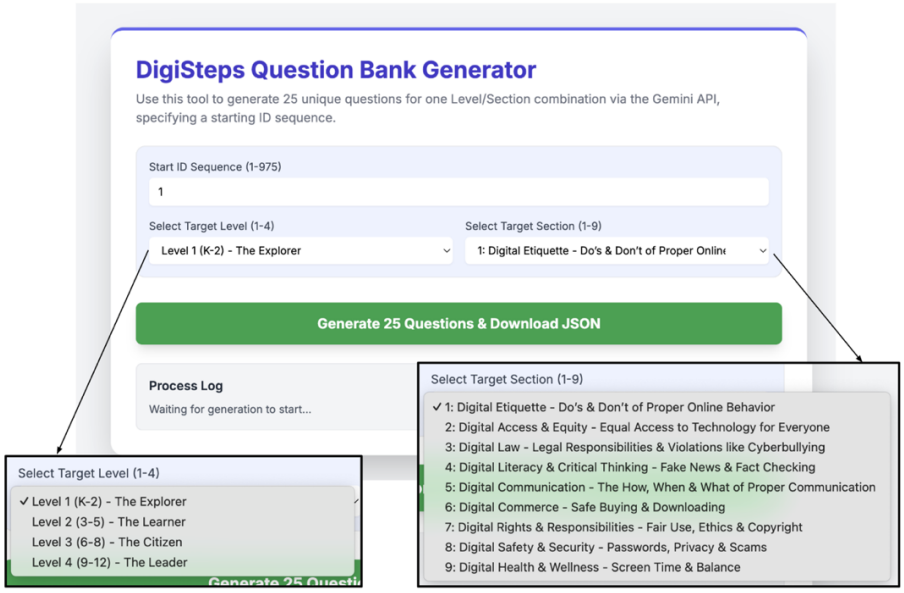


Figure 6

The Question Bank Generator in Action While Generating the First 25 Questions for Level 1 and Category 1

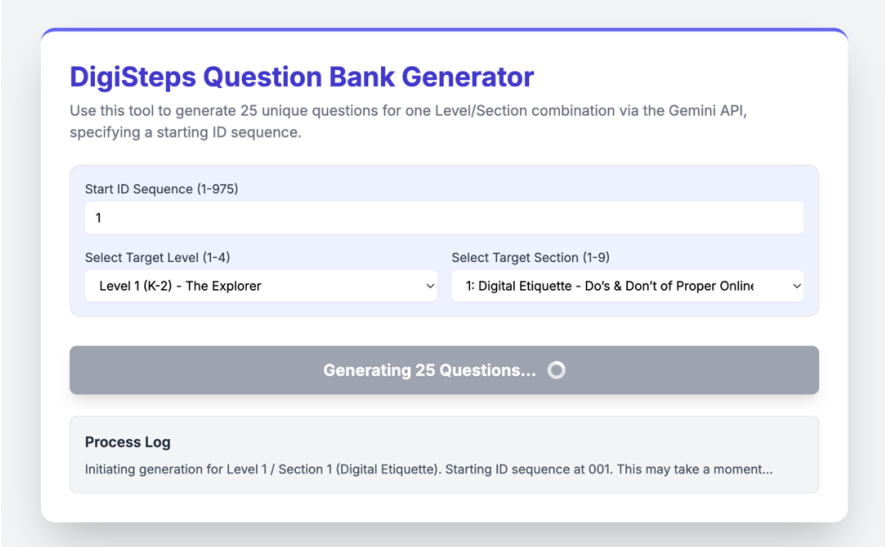
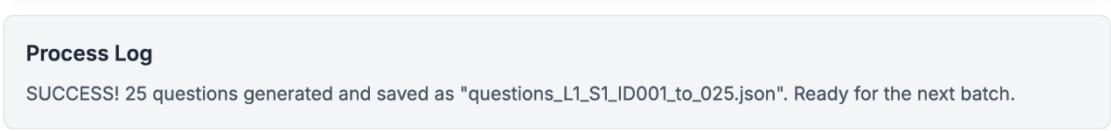


Figure 7

Process Log After a Question Batch Is Successfully Generated



The decision to generate 25 questions per batch was made to avoid the tool from crashing and to reduce the likelihood of errors during generation. Larger batch sizes were found to place greater strain on the system, potentially affecting output quality and reliability. This batch size also provides an efficient workflow, as four iterations are sufficient to complete the required 100 questions for each level-category combination. The prompts used for each digital citizenship category are illustrated in the code snippet presented in Figure 8. They are the same descriptions as those presented in Table 1.

Bias in Correct Answer Distribution

During the development of Version 1.0 of the question bank, technical testing revealed a bias in the distribution of correct answer positions. Specifically, over 90% of correct responses were concentrated in the second and third answer options, while fewer than 5% appeared in the first and fourth positions. This imbalance posed a risk to the validity of the application, as users could potentially identify patterns and guess correct answers without fully engaging with the content.

To address this issue, the generation logic was refined to ensure a more balanced distribution of correct answers. The “correct_index” values (0, 1, 2, 3) were systematically controlled to achieve an approximately equal representation across each batch of 25 questions. The revised approach aims for each index to appear at least six

times per batch, thereby reducing predictability and promoting more authentic user engagement with the scenarios.

While generative AI significantly improved the efficiency of question development, its use also required careful oversight to ensure quality and accuracy. Generated questions were reviewed and refined when necessary to address potential issues such as bias, inconsistency, and misalignment with the intended learning objectives, ensuring that the final question bank remained pedagogically sound and reliable.

Figure 8

Category-Specific Prompts Used to Generate Questions

```
const SECTION_DETAILS = [
    {
        id: 1,
        title: "Digital Etiquette",
        description: "Do's & Don't of Proper Online Behavior",
        context: "Proper behavior online, respectful communication, professional, avoiding harmful actions. Consider the human behind the screen. Consider your
    },
    {
        id: 2,
        title: "Digital Access & Equity",
        description: "Equal Access to Technology for Everyone",
        context: "Equal opportunities for all users to participate online; solving digital divide issues."
    },
    {
        id: 3,
        title: "Digital Law",
        description: "Legal Responsibilities & Violations like Cyberbullying",
        context: "Legal responsibilities: cyberbullying, copyright, plagiarism, hacking, illegal downloads, acceptable use."
    },
    {
        id: 4,
        title: "Digital Literacy & Critical Thinking",
        description: "Fake News & Fact Checking",
        context: "Ability to find, evaluate, and use information online; understanding media and technology."
    },
    {
        id: 5,
        title: "Digital Communication",
        description: "The How, When & What of Proper Communication",
        context: "Proper and effective use of messaging, email, social media, and online collaboration tools. To communicate properly, learn HOW to use digital
    },
    {
        id: 6,
        title: "Digital Commerce",
        description: "Safe Buying & Downloading",
        context: "Safe and responsible buying/selling online; identifying scams, fraud, or risky financial behaviors."
    },
    {
        id: 7,
        title: "Digital Rights & Responsibilities",
        description: "Fair Use, Ethics & Copyright",
        context: "Users' rights (access, privacy, freedom of expression) and responsibilities (ethical use, reporting abuse)."
    },
    {
        id: 8,
        title: "Digital Safety & Security",
        description: "Passwords, Privacy & Scams",
        context: "Protecting devices, accounts, personal data; passwords, phishing avoidance, cybersecurity basics."
    },
    {
        id: 9,
        title: "Digital Health & Wellness",
        description: "Screen Time & Balance",
        context: "Physical and mental well-being online: screen time balance, ergonomics, cyberbullying stress."
    }
```

