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Needs Analysis of the CG2G Digital Module for ICT and Environmental Literacy

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Abstract

The integration of ICT literacy and environmental education is increasingly important for supporting sustainable learning, especially in rural settings. However, many rural students still face challenges such as limited digital competence, unequal access to devices, and restricted learning resources. This study examined the learning needs for the development of the CG2G Digital Module, which combines ICT and environmental literacy based on the ASSURE instructional design framework. A quantitative survey involving 47 Year Six students from a rural primary school in Hulu Terengganu, Malaysia, was conducted using a validated questionnaire adapted from the VAK Learning Styles Self-Assessment. Descriptive analysis showed that students had moderate ICT skills (overall mean = 3.12, SD = 0.54), especially in basic computer and internet use, but weaker skills in applications such as word processing and online educational tools. Their environmental awareness was relatively strong (overall mean = 3.78, SD = 0.46), particularly in recycling practices and water cleanliness. The results also indicated that kinesthetic learners formed the largest group (36.17%), suggesting the need for more hands-on and interactive learning approaches. These findings provide important guidance for structuring the CG2G module to better support ICT and environmental literacy among rural students.

Keywords: ASSURE Model, Environmental Literacy, ICT Literacy, Needs Analysis, Rural Education

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1. Introduction

The integration of ICT literacy and environmental education has become a major concern in many countries as they work toward the United Nations Sustainable Development Goals (SDGs). In particular, SDG 4 stresses the importance of inclusive and high-quality education, while SDG 13 highlights the urgency of addressing climate change. These two goals influence current educational priorities, especially the need for students to function confidently in digital environments and to understand environmental issues in their daily lives. ICT literacy today covers more than using devices; it also involves searching for reliable information, evaluating digital content, and communicating through online platforms. At the same time, environmental literacy encourages children to develop responsible attitudes and practices for protecting the natural environment. In Malaysia, these priorities can be seen in the Ministry of Education's 2027 School Curriculum Framework and the Digital Education Policy (DEP). Both documents call for the strengthening of digital skills across subjects while promoting sustainability as an important value for all students. Although these policies offer a strong direction, rural schools often face different realities. Many communities still struggle with unstable internet access, limited devices, and socioeconomic challenges. As a result, students in these areas tend to show lower ICT competence compared to those in urban settings. Research conducted after the COVID-19 pandemic also revealed that the digital divide became more visible when online learning was introduced, leaving many rural children at a disadvantage. Because of these challenges, the use of instructional design approaches that consider learners' backgrounds becomes essential.

Needs-based instructional planning helps teachers identify what students already know, what they are lacking, and how they prefer to learn. In this study, the ASSURE model is used as the main framework because its first stage, Analyse Learners, focuses on understanding students' characteristics before designing learning materials. This step is especially

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important when working with rural children, whose learning context may differ from national assumptions about digital readiness. What makes this study unique is its attempt to examine ICT literacy and environmental literacy together, rather than treating them as two unrelated areas. Past studies usually focus on only one domain—either digital competence or environmental knowledge. However, for rural contexts, both skills are equally important and can support each other. When students improve their ICT literacy, digital tools can be used to deliver more engaging and practical environmental education. At the same time, environmental topics can provide meaningful contexts for practising ICT skills. Therefore, this study investigates rural students' ICT abilities, their environmental knowledge, and their learning styles to guide the development of the CG2G Digital Module. By linking these findings to the ASSURE model, the study aims to support the creation of learning materials that are relevant, accessible, and responsive to the needs of rural Malaysian students

These challenges underscore the importance of adopting instructional design approaches that are responsive to learners' contexts. Needs-based instructional design provides a structured way to identify students' competencies, preferences, and challenges before creating appropriate teaching strategies and learning materials. In this study, the ASSURE model is employed as a guiding framework because it emphasises analysing learner characteristics as a prerequisite for effective instructional planning. By focusing specifically on the Analyse Learners stage, the model ensures that module design decisions are grounded in empirical evidence about students' actual needs and readiness (Choi, Choi, & Park, 2022; Senadheera, Ediriweera, & Rupasinghe, 2024). What sets this study apart is its dual emphasis on ICT and environmental literacy. While previous research has often examined these two areas separately focusing either on improving students' digital competence (Baek et al., 2023) or on strengthening environmental awareness and sustainable behaviours (Hajj-Hassan, 2024)—few studies have sought to integrate them within a single evaluation framework. Addressing both simultaneously is particularly relevant in rural contexts, where access to technology can be harnessed as a powerful tool to enhance sustainability learning. This study therefore aims to evaluate rural students' ICT competencies, environmental knowledge, and learning styles in order to inform the development of the CG2G Digital Module. By situating the findings within the ASSURE instructional design model, the study not only contributes to the design of contextually appropriate digital learning resources but also offers insights for advancing equitable and sustainable education in rural Malaysia.

