

DEVELOPING QR CODE-BASED READING MEDIA FOR INFORMATION TECHNOLOGY STUDENTS: A DESIGN SCIENCE RESEARCH

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Abstract: This study was conducted to develop a QR code-based instructional medium aimed at enhancing Information Technology (IT) students' reading comprehension and awareness of digital ethics at State Polytechnic of Lampung as a vocational university. This study applied Hevner's Three Cycle View of Design Science Research by identifying classroom-based problems (relevance cycle), developing QR-integrated worksheets (design cycle), and grounding the design in theory and the TPACK framework, resulting in a practical and pedagogically sound learning tool. The media comprised interactive worksheets containing QR codes that directed students to curated digital texts on IT topics. Each text was accompanied by comprehension tasks and grammar-based activities, encouraging vocabulary expansion, inferential reading, and ethical reasoning. The results indicated that the media supported student engagement, improved understanding of IT-specific reading materials, and fostered character values including digital responsibility and honesty. The worksheet was evaluated through a theoretical lens, highlighting its instructional relevance and applicability in English for Specific Purposes (ESP) settings. The findings demonstrate how QR code-based media can serve dual purposes (developing linguistic competence and instilling ethical awareness). This paper contributes to the growing field of technology-enhanced ESP instruction by providing a replicable model for integrating digital content and character education into technical English learning environments.

Keywords: *digital ethics, DSR, ESP, reading comprehension, QR code*

INTRODUCTION

In the age of rapid digitalisation, higher education students are expected not only to master language proficiency but also to develop ethical literacy in using digital technologies. This view is strongly supported by Tang and Chaw's research (2016), which emphasises that effective technology use in educational contexts requires not only digital skills and critical thinking but also ethical literacy. Such integration is particularly crucial in vocational and professional fields such as Software Engineering (*Teknologi Rekayasa Perangkat Lunak* or *TRPL*), where students must be able to comprehend and produce technical texts in English while demonstrating responsible digital behaviour. Furthermore, Gudmundsdottir et al.

(2024) also stress the importance of fostering digital responsibility among young learners by promoting ethical understanding from an early stage. However, classroom realities reveal a significant gap between these expectations and students' actual competencies. Many students struggle to understand technical texts in English (Sachran et al., 2022). Moreover, although vocational education aims to prepare graduates to enter the workforce immediately, students often lack sufficient time and structured opportunities to internalise technical terminology during their studies (Rejeki et al., 2022). In addition, key aspects of ethical awareness, such as cybersecurity, software piracy, and responsible online communication, are still rarely addressed in English for Specific Purposes (ESP) instruction.

Therefore, this gap highlights the significance of the present study, which directly responds to current scholarly calls (Tang & Chaw, 2016; Gudmundsdottir et al., 2024) by proposing an integrated approach that combines language learning, technical literacy, and digital ethics in TRPL education. By addressing two main challenges: limited comprehension of English technical texts (Sachran et al., 2022) and insufficient ethical grounding in technology use (Rejeki et al., 2022). This research offers a timely contribution to ESP curriculum development. This is especially relevant in light of Wen & Thomson's warning (2007) that knowledge unguided by ethical values can lead humanity blindly toward harmful consequences. Thus, embedding ethical literacy into ESP instruction is not merely a methodological refinement but an essential step toward shaping digital professionals who are both competent and ethically responsible.

The preliminary situations that motivated this study were identified through initial classroom observations, informal student interviews, and curriculum analysis at a vocational higher education institution offering a Software Engineering (*TRPL*) program at Lampung State Polytechnic in the second semester of the academic year of 2024/2025, involving 2 classes. In the observation, the students were asked to read and comprehend the text about IT. Most of them seemed silent and confused, and even opened Google Translate to understand the questions given related to the text. Moreover, after interviewing some students informally, it was known that they had not studied to read English texts, especially with IT terms as well as digital ethics using mobile-based tools. They used their mobiles to know the meaning of the words by opening Google Translate without caring about the contexts of the words when they needed to know. Then, analysing the curriculum showed that no module had been available discussing English for IT with its terms and digital ethics for this program. Thus, these situations included: (1) students' low proficiency in reading English technical texts, particularly those containing IT-specific terminology; (2) the absence of explicit discussions on digital ethics in current ESP course materials; and (3) the limited use of interactive, mobile-based tools that could connect language learning with real-world ethical scenarios in IT workplaces. Together, these conditions reveal a critical need for an instructional artefact that simultaneously addresses linguistic, technical, and ethical dimensions of learning.

This gap highlights the need for instructional approaches that integrate language learning with the cultivation of character and ethical values. It is emphasised for the role of technology in enhancing educational experiences, such as the condition in which students are as the centre in using technology to learn (Kalyani, 2024). Among these tools, QR code-based media have emerged as a promising strategy (Sari & Qonita, 2024; Kandiri, et.al., 2025). QR (Quick Response) code is a 2D matrix code that is designed by keeping two points under consideration, and recently it has been used widely in various life sides

including academics (Tiwari, 2016). By scanning QR codes, students can instantly access curated reading materials on their own mobile devices, facilitating independent learning, contextual engagement, and flexible access.