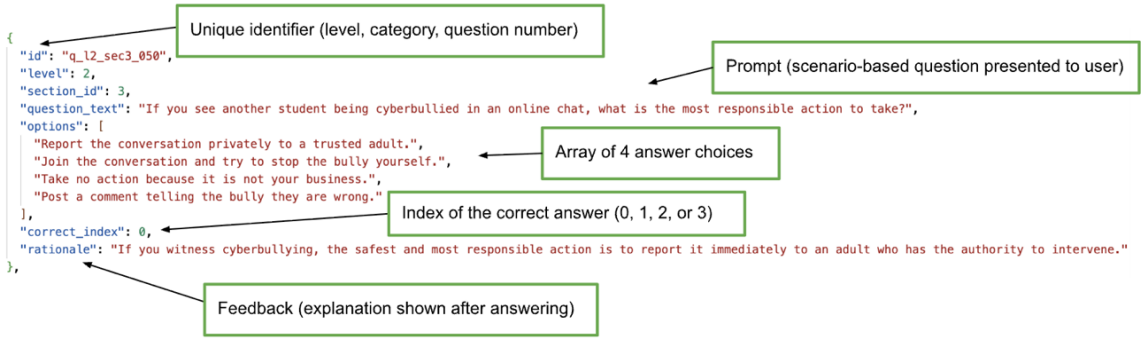
Data Structuring of the .json Files

DigiSteps utilizes structured .json files to store and manage the question bank, providing a lightweight and flexible data storage solution. This format was selected due to its simplicity, readability, and compatibility with web-based applications, allowing for efficient data retrieval and seamless integration with the frontend.

The data is organized hierarchically based on levels and categories, enabling the application – namely the Random Question Selection Logic – to filter and retrieve relevant content based on user selections. Each question is stored as an individual object within the list of objects and follows a standardized structure to ensure consistency throughout the backend file.

Figure 9

Structure of a Question Object Within the DigiSteps .json Database



Each question entry includes a unique identifier, a scenario-based prompt, a list of four answer options, the index of the correct answer, and rationale for the feedback. This structured format allows the application logic to select questions, validate user responses, and provide immediate feedback. An actual question "object" illustrating the representation of the .json structure is shown in Figure 9. This question is for Level 2,

"The Learner," and from Category 3, "Digital Law." It is number 50 out of 100, as indicated by the "id."

Application Logic and Functionality

The application logic of DigiSteps governs how user interactions are translated into dynamic content delivery and feedback. The system is designed to respond to user input in a structured sequence, ensuring a smooth and interactive experience. The three main components are: the *Category Description Selection Logic*, the *Random Question Selection Logic*, and the *Scoring Logic*.

Category Description Selection Logic. When a user begins a session, they first select a level corresponding to their grade band, followed by a specific digital citizenship category. Based on these selections, the application filters the .json file containing the 36 category descriptions (four descriptions for each category depending on the level) and retrieves the relevant level-appropriate description.

Random Question Selection Logic. Based on the user's level-category selections, the application filters the .json dataset to retrieve the relevant subset of questions associated with the chosen level and category. From this filtered pool of 100 questions, the system randomly selects five "unique" questions to generate a practice session. Each question is presented sequentially, allowing the user to select one of four possible responses. Upon submission, the application compares the user's selected answer with the stored "correct_index" value to determine correctness. Immediate feedback is then displayed, providing a rationale for the correct answer that reinforces the underlying concept.

Scoring Logic. The application maintains a running score throughout the session, incrementing the score for each correct response. At the end of the five-

question sequence, a final score is calculated and displayed to the user, along with a summary message designed to encourage reflection and continued engagement.

The overall sequence of operations illustrated earlier in Figure 4 outlines the various system components, and the flow of user interaction and system response.

Frontend Development: React and User Interface

The frontend of the DigiSteps application was developed using React to create a dynamic, responsive, and maintainable user interface. React's component-based structure allows developers to build reusable elements, and its state management enables the interface to update efficiently in response to user actions without reloading the entire page. This framework simplifies the implementation of features such as level and category selection, randomized question display, progress indicators, and interactive feedback, resulting in a smoother and more visually polished user experience compared to using plain HTML, CSS, and JavaScript (Jonathan & Suprihadi, 2023).