2. Literature Review

Research on ICT literacy and environmental education has expanded across many countries, yet most studies still treat these two domains separately. This separation creates a gap in understanding how digital competencies may actually support environmental learning, especially for rural students. Earlier studies often highlight the importance of ICT for 21st-century skills and the growing need for environmental awareness, but few attempt to explain how these two forms of literacy intersect and influence one another. For rural education, where both technological access and exposure to environmental issues can be limited, it is important to view ICT and environmental literacy not as parallel fields but as areas that can reinforce each other. This literature review therefore examines three key strands: ICT literacy in education, environmental literacy in schools, and the role of needs analysis in instructional design. The aim is to show where the gaps exist in previous work and why the CG2G Digital Module needs a dual-integration approach.

2.1. ICT Literacy in Education

ICT literacy today includes technical skills, digital communication, and the ability to evaluate online information. Many studies report that ICT use can improve student motivation and broaden access to knowledge. However, the picture is not always consistent, especially for students from rural backgrounds. For example, Johnson and Smith (2020) argue that ICT strengthens higher-order thinking, while Lee and Wilson (2022) explain that digital tools help students develop collaborative abilities. Yet, how far these benefits can be realised depends heavily on local conditions. Several studies found that rural schools face more serious obstacles such as poor connectivity or lack of devices, which limit the effectiveness of ICT integration. Heng and Sol (2020) show that infrastructure remains the main barrier rather than students' willingness to learn. During the COVID-19 pandemic, the difference between urban and rural areas became more obvious; students in remote areas had difficulty participating in online learning and often lacked the skills to evaluate digital information critically (Hashim et al., 2021). Compared with urban students who already practise online collaboration or digital creativity, rural students tend to focus mainly on basic tasks. This contrast indicates that ICT literacy development must be context-sensitive. Teachers also play a central role because their confidence and teaching strategies directly affect students' readiness. Roberts and Patel (2021) point out that even when devices are available, students may still not achieve strong digital literacy if teachers do not model effective practices. Overall, the research

suggests that ICT literacy is unevenly distributed and shaped by local challenges. For this reason, any digital module designed for rural learners must be grounded in an understanding of their specific constraints and learning needs.

2.2. Environmental Literacy in Schools

Environmental literacy is recognised as a foundation for sustainability, yet its implementation in schools is often inconsistent. Many studies highlight positive impacts of environmental education, but they also point out limitations in curriculum coverage and teaching approaches. For example, Green and Marcus (2022) argue that early exposure can cultivate responsible habits, but they note that these outcomes depend on meaningful learning activities rather than only theoretical knowledge. Roberts and Davis (2023) similarly observe that students who engage with real environmental issues tend to show stronger behavioural change. However, when comparing different contexts, rural schools often face a contradiction. Although rural communities are usually closer to natural resources, environmental literacy programmes may not be well-supported due to limited teaching materials and training. This makes environmental education less structured compared to urban schools. Recent research has suggested that digital tools can make sustainability topics more accessible and engaging, especially when used to simulate environmental problems or demonstrate real-world scenarios. Thompson and Davis (2023) argue that ICT-based activities can help students see the relevance of environmental issues to their daily life, which in turn strengthens motivation to adopt pro-environmental behaviours. The literature thus shows a potential synergy: digital platforms can compensate for curriculum gaps in environmental education, while environmental topics can provide meaningful content for ICT learning. Yet, this synergy is rarely explored in previous studies, especially at the primary school level.