In language learning contexts, QR codes have shown considerable potential for contextualising instructional content. Research indicates that context-aware technologies, such as QR codes, can effectively support foreign language acquisition by linking digital resources to real-world environments, thereby enhancing learners' engagement and comprehension (Lee, 2022; Liu & Huang, 2021). For instance, QR codes can deliver authentic reading materials embedded with culturally relevant or situational language use, fostering both linguistic and pragmatic competence. Moreover, these materials can be intentionally designed to incorporate themes of digital ethics, such as phishing awareness, intellectual property rights, and responsible online behaviour. Integrating such topics not only expands learners' technical and academic vocabulary but also cultivates critical digital literacy and promotes values aligned with responsible digital citizenship (Ribble, 2015; ISTE, 2019). Thus, QR codes serve not merely as access points to content, but as pedagogical tools that bridge language learning with essential 21st-century competencies.

QR code-based materials also function as multimodal texts, combining written language, visual design, and interactive digital elements to create meaning (Kress & van Leeuwen, 2001; Jewitt, 2014). Rather than offering static content, they enable learners to navigate layered resources, such as technical readings, ethical scenarios, and contextual glossaries, through a single scan, mirroring the mode-rich communication common in real-world IT environments. This multimodal affordance supports both language comprehension and critical engagement with professional and ethical dimensions of digital practice.

Despite the growing recognition of technology's role in language instruction, few studies have systematically developed and evaluated QR code-based reading materials through an instructional design framework to teach foreign language for vocational university-level students. Furthermore, limited research has explored how such technology-enhanced media can explicitly foster both language literacy and character values. This presents a clear gap in both the literature and pedagogical practice, especially in the teaching of English for IT students within ESP programs.

The present study adopts the Design Science Research (DSR) methodology as introduced by Hevner (2007), emphasising the development of artefacts, such as instructional media, intended to solve real-world problems, and combines iterative design with theoretical evaluation. In this study, TPACK (Technological Pedagogical Content Knowledge) serves as the integrative theoretical framework that guides the entire DSR process, from problem identification to artefact design, implementation, and evaluation. Specifically, TPACK informs how three core knowledge domains are synergistically combined: (1) content knowledge (CK), the technical English vocabulary and digital ethics concepts relevant to IT students; (2) pedagogical knowledge (PK), strategies for scaffolding reading comprehension and ethical reflection through task design; and (3) technological knowledge (TK), the affordances of QR codes and mobile learning to deliver contextualised, interactive content. By embedding TPACK into the DSR cycle, the study ensures that the resulting QR-based worksheet is not merely a technological tool, but a coherent instructional artefact where technology, content, and pedagogy are deliberately aligned to achieve dual learning outcomes: Language literacy and digital ethical awareness. This integration allows the

design to be both functionally effective and educationally meaningful, fulfilling DSR's goal of producing rigorous, relevant, and impactful solutions. Using this approach, the study aims to design, develop, and evaluate a QR code-based English reading worksheet that is pedagogically sound, content-relevant to IT contexts, and infused with themes that promote digital responsibility and ethical awareness.

This research seeks to answer the following questions:

1. How can QR code-based reading medium be effectively designed for English for IT learners?
2. What are the characteristics of QR code-based reading medium in enhancing language literacy and digital ethics?

Thus, the objectives of this research were 1) to design and develop a QR code-based English reading medium for IT (TRPL) students that integrates technical vocabulary, authentic IT-related content, and themes of digital ethics, guided by the Technological Pedagogical Content Knowledge (TPACK) framework, and 2) to identify and analyse the key characteristics of the developed QR code-based reading medium that contribute to enhancing (a) language literacy, particularly reading comprehension of technical English texts, and (b) awareness and reflection on digital ethics among vocational higher education students.

Theoretically, this research contributes to the discourse on technology-enhanced language education and design-based instructional research. It illustrates how instructional artefacts can be purposefully created to support both linguistic and character development outcomes. Practically, the study offers a replicable model for ESP educators seeking to implement interactive and ethically informed reading tasks, particularly in technical learning environments such as English for Information Technology.

METHODS

This study employed the Design Science Research (DSR) methodology as the primary research approach to develop and evaluate a QR code-based reading comprehension medium for students in an English for IT course. DSR was chosen because it focuses on the creation and refinement of artefacts intended to solve real-world problems while contributing to theoretical knowledge (Hevner, 2007). The artefact in this research was an instructional worksheet containing QR codes that directed students to curated digital reading materials and comprehension tasks.

This study employed a Design Science Research (DSR) methodology grounded in Hevner's (2007) Three-Cycle View (the Relevance, Rigour, and Design Cycles), which emphasises the iterative development and theoretical evaluation of instructional artefacts. Given that this phase focuses on conceptual design and validation rather than empirical testing with human subjects, the research relied on systematic document analysis and theoretical evaluation as its primary methodological approaches.

Systematic document analysis refers to a structured process of examining written documents, such as: 1) the curriculum document of the vision of *TRPL* program (Organising higher vocational education in the field of software engineering that is oriented towards noble morals) which is related to the need of digital ethics by the students; 2) the document

of Code of Ethics by ACM (The Association for Computing Machinery), as the world's largest computing society (a) to contribute to society and human well-being, recognising that all individuals are stakeholders in computing; b) to avoid harm in the design and deployment of technology; c) to act with honesty and trustworthiness; d) to uphold fairness and actively oppose discrimination; e) to respect the intellectual and creative labor behind new ideas, inventions, and computing artifacts; f) to protect personal privacy; and g) to honor confidentiality in professional engagements); and 3) the document of worksheets as the artifacts based on the preliminary situations of this study (students' limited ability to comprehend English technical texts, the absence of explicit digital ethics content in existing ESP materials and the restriction of using mobile-tools to learn this).