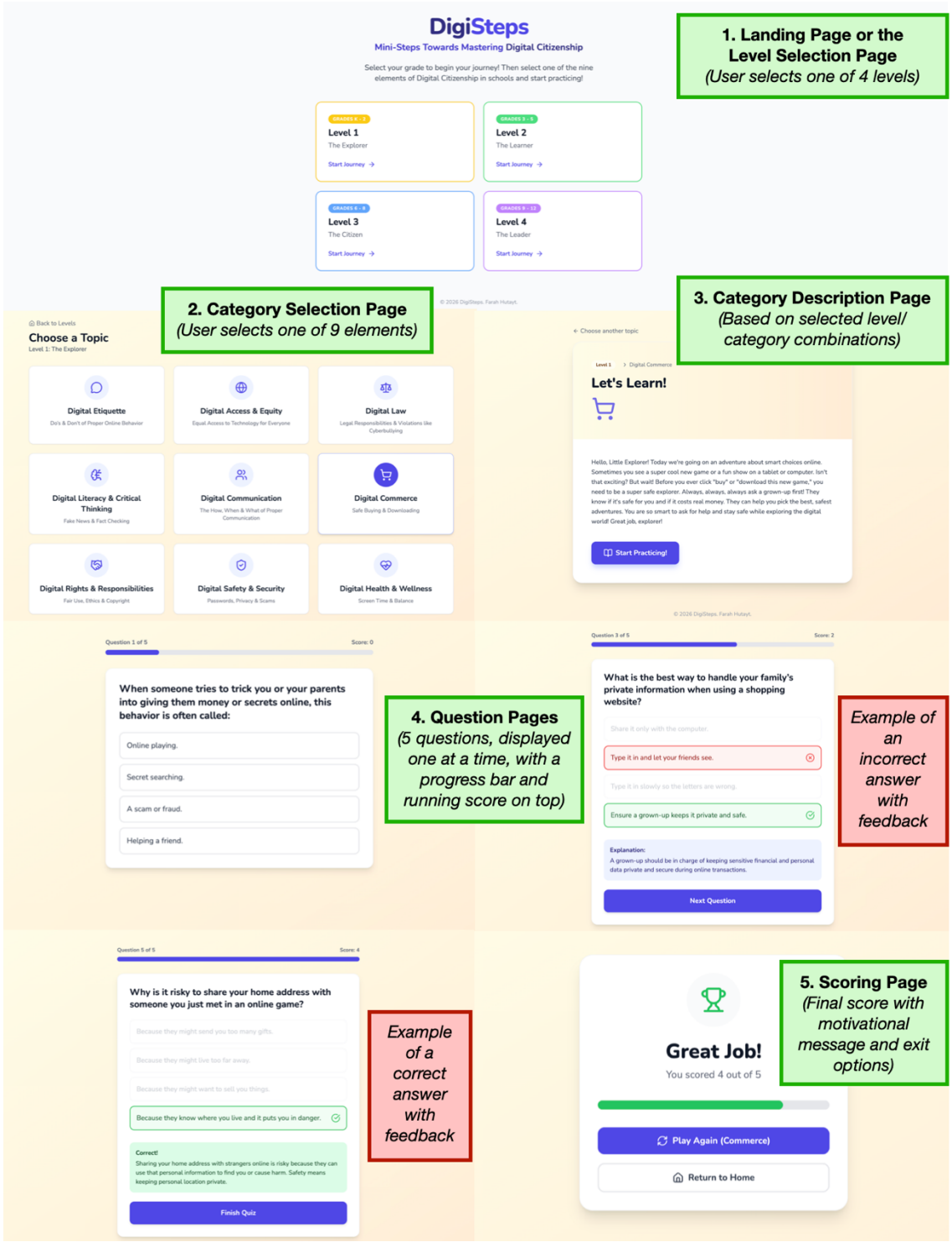
The user interface was also designed to enhance usability and engagement. Clear visual hierarchy, progress bars to track progression through the five-question sequence, and interactive elements such as hover effects provide immediate feedback, guide navigation, and reinforce the interactive nature of the application. These design choices align with established principles of user-centered design, which emphasize responsiveness, visual feedback, and overall user experience (Hassenzahl & Tractinsky, 2006).

Technical Outcome: Final Product and Features

The final product of this project, DigiSteps, is a fully functional web application that allows K–12 students to practice digital citizenship skills in an engaging, low-stakes environment. The application integrates the question bank, an interactive user

Figure 10

Screenshots Highlighting the Main Screens of the Application



interface, and application logic to deliver a seamless and responsive experience. Key features include level and category selection, randomized question presentation, immediate feedback, progress tracking, and a scoring system.

Figure 10 presents a series of screenshots highlighting the main screens of the application, including the level and category selection menus, category description page, question pages, and the final scoring page. Figure 11 illustrates how each level has a distinct background color that runs throughout all subsequent pages for visual clarity and aesthetic purposes. The flowchart presented earlier in Figure 2 serves as a reminder of the user journey through the application.

To ensure accessibility across devices, the application was tested on a range of screen sizes, including desktop, tablet, and mobile views. Figure 12 shows the interface rendered on different devices, demonstrating the responsive layout and consistent user experience.

The live version of DigiSteps is accessible via the following link: digisteps-app.vercel.app. This allows educators, students, and other stakeholders to explore the functionality and interactive features firsthand. Screenshots and device renderings presented in this section serve to complement the live product by providing a clear view of the application's structure, flow, and user interface design.

Figure 11

Screenshots Illustrating the Different Colors Associated with Each Distinct Level