2.3. Needs Analysis and Instructional Design

A needs analysis is essential in instructional design because it helps align learning materials with learners' abilities and contexts. Smaldino et al. (2019) emphasise that without a careful needs analysis, instructional resources may miss their target and fail to support equitable learning. Different models such as ADDIE and ASSURE are frequently used, but the ASSURE model is considered more practical for classroom environments because it starts with analysing learner characteristics before selecting teaching strategies. Recent studies have used the ASSURE model to design digital modules and gamified learning activities, especially in science and technology subjects. Choi et al. (2022) report that the model supports active engagement, while Pratama et al. (2023) found that incorporating learners' preferences increases learning motivation. However, most existing needs analyses focus on a single area such as ICT skills or science concepts. Yani et al. (2020), for example, evaluated students' ICT abilities only, without linking these abilities to other learning domains. Very few studies examine the dual needs of ICT literacy and environmental literacy together. This gap is significant because the two areas can intersect in meaningful ways. ICT tools can help students observe environmental issues, analyse data, and participate in collaborative problem-solving. At the same time, environmental content can provide authentic tasks that strengthen ICT skills through real-life application. In rural contexts, this intersection becomes even more important because students may lack both digital competence and structured environmental learning experiences. By applying the ASSURE model to analyse learners' needs across both domains, this study contributes a more integrated perspective. The findings will inform the design of the CG2G Digital Module so that it responds to two urgent educational priorities at the same time: reducing the digital divide and promoting sustainability awareness among rural students.

The objectives of the research:

a. To evaluate the general characteristics, digital competencies, and environmental knowledge of rural primary students as a foundation for the development of the CG2G digital module.
b. To identify students' preferred learning styles and analyse their implications for effective instructional strategies in line with the ASSURE model.
c. To determine instructional design elements—such as multimedia, gamification, and multimodal delivery—that best align with students' needs in order to enhance ICT and environmental literacy

3. Methodology

3.1. Research Design

This study applied a quantitative descriptive design because it allowed the researcher to obtain measurable information about students' ICT competencies, environmental knowledge, and learning preferences. Such a design is commonly used in early-stage needs assessment studies, where the purpose is not to test causal relationships but to describe learners' conditions before developing an instructional intervention. The findings from this design were important to

guide the planning of the CG2G Digital Module, especially in understanding the readiness of rural students toward digital learning activities.

3.2. Population and Sample

The population of this study consisted of Year Six students from rural primary schools in the Hulu Terengganu district. A purposive sampling strategy was used to select one school. The decision to focus on a single school was based on two considerations. First, rural schools in this district share similar characteristics in terms of socioeconomic background, class size, and availability of ICT facilities, which makes the selected school a reasonable representation of rural diversity in this region. Second, needs analysis studies often begin with a smaller, context-specific site to allow deeper examination of learner characteristics without the logistical constraints of multi-school sampling. The selected school had a functioning computer lab and basic internet access, ensuring that students had minimum technological exposure required to answer the ICT-related items. A total of 47 students participated in the study. Although the number is modest, it is acceptable for descriptive analysis, especially when the sampling unit is restricted to a single rural school. Previous rural needs analysis studies have used similar sample sizes for exploratory purposes. Moreover, the sample reflected almost the entire Year Six enrolment at the school, giving a realistic picture of the local learning conditions.

3.3. Research Instrument

The instrument was a structured questionnaire adapted from the VAK Learning Styles Self-Assessment (Chislett & Chapman, 2005) and extended with items that measured ICT skills, prior digital experience, and environmental knowledge. The questionnaire consisted of three main sections, as shown in Table 1.

Table 1. Description three sections in questionnaire

Section	Description	Number of Items
A	Student demographic information	5
B	Questions related to general characteristics, competencies, prior knowledge, and experience	10
C	Learning style identification questions	30

Content validation was carried out by three experts in science education and instructional design, who reviewed the items for clarity, relevance, and alignment with the purpose of the study. A pilot test involving 20 students from a different school produced a Cronbach's Alpha value of 0.82, indicating that the instrument had acceptable internal consistency.

3.4. Data Collection

Data collection procedures followed official approval from the Malaysian Ministry of Education through the Educational Planning and Research Division (EPRD), as well as endorsement from the Terengganu State Education Department. School administrators were briefed, and parental consent was obtained for all students. The questionnaire was distributed in person by the researcher to minimise misunderstanding of instructions and to maintain high completion accuracy. Out of 60 questionnaires distributed, 47 were completed and returned, giving a response rate of 78%.

3.5. Data Analysis

The data were analysed using descriptive statistics, including mean scores, percentages, and standard deviations, through SPSS Version 29.0. This form of analysis was appropriate for identifying patterns in ICT competencies, environmental knowledge, and learning preferences among rural students. To support clearer interpretation, mean values were categorised as follows in Table 2.