In the Relevance Cycle, theoretical evaluation was conducted using the TPACK framework to analyse the root causes of learning challenges identified through classroom observations and initial interviews in the TRPL program. This evaluation revealed an imbalance across the three knowledge domains: 1) Content Knowledge (CK) in which about how the students comprehended English technical texts and how they were exposed to digital ethics issues; 2) Pedagogical Knowledge (PK) about how ESP teaching strategies were designed for technical literacy or ethical reflection; and 3) Technological Knowledge (TK) about how mobile technologies (like smartphones) were used to learn for contextualising learning English content. This tried to ensure the problem addressed was genuinely relevant to real-world classroom needs.

In the Rigour Cycle, the study established a theoretical foundation for artefact development by employing the TPACK framework as the primary lens for design and evaluation. Specifically, three integration criteria were defined a priori: 1) Content Knowledge (CK) must include both IT-specific technical terminology (such as firewall, phishing, encryption) and core digital ethics concepts consistent with the ACM Code of Ethics (such as data privacy, intellectual property); 2) Pedagogical Knowledge (PK) must be operationalised through task designs that support reading comprehension while encouraging ethical reflection (such as through problem-based questions); and 3) Technological Knowledge (TK) must utilise tools like QR codes not just as access points, but as enablers of mobile, contextual, and self-directed learning. The artefact would be considered theoretically rigorous only if Content, Pedagogical, and Technological Knowledge were coherently integrated, not just placed side by side, reflecting TPACK's core principle of synergistic knowledge intersection.

In the Design Cycle, the artefact is developed and refined through TPACK-informed decisions, such as integrating IT ethics into technical texts (CK), embedding reflective questions (PK), and using QR codes for contextual access (TK). To align the design with real classroom needs, a limited formative implementation was conducted in two TRPL classes, where students' informal feedback on accessibility, clarity, and engagement informed minor refinements to layout and instructions. Although this phase prioritises theoretical and content validation over full empirical testing, these iterative adjustments, guided by DSR principles and evaluated through the TPACK lens, ensure that technology, pedagogy, and content cohesively support the dual goals of enhancing technical language literacy and fostering digital ethical awareness.

In addition to developing the artefact, this study aimed to identify the specific characteristics of the QR code-based reading medium that enhance technical language literacy and digital

ethical awareness. After finalising the worksheet through the Design Science Research (DSR) cycles, a content analysis was conducted using an analytical rubric organised into four dimensions: (1) support for technical language literacy, (2) integration of digital ethics themes, (3) pedagogical design, and (4) technological affordances. The rubric was grounded in English for Specific Purposes (ESP) principles (Hutchinson & Waters, 1987), the ACM Code of Ethics (Association for Computing Machinery/ ACM, 2018), and values-based pedagogy frameworks (Nucci, 2022; UNESCO, 2021). This analysis provided the theoretical–empirical basis for answering Research Question 2.

The instruments of this research were the artifacts resulted and rubrics to evaluate the artefacts based on TPACK. Then, the data analysis was content analysis to analyse the availability of TPACK in the artefacts in each part of DSR cycles used, and Code of Ethics by ACM (The Association for Computing Machinery).

FINDINGS AND DISCUSSION

The following is the explanation to answer the two research questions in the Introduction.

Effective Design Features of QR Code-Based Reading Medium for English for IT Learners

The answer to the first research question was that the QR code-based reading medium was effectively designed by adopting the Design Science Research (DSR) methodology. This research adopts Hevner's Three Cycle View of Design Science Research, integrating the Relevance, Rigour, and Design Cycles (Hevner, 2007). This study shows that a QR code-based reading tool for English learners in IT can be created successfully. The artefact is not only pedagogically sound but also directly addresses the real-world challenges faced by TRPL students at Lampung State Polytechnic.

In the Relevance Cycle, the design was based on real classroom problems faced by the students of *TRPL* program at Lampung State Polytechnic, found through observations, informal interviews, and curriculum analysis. These problems showed three main issues based on TPACK frameworks: Content Knowledge (CK) in which students struggled to comprehend English technical texts and were rarely exposed to digital ethics issues such as software licensing or data privacy; (2) Pedagogical Knowledge (PK) in which ESP teaching strategies remained focused on general texts, lacking scaffolding specifically designed for technical literacy or ethical reflection; and (3) Technological Knowledge (TK) in which mobile technologies (like smartphones) were used passively to learn English, rather than as interactive tools for contextualising learning content. This misalignment provided a strong foundation for developing an artefact that explicitly integrates all three domains, ensuring the problem addressed is genuinely relevant to real-world classroom needs.

The QR code–based reading medium developed in this study successfully met the theoretical rigour criteria established a priori in the Rigour Cycle. As required by the TPACK framework, the artefact does not treat Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK) as separate elements, but rather as interconnected and mutually supporting areas.

In the Rigour Cycle, the Content Knowledge (CK) embedded in the QR code–based reading medium goes beyond technical vocabulary by intentionally integrating core principles from

the ACM Code of Ethics (2018). Each of the ten mini case studies (Appendix 1) was designed to simultaneously teach IT-specific terminology, such as firewall, phishing, encryption, and multi-factor authentication, and contextualise these concepts within real-world ethical dilemmas. For instance, scenarios involving unsecured Wi-Fi, unencrypted data, or shared passwords directly invoke ACM principles like protecting personal privacy (f), honouring confidentiality (g), and avoiding harm (b). This dual focus helps students understand not just the technical parts, but also the digital ethics involved in computing work. Table 1 shows an analysis of one of the worksheets.