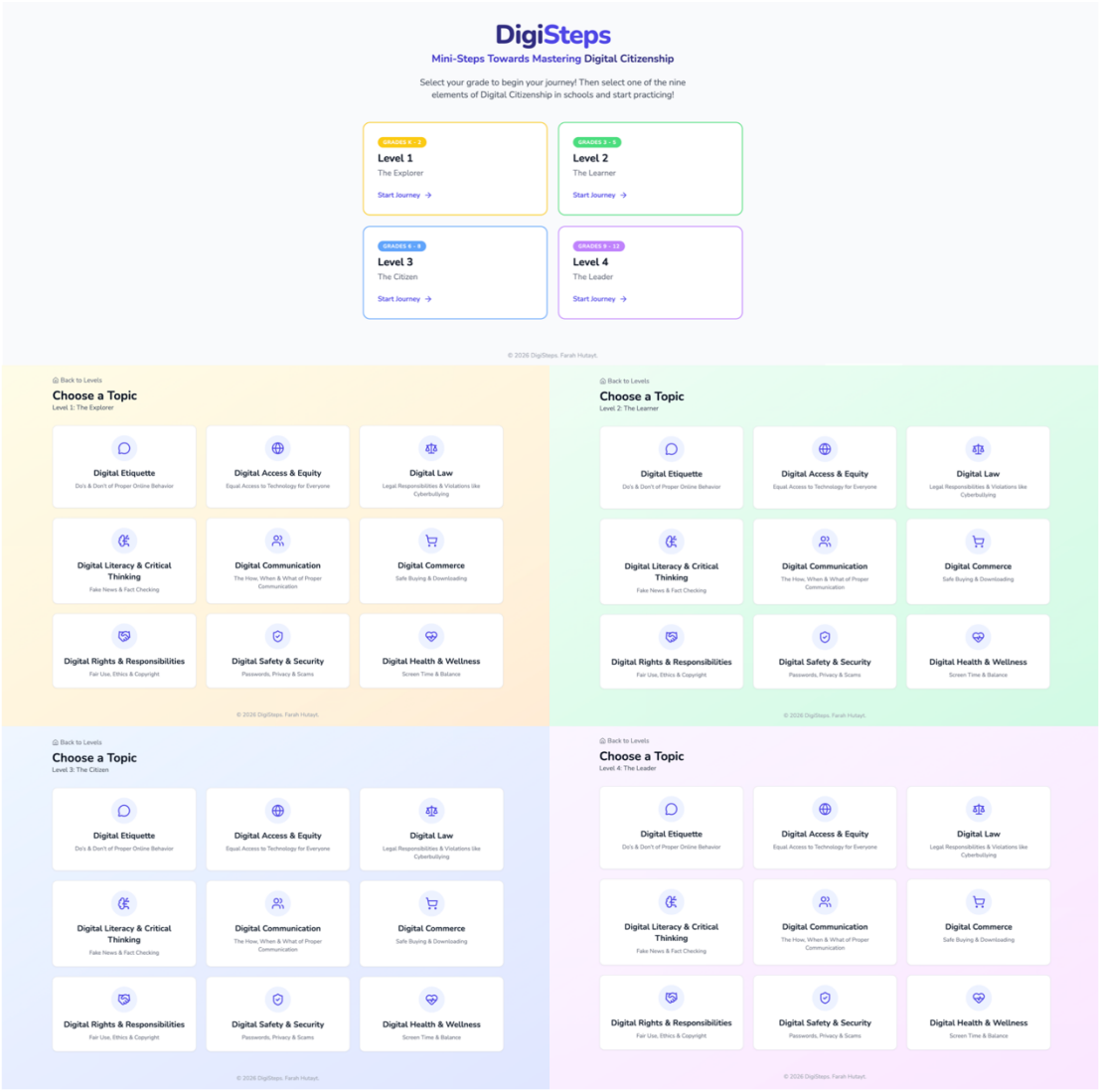
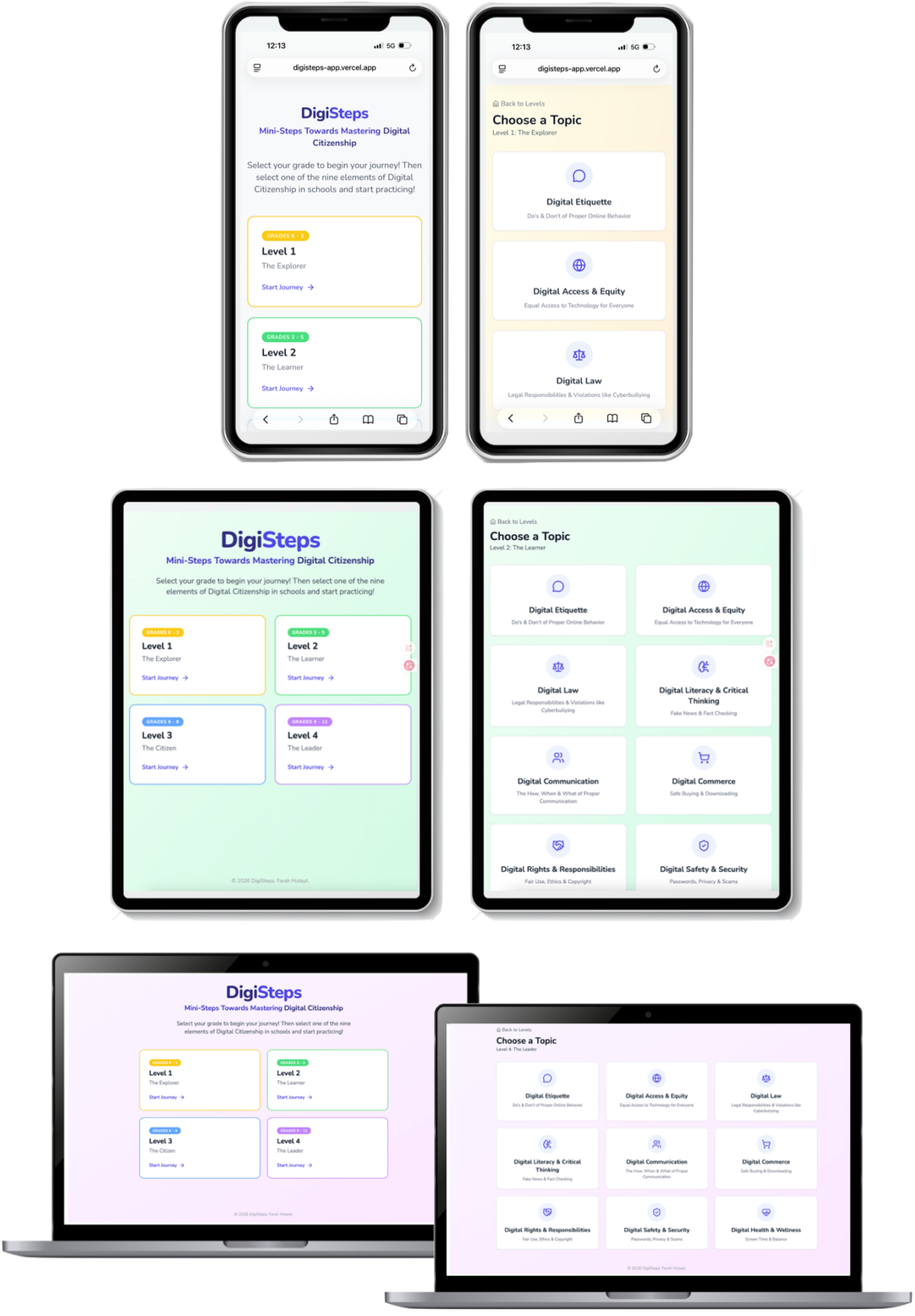


Figure 12

The Rendering of DigiSteps on a Mobile Device, Tablet, and Computer



Educational Outcomes: Discussion of Project Impact

Beyond the technical outcomes of the product implementation phase, which include the development of the application and the final deliverables, DigiSteps also has a significant educational impact on its intended users and the stakeholders involved. The following section presents a discussion of the expected educational outcomes and the potential impact of the project on students, educators and educational leaders.

Impact on Students (Primary Users)

The educational value of DigiSteps lies not simply in its functionality, but in how its design supports meaningful learning processes. By providing a low-stakes environment for practicing digital citizenship through scenario-based questions, the application shifts learning from passive content consumption to active engagement. This is significant, as interactive and technology-supported learning environments have been shown to promote deeper understanding and improved retention compared to traditional instruction (Alam et al., 2025).

Furthermore, the inclusion of immediate feedback enables students to engage in continuous self-correction and reflection, supporting the development of metacognitive skills. Recent studies emphasize that timely and targeted feedback enhances learners' ability to regulate their learning, improve understanding, and sustain motivation, particularly in digital environments (Weidlich et al., 2025). Research also suggests that feedback-supported and interactive tasks can positively influence learner engagement and confidence (Shaddad & Jember, 2024). Within DigiSteps, feedback is embedded directly into each interaction, encouraging learners to actively process and apply new knowledge rather than simply selecting answers.