Table 2. Level Interpretation for Mean Scores

Mean Score Range	Interpretation Level
1.00 - 2.00	Low level
2.01 - 3.00	Moderate-low level
3.01 - 4.00	Moderate-high level
4.01 - 5.00	High level

Demographic information was cross-checked using school records to ensure accuracy. The results were interpreted in relation to the "Analyse Learners" stage of the ASSURE model, which emphasises understanding learners before designing instructional materials.

3.6. Ethical Considerations

Ethical approval was granted by the Educational Planning and Research Division (EPRD), Ministry of Education Malaysia. Participation was voluntary, and students were assured that their identities would remain anonymous. Parental consent forms were collected for all respondents. The study followed the ethical principles outlined in the Helsinki Declaration concerning research with human participants.

4. Results and Discussion

The findings of this study provide insight into the general characteristics, ICT competencies, environmental knowledge, and learning preferences of rural students. These results form the foundation for designing the CG2G Digital Module based on the Analyse Learners stage of the ASSURE instructional design model.

4.1. General Characteristics and Socioeconomic Background

The sample involved 47 pupils aged 12 years, with more female than male respondents. All students were Malay and lived close to the school area, which shows that the community is rather homogenous. When examining their socioeconomic background in Table 3, almost 85% of the families reported monthly income below RM2000. This situation reflects a typical rural economic profile, where households may face limitations in providing digital devices or stable internet access at home. Instead of only describing the income distribution, this pattern suggests a more important implication: students from low-income families often develop uneven ICT skills because their opportunities to practise using computers or online platforms are restricted. At the same time, previous studies also noted that limited home resources do not necessarily reduce students' awareness of environmental issues, since many rural communities practice recycling, waste separation or agriculture-related activities in their daily life.

Table 3. Household Income of Students' Families

Household Income	< RM499	RM 500–1999	RM 2000–2999	> RM3000
Percentage (%)	36.17%	48.93%	8.52%	6.38%

Research by Heng and Sol (2020) showed a similar pattern where rural students' ICT exposure is largely shaped by family economic status. Meanwhile, Hashim, Yusof and Hamid (2021) argued that the digital divide in Malaysia is influenced not only by infrastructure but also by household financial ability to sustain digital learning tools. When these findings are interpreted together with the present study, a clearer relationship appears: students may enter the classroom with weaker ICT literacy but relatively stable environmental understanding, creating an imbalance between the two domains. For the ASSURE model, this imbalance is very important during the Analyse Learners stage. It means that the CG2G Digital Module should not assume high ICT proficiency and must include features that support simple navigation, step-by-step guidance, and low-bandwidth usage. At the same time, their stronger environmental knowledge can be used as an anchor to design activities that encourage deeper reflection, problem-solving and community-based tasks. In this way, the module becomes more equitable and better aligned with the actual needs of rural learners.

4.2. Students' Competencies Prior Knowledge, and Experience of Students

The analysis of students' competencies and prior knowledge offers a clearer picture of how ICT skills and environmental literacy develop differently among rural learners. Instead of only presenting the descriptive scores, the pattern in Table 4 shows that students possess uneven abilities across the two domains. Their ICT related skills, especially those related to basic computer operation and simple internet searching, appear at a moderate level. However, when tasks involve more structured digital work such as producing documents using Microsoft Word or selecting suitable multimedia for learning their confidence becomes noticeably lower. This difference suggests that students are familiar with everyday digital habits but have limited experience with more academic-oriented applications, which are usually needed for effective online learning.

On the other hand, their environmental literacy shows a stronger and more stable pattern. Items related to the meaning of recycling, the importance of protecting nature, and awareness of water cleanliness received high mean scores, indicating that environmental understanding is already part of their daily knowledge and community practices. The contrast between high environmental awareness and moderate ICT competency implies that these students enter the

learning environment with a cognitive advantage in environmental topics but a practical disadvantage in digital skills. In other words, they know what environmental issues are, but they may not yet know how to use digital tools to explore or communicate these issues. This imbalance is important for module design because it affects how students interact with digital content. For example, although learners care about environmental protection, the low scores on using environmental websites or searching online information show that they are not fully engaging with digital sources related to these topics. This gap highlights the need for the CG2G Digital Module to integrate environmental content through simple, guided ICT activities rather than assuming students can navigate digital resources independently.