Table 1. An Analysis of One of the QR Code-Based Reading Worksheets

Mini Case Study	ACM Principles	IT Vocabulary
1. Unsecured Wi-Fi	b) Avoid harm f) Protect personal privacy	public Wi-Fi, VPN, encrypted connection, data breach
2. No Firewall	b) Avoid harm g) Honour confidentiality	firewall, IP address, network security, vulnerability
3. Unknown Software	b) Avoid harm e) Respect intellectual labour	malware, adware, unverified source, piracy, system performance
4. Unencrypted Data	f) Protect personal privacy g) Honour confidentiality	encryption, plain text, database, customer data, credit card details, confidentiality
5. Phishing Email	b) Avoid harm c) Act with honesty and trustworthiness	phishing, spoofing, credentials, login credentials, email security
6. No Security Updates	a) Contribute to society and human well-being b) Avoid harm	security patches, updates, vulnerability, exploit, malware, antivirus subscription
7. Public Wi-Fi Access	b) Avoid harm f) Protect personal privacy	public Wi-Fi, remote access, identity theft, company portal
8. No Multi-Factor Authentication	b) Avoid harm g) Honour confidentiality	multi-factor authentication (MFA), weak password, authentication, account breach
9. Unwiped Devices	f) Protect personal privacy g) Honour confidentiality	data wipe, device disposal, internal documents, leakage, hard drive
10. Shared Password	c) Act with honesty and trustworthiness g) Honour confidentiality	shared password, credential, suspicious activity, accountability
Note: ACM Code of Ethics (2018): a) Contribute to society and human well-being; b) Avoid harm; c) Be honest and trustworthy; d) Uphold fairness and oppose discrimination; e) Respect intellectual property; f) Protect personal privacy; and g) Honour confidentiality		

This method meets the theory-based requirement from the Rigour Cycle in which Content Knowledge is not just a list of words, but a mix of technical and ethical knowledge based on global professional rules. Instead of adding ethics separately, the design includes ACM guidelines as part of every reading activity. For example, learning about firewalls (CK) becomes more than memorising definitions, but it is about understanding how neglecting them harms users (ACM), and discussing password sharing (CK) connects to professional

integrity and accountability. This means each word and grammar exercise has real-world professional purpose. Because of this, the final product shows how teaching English for specific purposes in vocational IT can help students gain both language skills and a strong sense of ethics in the digital world. Thus, this directly answers Tang and Chaw's call (2016) for 'ethical literacy' in technology education and Wen and Thomson's concern (2007) that knowledge without values can be harmful. By including ACM ethics throughout the content, this approach makes sure that language learning is always connected to professional responsibility.

While prior studies have used QR codes to support ESP vocabulary (Ishikawa in Rafiq et al., 2021), develop digital modules (Laksana et al., 2024), enable augmented reality for advanced learners (Rizkina et al., 2025), or aid listening comprehension (Tsuraya & Salsabila, 2025), they primarily focused on linguistic or technical skill development and did not integrate ethical literacy as a core instructional component. Meanwhile, this study extends existing research by embedding digital ethics into the content and design of a QR-based ESP artefact, demonstrating how mobile technology can simultaneously advance language proficiency and character formation within a theoretically grounded, design-based approach.

Moreover, in the Rigour Cycle, the Pedagogical Knowledge (PK) embedded in the QR code-based reading medium is not just an extra feature, but it is a key part of the design. It follows the Rigour Cycle's main idea that tasks should help readers or learners' reading comprehension and provoke ethical reflection. This is done through a step-by-step method that takes learners from understanding words to making smart, thoughtful decisions. This turns reading from something that the learners just do into something that makes them think deeply about values.

In addition, in Rigour Cycle, the Pedagogical Knowledge design of the QR code-based reading medium strategically scaffolds learning through three interconnected layers grounded in constructivist and situated learning principles (Vygotsky, 1978; Lave & Wenger, 1991). First, each worksheet opens with pre-reading prompts, such as 'Have you ever connected to public Wi-Fi? What risks might exist?' or 'What do you think "phishing" means in IT?', that activate students' prior knowledge and real-world experiences, serving as cognitive anchors for new technical content. Second, comprehension tasks are carefully sequenced to increase in cognitive demand: from literal understanding (like 'What is a firewall?'), to inferential analysis (like 'How could unencrypted data harm customers?'), and finally to ethical-reflective reasoning (like 'If you were the IT admin, what would you do, and why?'). This progression ensures that language learning and ethical development occur simultaneously rather than sequentially; for example, in the Phishing Email case study, students decode the term spoofing (Content Knowledge), infer the attacker's method (comprehension), and evaluate the scenario through ACM ethical principles such as honesty (c) and harm avoidance (b) all while practicing grammar in context, such as if-clauses ('If you receive a suspicious email, you should...'). Third, the medium employs problem-based, scenario-driven pedagogy characteristic of vocational education, immersing learners in authentic workplace dilemmas, like using unsecured café Wi-Fi, that mirror the complex, ill-structured challenges IT professionals encounter, thereby fostering situated learning where technical language, ethical judgment, and professional identity converge.