The structured progression across levels further supports learning by scaffolding content according to developmental stages. This allows learners to build foundational understanding before progressing to more complex concepts, reinforcing both confidence and competence. In this sense, DigiSteps does not only deliver content, but organizes learning in a way that reflects effective instructional design principles. The use of levels also contributes to sustained engagement, as students are provided with clear goals and a sense of progression.

However, the extent of these benefits depends on how the application is used. As a self-directed tool, its impact relies on sustained engagement and meaningful interaction with the content. DigiSteps is designed to complement existing digital citizenship instruction, and without guidance or reinforcement from educators, there is a risk that engagement may remain surface-level rather than leading to deeper conceptual understanding.

Overall, DigiSteps demonstrates how interactive digital tools can support active, feedback-driven learning while providing a safe and engaging space for students to practice essential digital citizenship skills. At the same time, it highlights the importance of integrating such tools within structured learning environments to maximize their educational impact.

Impact on Educators and Educational Leaders (Secondary Users)

DigiSteps is designed to complement, rather than replace, existing digital citizenship lessons. By providing structured, level-appropriate practice, educators can use the application as a reinforcement or homework tool, saving preparation time while maintaining consistent content coverage. Research indicates that structured digital tools

that align with curriculum goals can enhance teacher efficiency and support effective instruction (Siyam et al., 2025).

The application's modular design allows for flexible integration into lessons at multiple points – pre-class, in-class, or post-class as entry or exit tickets – supporting differentiated instruction and accommodating varying class schedules or student needs. This flexibility enables educators to tailor the tool to their instructional context while maximizing student engagement and learning opportunities.

DigiSteps also functions as an indirect assessment and feedback tool. Its immediate feedback mechanisms help teachers monitor student understanding, even without formal reporting dashboards. However, its effectiveness relies on teacher engagement and the interpretation of student responses; the tool alone cannot replace the need for a teacher's presence. Evidence suggests that technology-supported formative assessment enhances instructional quality when educators actively apply insights to guide teaching (Okafor, 2025).

From the perspective of educational leaders, DigiSteps offers a scalable solution that can be used across multiple classes or grade levels, promoting consistency in how digital citizenship is taught. The standardized content ensures that all students receive the same foundational digital citizenship instruction. This makes adoption more attractive and practical from a strategic perspective.

Nonetheless, DigiSteps is most effective when integrated thoughtfully into the curriculum, and when it receives support from school leadership. Without guidance, training, or alignment with classroom objectives, its impact may be limited. If the adoption remains superficial and the WebApp is not used consistently, then this limits its impact on instruction and learning outcomes. Future iterations could include teacher

dashboards or analytics to further support instructional decisions and maximize educational outcomes.

Testing Phase

Due to time constraints and the scope of this course, informal testing with teachers and students has not yet been conducted. However, a pilot testing framework has been designed to gather feedback from teachers on usability, functionality, and overall effectiveness once time permits. This framework includes an optional survey based on the UTAUT (Unified Theory of Acceptance and Use of Technology) model, which measures perceived ease of use, perceived usefulness, and behavioral intention to use the application. This survey can be shared with teachers and educational stakeholders – including the school's Director of Learning – to provide insights that will inform future iterations and improvements. The questionnaire is included in the Appendix for reference.

Extensions and Future Development

One of the four main objectives of this project is to "build a scalable structure that supports immediate deployment while laying the groundwork for future expansion." As such, the structural design of DigiSteps took into account the ease of implementing extensions in future versions. Many of the proposed extensions aim to aim to improve accessibility, expand the application's reach, and enhance its overall usability for a wider range of stakeholders.

Providing Multilingual Support

Future versions of DigiSteps may incorporate multilingual functionality to support learners from diverse linguistic backgrounds. This would instantly allow the application to be more accessible, particularly in international and multilingual

educational settings. Currently, the workaround to allow DigiSteps to be available to non-English learners is by using the third-party extension, Immersive Translate, which offers numerous languages to choose from (see Figure 13). By downloading this onto Chrome, users can translate any website into the language of their choice. The design choice to make DigiSteps predominantly text-based was so that it would support the functionality of this extension. Figure 14 shows examples of some pages translated to multiple languages. However, not all translations are entirely correct using this extension (see Figure 15). Nevertheless, it is a useful feature that maximizes the reach of the WebApp in its current state and its availability to a wider audience.

Figure 13

Subset of Languages Offered for Translation by Immersive Translate

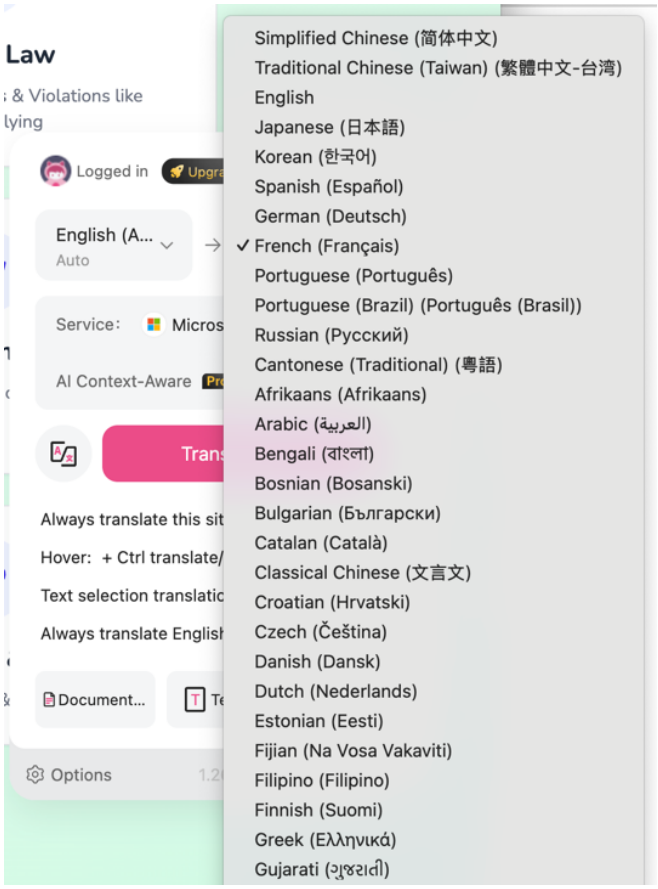


Figure 14

DigiSteps Translated to Different Languages – French, Korean, and Arabic – Using Immersive Translate on Chrome

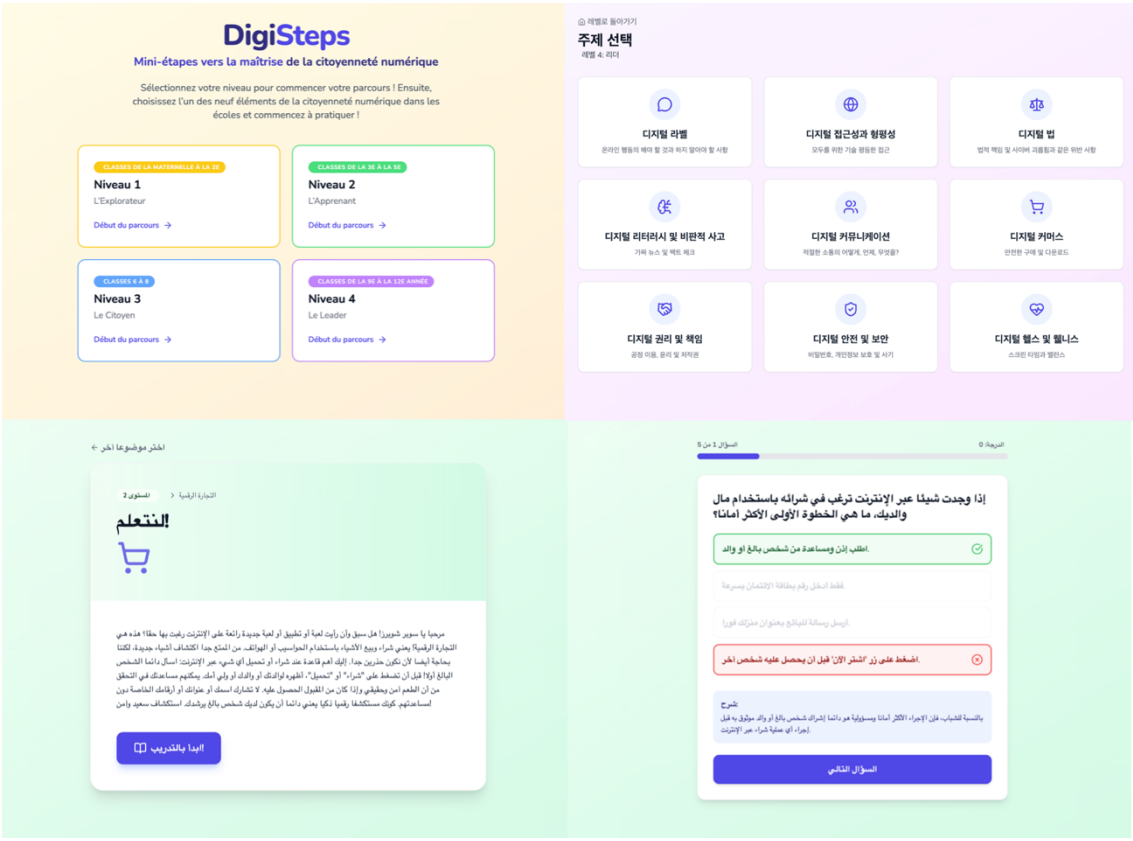
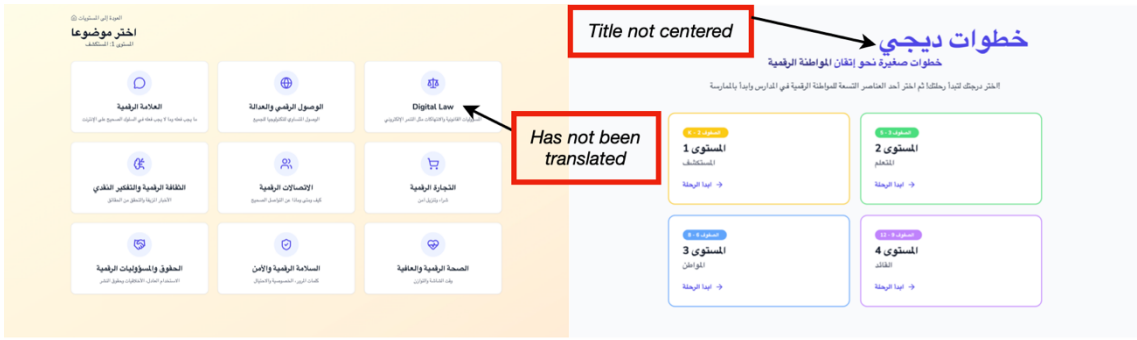


Figure 15

Common Mishaps in Translation When Using Immersive Translate



Instead of using a third-party extension, if generative AI features were to be integrated into DigiSteps, a language-selection dropdown can be added to the home

page, which then calls AI platforms asking them to translate the page to the desired language. Again, this will work since the WebApp is predominantly text-based. However, this may incur extra costs for the developer and must ensure that user has access to AI platforms. Therefore, before taking this design decision, benefits and drawbacks should be carefully considered.

A more concrete option would be to hardwire multilingual support into the code. This would require three alterations. First, this requires generating separate .json files for each desired language, by translating the current English versions. Second, there must be a user input dropdown on the landing page for users to select their desired language. And finally, based on the selected language there must be a "file selection logic" that fetches the correct .json files based on the language selected.

Creating a Mobile App Version

To further increase accessibility and usability, a mobile application version of DigiSteps may be developed. This would make DigiSteps a truly "self-contained" application rendering it fully functional offline without the need for an internet connection, other than for the initial download. This would allow users to engage with the platform more conveniently across different devices, supporting both in-school and at-home learning environments. This extension increases accessibility by overcoming internet connectivity issues.

Implementing Immersive Readers

The integration of immersive reader features can support younger learners and students with varying reading abilities – particularly those with dyslexia and ADHD – as well as English language learners, thus making the application more inclusive and available to a larger population. Such tools can enhance comprehension by offering

text-to-speech, adjustable text sizes, and other accessibility features, ensuring that all users can engage effectively with the content. The text-to-speech feature can be implemented for at least the first two levels: “The Explorer” and “The Learner.” Since DigiSteps is predominantly text-based, this eases the implementation of such features.

Leveraging Generative AI Beyond School Contexts

While the current version intentionally avoids reliance on generative AI to ensure equitable access, future iterations may explore the integration of AI to dynamically generate questions and scenarios. This would allow for more personalized and adaptive learning experiences, particularly in contexts where users have access to such technologies.