Thus, the artifact fulfills the TPACK criterion for PK not by adding 'ethics questions' as a separate section, but by weaving pedagogical intentionality into every task, so that every act

of reading becomes an opportunity for both linguistic growth and professional identity formation. This approach directly responds to Tang and Chaw's call (2016) for pedagogies that cultivate 'ethical literacy' alongside technical skill, and demonstrates how ESP instruction in vocational contexts can move beyond language-as-tool toward language-as-practice-of-professionalism.

Furthermore, in the Rigour Cycle, Technological Knowledge (TK) dimension of the developed medium fulfils the a priori criterion established in the Rigour Cycle: QR codes are not used as passive hyperlinks or mere delivery mechanisms, but as intentional pedagogical enablers that facilitate mobile, contextual, and self-directed learning. First, QR codes provide instant, app-free access to curated digital content through students' personal smartphones—requiring only a standard camera, which ensures universal accessibility in resource-constrained vocational settings and transforms everyday devices from passive tools like Google Translate into active portals for professional learning, in line with inclusive edtech principles (UNESCO, 2021). Second, the technology supports contextual learning by embedding resources within authentic workplace scenarios; for instance, scanning the QR code in the Unsecured Wi-Fi task leads not to a dictionary definition but to a situated narrative about a marketing team using café Wi-Fi, thereby bridging classroom instruction and real-world IT practice through just-in-time, context-aware access (Liu & Huang, 2021). Third, the design fosters self-directed learning by allowing students to control the pace, sequence, and depth of their engagement, enabling them to scan, re-scan, pause, or revisit content as needed, which supports metacognitive regulation and accommodates diverse proficiency levels, from those needing repeated exposure to terms like multi-factor authentication to those ready to explore the ethical dimensions of data leakage (Kalyani, 2024).

Furthermore, as these worksheet artefacts were designed to support independent access to reading texts using students' personal devices, allowing them to work independently within their respective teams, it was in relation with the study by Maitlo et al. (2024) finding about the effectiveness of using mobile application for self-directed learning for college students to improve their English. Thus, the QR code serves as more than a simple shortcut, but it functions as a multimodal media (Kress & van Leeuwen, 2001) by integrating linguistic input, digital ethics, and professional context into a unified learning experience. In this way, the artefact reflects TPACK's central principle that technology is not merely added to instruction, but woven into its structure to form a cohesive, purposeful, and educationally significant whole.

The final QR code-based reading worksheet embodies the iterative, classroom-responsive development process outlined in the Design Cycle of Design Science Research (DSR). As intended, the artifact was not produced as a static product but refined through TPACK-informed decisions that ensured deep synergy among its core dimensions: IT ethics were meaningfully embedded within technical texts (Content Knowledge), reflective and scenario-based questions were strategically integrated to scaffold both comprehension and moral reasoning (Pedagogical Knowledge), and QR codes were implemented not as decorative elements but as functional enablers of mobile, contextual learning (Technological Knowledge).

This integration was further strengthened through a limited formative implementation in two TRPL classes, which served as a crucial bridge between theoretical design and real-world usability. Students provided informal, qualitative feedback focused on three practical

dimensions: accessibility (QR codes worked seamlessly on personal smartphones without extra apps), clarity (initial dense texts were revised with headings and glossaries), and engagement (real-world scenarios like phishing and unsecured Wi-Fi were perceived as relevant and authentic). This input led to minor but meaningful refinements, such as simplifying instructions, repositioning QR codes for consistency, and rephrasing reflective prompts from abstract to action-oriented (e.g., ‘What would you do as a developer, and why?’).

This iterative refinement process produced an artefact that embodies full TPACK integration, where content, pedagogy, and technology mutually reinforce one another. Content Knowledge (CK) presents authentic IT vocabulary seamlessly integrated with digital ethics from the ACM Code of Ethics, ensuring that language learning simultaneously cultivates digital ethics. Pedagogical Knowledge (PK) is realised through scenario-based tasks that require learners to apply linguistic forms, such as if-clauses, alongside ethical reasoning, transforming reading into a vehicle for professional identity formation. Technological Knowledge (TK) functions as a pedagogical mediator through QR codes that enable self-directed, contextual learning with minimal technical barriers. This integration ensures the artefact serves as a relevant, inclusive, and meaningful instructional medium for vocational students. Together, these three domains converge to create a coherent instructional experience: the content (CK) provides professional relevance, the pedagogy (PK) structures cognitive and ethical engagement, and the technology (TK) enables flexible, contextual access. It is this synergistic intersection, not the presence of isolated components, that fulfils TPACK’s core promise and ensures the artefact effectively advances both language literacy and digital ethical awareness in vocational IT education.

This synergistic integration aligns with Mishra and Koehler’s (2006) assertion that TPACK’s power lies not in the sum of its parts, but in their intersection where technology transforms how content is taught and learned. Furthermore, the use of authentic, ethics-infused scenarios reflects Lave and Wenger’s (1991) situated learning theory, positioning students as emerging professionals who construct identity through meaningful practice. The QR code, in this context, functions not as a mere tool but as a pedagogical mediator (Koehler & Mishra, 2009), enabling multimodal, self-directed engagement that mirrors real-world IT workflows (Kress, 2003). Critically, this approach responds to ACM’s (2018) call for ethics to be embedded in computing education and Tang and Chaw’s (2016) warning that technical competence without ethical grounding risks societal harm.