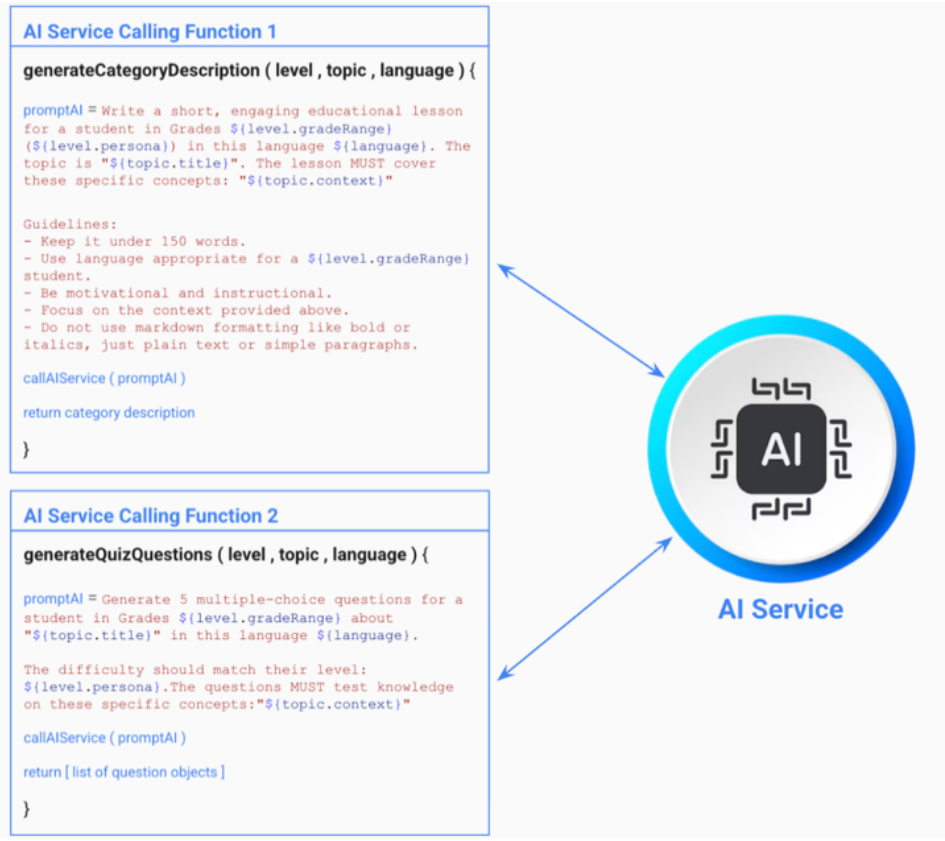
In this enhanced version, the modified code will have functions that call the AI service. This is essentially how the prototype of DigiSteps functioned, calling Gemini Services to generate category descriptions and questions. The two new functions will replace the following components: the existing .json files that act as the application’s static database, the question selection logic, and the category description selection logic. The functions will have pre-stored prompts tailored to the specific combination of parameters that a user can select. Depending on the user input, the appropriate prompt will be created and fed to the generative AI service. For example, if a user selects “Level 1,” “Digital Access,” and “French,” the system would prompt the AI service to generate an appropriate category description along with a set of five relevant questions aligned with the specified level, category, and language. The questions will be returned as a list of question objects. Figure 16 shows a conceptual model of what the AI-calling functions will look like. In this approach, the effectiveness of the system would largely depend on crafting smart, well-structured and context-aware prompts for the AI service.

A key advantage of this feature is that it enables DigiSteps to extend beyond the K–12 educational context and target other personas too. Digital citizenship is not limited to schools but is equally relevant in professional and societal contexts, including sectors such as healthcare, business, and engineering. By reframing DigiSteps to cover this wider umbrella of potential users, the application can be adapted to create personalized versions tailored to different user groups and use cases. Once the foundational structure is established, this expansion would primarily require modifications to the prompts used to guide content generation. While digital citizenship concepts are relatively constant, this approach allows the system to remain responsive to emerging trends and evolving digital challenges by generating up-to-date and contextually relevant content.

However, the integration of generative AI also introduces potential limitations, including concerns related to content accuracy, bias, and consistency, as well as dependence on external services, which would require careful monitoring and validation to ensure the reliability and educational appropriateness of the generated material. For example, recent research by Fang et al. (2024) found that large language models frequently generate content that reflects underlying biases and may produce unreliable information, raising concerns about the accuracy and fairness of AI-generated outputs. This consideration reinforces the intentional design decision in the current version to rely on a validated, self-contained question bank, ensuring that all users can access DigiSteps reliably regardless of internet connectivity or subscriptions to AI platforms.

Figure 16

Conceptual Model of the AI-Calling Function in the Modified Code



Integrating Enhanced Features

Additional features such as user accounts, progress tracking, and analytics dashboards may be incorporated to provide deeper insights into user performance and engagement. These features would enable both students and educators to monitor progress over time and tailor learning experiences accordingly.

This extension will require a substantial amount of development and will move the application away from the design choice of it being a “lightweight” application requiring no sign-ins. The shift in concept will make DigiSteps more of a platform that requires a proper database at its backend, authorized access, and higher levels of processing.

CHAPTER 5

CONCLUSIONS

Summary of Outcomes and Broad Conclusions

Digital citizenship is an essential skill for students navigating today's connected world, yet opportunities for structured practice are often limited. DigiSteps was developed to address this need by providing a web-based, interactive platform that complements existing curricula. The purpose of this project was to design and develop a web-based application grounded in the TPACK framework, that supports the practice and understanding of digital citizenship among K–12 students. The project aimed to provide a structured, interactive, and low-stakes environment where learners can engage with scenario-based questions, receive immediate feedback, and progress through scaffolded levels. From a technical perspective, DigiSteps successfully delivered a functional, responsive application built with React, supported by a structured question bank stored in a .json format, and designed to be extensible for future enhancements such as multilingual support, immersive readers, and AI-driven content generation.

Educationally, the application provides meaningful learning opportunities for students by promoting active engagement, reflection, and self-regulated learning. The structured levels, scenario-based questions, and immediate feedback collectively encourage students to internalize key digital citizenship concepts while practicing in a safe, controlled environment. For educators and educational leaders, DigiSteps complements existing curricula by offering an easily integrable tool that supports formative assessment and can be scaled across multiple classes or grade levels. The design of the application ensures that content is consistent, accessible, adaptable, and

pedagogically aligned with Ribble's framework, providing a foundation for immediate classroom use.

Overall, DigiSteps exemplifies how thoughtfully designed educational technology can not only deliver content, but also foster responsible digital citizenship, empower learners as active participants in digital spaces, and provide educators with practical, flexible tools for teaching and reinforcement. The project underscores the importance of integrating technical, pedagogical, and user-centered design principles to create meaningful, impactful learning experiences.

Project Limitations

The scope of this project was primarily focused on the design and development of a functional web-based application, rather than on large-scale implementation or empirical evaluation. As such, several limitations should be acknowledged. Limitations highlight opportunities for future growth and refinement.

Firstly, due to time constraints and the scope of the project, the application did not undergo extensive real-world testing with a broad sample of users. While the tool was designed with pedagogical and technical considerations in mind, the absence of formal pilot testing or data collection limits the ability to draw evidence-based conclusions regarding its effectiveness in improving student learning outcomes or engagement. Pilot testing and data collection are the next steps beyond this point.

Secondly, the current version of DigiSteps does not include advanced features such as user accounts, progress tracking, or analytics dashboards. While the application provides immediate feedback at the individual question level, it does not allow educators to systematically monitor student performance over time or make data-

informed instructional decisions. This limits its potential as a comprehensive assessment tool in its present form.

Additionally, the application is designed to function as a supplementary learning tool rather than a standalone instructional solution. Its effectiveness therefore depends on integration within existing teaching practices. Without structured guidance or alignment with classroom instruction, there is a risk that student engagement may remain surface-level, limiting deeper conceptual understanding.

Finally, although the question bank was carefully developed and structured, it remains finite and may not fully capture the breadth and evolving nature of digital citizenship topics. While this was an intentional design choice to ensure accessibility and avoid reliance on external technologies, it may limit long-term adaptability of content. Future versions that call on AI services to generate content on the spot will solve this limitation, ensuring the content is always current and making the application accessible to a wider audience and wider range of personas beyond the school context.

Overall, these limitations reflect the defined scope and constraints of the project rather than fundamental flaws in its design. Importantly, they highlight clear opportunities for future refinement, development, and empirical validation to enhance both the functionality and educational impact of DigiSteps.

Recommendations and Implications

Beyond extensions and technical enhancements which were discussed in the previous chapter, future work should also focus on evaluating the effectiveness and adoption of the application in real educational contexts. Two key areas for future research are identified: 1) evaluating the adoption and perceived usefulness of the application, and 2) determining the educational impact on student learning outcomes.

Following deployment, the application can be implemented across different grade levels within a school context, with data collected over a sustained period of use. Data may be collected through surveys and focus groups to examine educators' and students' perceptions of the tool's usefulness, ease of use, and overall value, guided by the Unified Theory of Acceptance and Use of Technology (UTAUT) as a conceptual framework. The survey presented in the Appendix can be used by educators. This would provide insights into the factors influencing adoption and effective integration into classroom lessons.

An alternative direction would be to conduct an empirical study to investigate the impact of DigiSteps on specific factors, namely student achievement and motivation. A quasi-experimental research design, incorporating pre- and post-tests alongside a control group, could be used to measure the extent to which the application improves students' understanding of digital citizenship concepts and their motivation. Such empirical evaluation would strengthen the evidence base for the effectiveness of the tool and inform further refinement.

In conclusion, DigiSteps represents an effort to bridge the gap between theoretical understanding and practical application in digital citizenship education. The development of DigiSteps demonstrates how thoughtfully designed digital tools can support learners in developing essential skills for navigating online environments responsibly. By providing a structured, interactive, and low-stakes platform, the application encourages students to actively engage with digital citizenship concepts, practice decision-making, and reflect on their online behavior. While the project focused on design and technical implementation, it lays a foundation for promoting iCitizenship, helping students become informed, ethical, and responsible participants in

digital spaces. DigiSteps highlights the potential of technology to not only deliver content but to shape the behaviors and mindsets necessary for safe, constructive, and empowered participation in today's increasingly connected world.

APPENDIX

PILOT TESTING QUESTIONNAIRE FOR DIGISTEPS WEB APPLICATION (FOR EDUCATORS)

Thank you for taking the time to participate in this evaluation of the DigiSteps web application. DigiSteps is an interactive tool designed to support K–12 students in practicing digital citizenship skills through scenario-based learning.

The purpose of this questionnaire is to gather feedback from educators and educational stakeholders on the usability, functionality, and educational value of the application. Your insights will help inform future improvements and development.

All responses will remain confidential and will be used solely for academic and research purposes. There are no right or wrong answers – please respond honestly based on your experience or impressions of the application.

Section 1: Background Information

1. What is your role?
☐ Teacher
☐ School Leader (e.g., Principal, Director of Learning)
☐ Curriculum Coordinator
☐ Instructional Coach
☐ Other: _____

2. What grade level(s) do you primarily work with?
☐ Primary (K–5)
☐ Middle School (6–8)
☐ High School (9–12)
☐ Multiple grade levels
☐ Other: _____

3. How familiar are you with digital citizenship concepts?
☐ Not familiar
☐ Slightly familiar
☐ Moderately familiar
☐ Very familiar
☐ Highly familiar

4. How often is digital citizenship addressed in your educational context?
☐ Never
☐ Rarely
☐ Occasionally

☐ Frequently
☐ Very frequently

Section 2: Perceived Usefulness

(Please rate the following statements on a scale of 1–5)
1 = Strongly Disagree | 5 = Strongly Agree

5. DigiSteps would support the development of students' digital citizenship skills.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

6. The application provides meaningful opportunities for applied learning and practice.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

7. DigiSteps would complement existing digital citizenship curricula or initiatives.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

8. The content appears relevant to real-world digital contexts.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

9. The level-based structure supports differentiation across learners.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Section 3: Ease of Use

(1 = Strongly Disagree | 5 = Strongly Agree)

10. The application interface is clear and easy to understand.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

11. Navigation within the app is intuitive.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

12. The application would be easy to implement within an educational setting.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

13. Students would be able to use the application with minimal support.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

14. The overall design supports a smooth and efficient user experience.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Section 4: Engagement and User Experience

(1 = Strongly Disagree | 5 = Strongly Agree)

15. The application appears engaging for learners.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

16. The scenario-based questions encourage critical thinking and decision-making.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

17. The feedback and scoring system would motivate continued use.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

18. The application is appropriate for the intended age groups.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Section 5: Behavioral Intention

(1 = Strongly Disagree | 5 = Strongly Agree)

19. I would consider implementing DigiSteps in my educational context.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

20. I would recommend DigiSteps to colleagues or other institutions.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

21. I would be interested in using future versions of the application.
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Section 6: Open-Ended Feedback

22. What aspects of DigiSteps do you find most effective or valuable?

23. What improvements would you suggest for future versions?

24. Are there any additional features or capabilities you would like to see included?

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