In conclusion, the QR code-based learning tool is an effective and interactive worksheet specifically designed for students in the English for IT course. Each section features a thematic heading, pre-reading questions to activate prior knowledge, a scannable QR code linked to the reading, and a variety of comprehension tasks. Question formats include multiple-choice, short-answer, vocabulary matching, and critical thinking questions that require students to apply if-conditional reasoning and ethical judgment. The digital text accessed through the QR code focuses on contextual IT-related themes such as cybersecurity, phishing, and digital ethics, fostering language development and critical thinking. Figure 1 illustrates the layout of the media artefact, and Table 2 provides examples of its components.

Table 2. Components of the QR Code-Based Reading Worksheet

No.	Worksheet Component	Quantity / Format Examples
1	Number of digital reading texts (via QR code)	3 or more
2	Number of digital ethics topics	3 topics or more (phishing, firewall, piracy, privacy, etc.)
3	Comprehension question formats	1 type or more: multiple choice, true-false, short response, open-ended question
4	Number of questions per text	5 questions or more
5	Integrated grammar activities	Whatever, for instance: If-clauses & Modals of obligation, etc.

A. Activity 1: Read the text in the QR codes below with your scanner! Circle the statement(s) related to each text correctly!

No	QR code of the text	Appropriate statement(s) based on the text
1		1. Programming is the process of writing instructions for a computer. 2. Python and Java are examples of hardware used in programming. 3. Programming requires logical thinking and problem-solving skills. 4. Programmers use programming languages to design websites and build hardware devices. 5. Programming is only important for building complex systems like AI.

10. Mini Case Study 10: Shared Password
 Rani works in the IT support department. She shares her login credentials with a co-worker who forgot their own. Later, there are suspicious activities under her account.
 Task: What could happen if someone shares their password?
 Answer: QR code number ...


1


2


3


4


5


6


7


8


9


10

Figure 1. Sample Section of the QR Code-Based Reading Worksheet

This synergistic integration aligns with Mishra and Koehler's (2006) assertion that TPACK's power lies not in the sum of its parts, but in their intersection where technology transforms how content is taught and learned. Furthermore, the use of authentic, ethics-infused scenarios reflects Lave and Wenger's (1991) situated learning theory, positioning students as emerging professionals who construct identity through meaningful practice. The QR code, in this context, functions not as a mere tool but as a pedagogical mediator (Koehler & Mishra, 2009), enabling multimodal, self-directed engagement that mirrors real-world IT workflows (Kress, 2003). Critically, this approach responds to ACM's (2018) call for ethics to be embedded in computing education and Tang and Chaw's (2016) warning that technical competence without ethical grounding risks societal harm.

In conclusion, the QR code-based reading medium shows how TPACK integration can align technical English, ethical literacy, and mobile technology into one coherent design. It not

only enhances students' reading comprehension but also fosters responsible digital practice, positioning language learning as part of professional identity formation.

Characteristics of QR Code-Based Reading Medium in Enhancing Language Literacy and Digital Ethics

Using the analytical rubric described in the Methods section, the QR code-based reading medium was examined across four dimensions: (1) support for technical language literacy, (2) integration of digital ethics themes, (3) pedagogical design, and (4) technological affordances. Grounded in ESP principles (Hutchinson & Waters, 1987), the ACM Code of Ethics (2018), and values-based pedagogy (Nucci, 2022; UNESCO, 2021), this analysis identifies how the medium cohesively fosters both language proficiency and ethical awareness in vocational IT education.

First, in terms of technical language literacy, the medium provides rich, contextual exposure to domain-specific vocabulary such as firewall, phishing, encryption, multi-factor authentication, and vulnerability. These terms are not presented in isolation but embedded within authentic IT scenarios, supporting incidental vocabulary acquisition aligned with ESP best practices (Hutchinson & Waters, 1987). Comprehension tasks progress from literal understanding to inferential and critical thinking, while grammar—particularly if-clauses and modals of obligation—is integrated meaningfully within ethical dilemmas (e.g., 'If a developer ignores a vulnerability, what harm could occur?'), reinforcing linguistic forms through purposeful communication.

Second, the integration of digital ethics themes is systematic and principled, directly anchored to the ACM Code of Ethics (2018). Each mini case study addresses core ethical concerns such as data privacy (f), harm avoidance (b), intellectual property (e), and confidentiality (g). For instance, the Unencrypted Data scenario highlights the professional duty to protect user information, while Shared Password underscores accountability and trust. As shown in Table 3, these themes are mapped to character values like integrity, responsibility, and digital accountability—demonstrating how technical content becomes a vehicle for moral reasoning and professional identity formation (Nucci, 2022).

Third, the pedagogical design employs scenario-based, problem-oriented tasks that mirror real-world IT challenges. Open-ended, reflective questions ('What would you do as a developer—and why?') scaffold learners from comprehension to ethical judgment, transforming reading into an active, dialogic process. This approach aligns with values-based pedagogy (UNESCO, 2021), which emphasises that skill development must be intertwined with character cultivation, especially in vocational contexts where graduates enter ethically sensitive professions.

Fourth, the technological affordances of QR codes enable mobile, self-directed, and context-aware learning. Students access curated digital texts instantly via personal smartphones—without requiring additional apps—ensuring inclusivity and ease of use. The technology supports flexible engagement (scan, revisit, explore at own pace), mimicking how IT professionals consume information in authentic settings. Thus, QR codes function not as decorative add-ons but as pedagogical mediators that bridge classroom learning and workplace practice.

Collectively, these four dimensions do not operate in isolation but converge to create a coherent, ethically grounded ESP experience. The medium exemplifies how language instruction in vocational education can move beyond linguistic competence toward shaping ethically aware digital professionals, a contribution that extends beyond prior QR code studies, which largely prioritised vocabulary or technical skill development (e.g., Ishikawa in Rafiq et al., 2021; Rizkina et al., 2025).

Related to language literacy, QR code use supported language literacy through contextual vocabulary exposure, inferential reading tasks, and grammar integration within authentic texts. The reading materials were intentionally aligned with IT-specific discourse to support vocabulary expansion and technical language comprehension. Terms such as VPN, Firewall, Malware, Phishing, Encryption, Vulnerability, Exploit, Identity theft, Multi-Factor Authentication, and Intrusion Detection System were integrated into texts and reinforced through task-based comprehension activities. This was in line with the previous studies done by Ishikawa et al. (as cited in Rafiq et al., 2021), who employed QR codes to improve ESP learners' reading comprehension and vocabulary in context, and by Rizkina et al. (2025), who applied QR-triggered AR vocabulary activities for advanced ESP learners. The media supported various dimensions of language literacy, particularly within the context of English for IT. Vocabulary items related to IT were intentionally included to enrich students' domain-specific lexicon. Reading comprehension tasks also required learners to make inferences, identify main ideas and supporting ideas based on the text, and respond to text-based questions. The learners also learned grammar in the context of IT, for instance, about conditional sentences.

This media also promoted active student engagement through a mobile-assisted learning flow, as illustrated in the learning process in Figure 2.

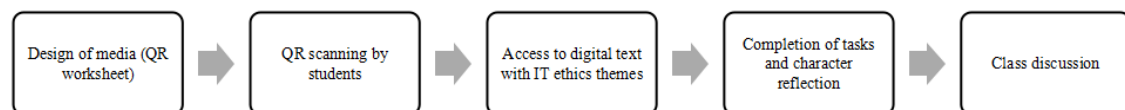


Figure 2. Learning Process Using QR Code-Based Reading Media

Beyond linguistic goals, the reading materials were designed to foster ethical reflection. In terms of digital ethics, the QR code in this case embedded themes like cybersecurity, piracy, and responsible online behaviour, encouraging students to evaluate dilemmas, apply ethical reasoning, and internalise values such as honesty, responsibility, and digital citizenship. Moreover, digital ethics issues such as data ownership conflicts, data monetisation, personal data security, transparency in data use, algorithmic bias, AI decision-making opacity, lack of informed consent, inadequate data governance, imbalance in digital power, privacy erosion were noted by Heavin and O'Connor (2024), and about disseminating information, privacy protection and data security, digital awareness, respect for freedom of expression, verification information, and respect intellectual property rights were also found by Sari et.al. (2024). Then, in this case, follow-up tasks invited learners to evaluate these scenarios using if-clauses, simulate and consider professional consequences.

In addition to supporting language acquisition, the media is designed to cultivate character values relevant to digital professionalism, with each text deliberately selected to convey

digital ethics. Table 3 presents the mapping of content themes and character value examples in this study.

Table 3. Example of Character Value Categories in the Material (Content Analysis)

No.	Reading/Text Theme	Emphasised Character Values
1	Unsecured Wi-Fi	Digital responsibility, caution
2	No Firewall	Risk awareness, responsibility
3	Unknown Software	Critical thinking, cybersecurity awareness
4	Unencrypted Data	Data privacy awareness, integrity
5	Phishing Email	Alertness, honesty
6	No Security Updates	Professional diligence, responsibility
7	Public Wi-Fi Access	Cybersecurity awareness, data protection
8	No Multi-Factor Authentication	Proactiveness, digital accountability
9	Unwiped Devices	Confidentiality, professional ethics
10	Shared Password	Trust management, responsibility
11	Programming Concepts (Text 1)	Logical thinking, persistence
12	Software Development Life Cycle (Text 2)	Planning, cooperation, continuous improvement
13	Version Control System (Text 3)	Collaboration, attention to detail, accountability

The findings indicate that the developed worksheet has potential not only to support reading literacy in a technical domain but also to embed character values relevant to students' future professional environments. Although the evaluation was based on literature and theoretical alignment rather than empirical testing, the artefact represents a model of technology-integrated language instruction that promotes both skill and value-based learning.

The analysis reveals that the QR code-based reading medium functions not merely as a language-learning tool but as an integrated pedagogical space where linguistic development and ethical formation converge. By embedding IT-specific vocabulary (such as firewall, phishing, multi-factor authentication) within authentic texts and coupling them with inferential and grammar-in-context tasks, the medium supports deeper language literacy aligned with ESP principles, consistent with Ishikawa et al. (as in Rafiq et al., 2021) and Rizkina et al. (2025), yet extending beyond vocabulary acquisition toward critical engagement with professional discourse. More significantly, the deliberate infusion of digital ethics, through scenarios on cybersecurity, data privacy, and algorithmic accountability, transforms reading comprehension into a site of moral reasoning, where learners apply conditional structures not just grammatically but ethically (like ‘If a developer ignores a vulnerability, what harm could occur?’). This dual focus reflects a pedagogical shift: rather than treating ethics as an add-on, the design weaves character values, such as responsibility, integrity, and digital accountability, into the fabric of language tasks themselves, as evidenced in Table 3. While the current evaluation is grounded in theoretical and content analysis rather than empirical data, the artefact demonstrates how mobile-assisted ESP instruction can move beyond skill transmission toward shaping ethically aware digital professionals, a dimension largely absent in prior QR code studies, which prioritised linguistic or technical outcomes over value-based learning. Thus, the true innovation lies not in the technology itself, but in its purposeful orchestration to serve both cognitive and character aims within vocational education.

CONCLUSION

This study concludes that the development of QR code-based reading media offers meaningful support for improving language literacy and promoting ethical awareness among

students in English for IT courses. The integration of contextual digital texts, embedded through QR codes, enables flexible, engaging learning that aligns with students' technological habits. The reading materials also serve a dual purpose by embedding values such as responsibility, honesty, and digital citizenship through content themes like phishing, piracy, and cybersecurity.

Although the media has not yet undergone empirical testing with students, its design was evaluated based on instructional principles and relevant literature, suggesting strong theoretical potential. The structured worksheet, which combines reading comprehension and grammar tasks, reflects a practical application of Design Science Research methodology. As a future direction, classroom-based implementation and quantitative analysis of learning outcomes are recommended to validate the media's effectiveness.

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APPENDICES

Appendix 1 QR Worksheet Examples

EXAMPLE 1

Mini Case Study: What's the Risk?

Instructions: Read the short scenario and find and write the-if-clause-sentence describing the possible consequence based on the QR code that you can scan.

Scenario example:

A company forgot to renew its antivirus subscription and hasn't updated its firewall. Employees often use weak passwords and connect to public Wi-Fi while working remotely.

Write sentences like:

If employees use public Wi-Fi, hackers might steal their data.

1. Mini Case Study 1: Unsecured Wi-Fi

A small marketing team works at a café using free Wi-Fi to access client files. They don't use VPNs or encrypted connections.

Task: What could happen if the Wi-Fi is not secure?

Answer: QR code number ...

2. Mini Case Study 2: No Firewall

A startup company skips installing a firewall on their network to save money. A week later, unknown IP addresses start trying to access their system.

Task: What happens if there's no firewall?

Answer: QR code number ...

3. Mini Case Study 3: Unknown Software

An employee downloads a free video converter from an unverified website. The next day, their PC becomes slow, and strange ads appear.

Task: What happens if software is downloaded from unknown sources?

Answer: QR code number ...

4. Mini Case Study 4: Unencrypted Data

Customer data is stored in plain text in the company's database. During a security audit, it's found that anyone with access can read names and credit card details.

Task: What happens if data isn't encrypted?

Answer: QR code number ...

5. Mini Case Study 5: Phishing Email

A finance staff member receives an email that looks like it's from the company CEO, asking for payment confirmation. The employee clicks the link and enters login credentials.

Task: What happens if a user clicks on a phishing email?

Answer: QR code number ...

6. Mini Case Study 6: No Security Updates

An IT admin forgets to update the system with the latest security patches. Soon after, a known vulnerability is exploited by malware.

Task: What happens if updates are not applied?

Answer: QR code number ...

7. Mini Case Study 7: Public Wi-Fi Access

Several remote workers access the company portal from a hotel's public Wi-Fi without using VPN. One worker later reports identity theft.

Task: What happens if users access systems through public Wi-Fi?

Answer: QR code number ...

8. Mini Case Study 8: No Multi-Factor Authentication

A hacker guesses a weak password and logs into a manager's account because no additional verification was required.

Task: What happens if MFA isn't used?

Answer: QR code number ...

9. Mini Case Study 9: Unwiped Devices

Old company laptops were donated to a local school without wiping the hard drives. Months later, internal documents are found online.

Task: What happens if devices aren't wiped before disposal?

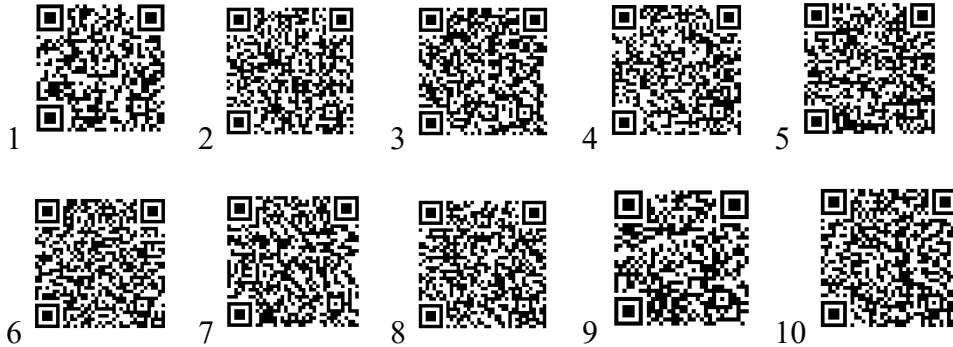
Answer: QR code number ...

10. Mini Case Study 10: Shared Password

Rani works in the IT support department. She shares her login credentials with a co-worker who forgot their own. Later, there are suspicious activities under her account.

Task: What could happen if someone shares their password?

Answer: QR code number ...



BIO STATEMENT

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