From the perspective of the ASSURE model particularly the Analyse Learners step, these findings show that instructional strategies must begin with scaffolded digital tasks, such as step-by-step navigation, icons-based instructions, or low-complexity multimedia activities. At the same time, the module can take advantage of students' stronger environmental knowledge by embedding problem-solving tasks, local case examples, and community-based scenarios that make learning more meaningful. The combination of both strengths and weaknesses provides a clearer rationale for designing a balanced digital module that supports students' ICT development while deepening their environmental understanding.

Table 4. Students' Competencies, Prior Knowledge, and Experiences

Item	N	Minimum	Maximum	Mean	Standard Deviation
I know how to use a computer for learning.	47	2.00	5.00	3.55	0.686
I have used the internet to search for information on a topic.	47	2.00	5.00	3.60	0.825
I have basic skills in using Microsoft Word and PowerPoint.	47	1.00	5.00	2.74	0.736
I choose appropriate videos and audio materials for learning.	47	2.00	5.00	3.06	0.791
I know the meaning of recycling.	47	3.00	5.00	4.21	0.657
I have heard about how to keep rivers or oceans clean.	47	1.00	5.00	4.23	0.983
I believe it is important to protect the environment for humans and animals.	47	2.00	5.00	4.57	0.651
I share information about ways to protect the environment.	47	1.00	5.00	3.28	1.077
I know how to use websites that help me learn about the environment.	47	1.00	4.00	2.60	0.771
I often use a smartphone to find information about the environment.	47	1.00	4.00	2.66	0.760

4.3. ICT Competencies and Prior Knowledge

The analysis of students' ICT competencies shows that their digital experience is uneven and mostly concentrated on simple, routine actions. Although the mean scores indicate moderate familiarity with basic operations such as using computers for learning and searching information online, these abilities represent only the surface layer of digital literacy. When tasks require more structured skills like preparing documents, creating slides, or exploring educational websites their confidence drops considerably. This suggests that students' digital exposure is shaped more by casual use rather than purposeful, academic-oriented engagement. The gap between basic and higher-order ICT skills becomes even more meaningful when compared with their environmental literacy, which is relatively stronger. Students can explain environmental concepts, but they struggle to use digital tools to explore or communicate those concepts effectively. This contrast shows that the challenge is not in understanding environmental issues, but in leveraging technology to deepen that understanding.

Previous studies also report similar patterns. Lee and Wilson (2022) found that students in rural areas often remain at the introductory level of digital literacy because they receive fewer opportunities to practise advanced applications. Likewise, Sani, Yusof, and Karim (2020) argued that ICT skills do not develop automatically with exposure; instead, they require consistent guidance, modelling, and reinforcement. When these findings are considered together with the present study, it becomes clearer that rural students' ICT limitations are not simply technical weaknesses but are connected to broader structural conditions such as home environment, teacher support, and infrastructure quality. From the ASSURE instructional design perspective, these insights have direct implications for the CG2G Digital Module.

Since students already show stronger environmental knowledge but weaker ICT skills, the module must be designed in a way that reduces cognitive load and supports gradual skill-building. Step-by-step instructions, visual cues, scaffolded tasks, and simple interface design are essential to ensure that learners do not feel overwhelmed when using digital tools. Gamification features—such as small challenges, immediate feedback, and point-based progression—can also help increase persistence and reduce anxiety toward more complex ICT tasks. By aligning these strategies with learners' actual readiness, the CG2G Digital Module can transform digital activities from potential barriers into supportive pathways that allow students to connect ICT skills with meaningful environmental learning.

4.4. Environmental Literacy

The analysis of environmental literacy shows that students have a strong conceptual understanding of sustainability issues. The high scores related to recycling and river cleanliness reflect that environmental awareness is already part of their everyday life and community exposure. Their positive attitude toward protecting nature also indicates that they value environmental responsibility, even though they come from rural backgrounds. However, this positive awareness does not fully translate into active behaviour. The lower levels of information sharing and limited use of digital platforms for environmental learning reveal a gap between what students know and what they actually practice. In other words, they understand environmental concepts, but they are not yet confident or motivated to apply this knowledge in a meaningful or consistent way. This pattern becomes more significant when contrasted with their ICT skills. Students show moderate ability in basic digital tasks but limited engagement with ICT tools specifically for environmental learning. This means that although they know about recycling or river protection, they rarely use digital resources to explore these topics further. This mismatch between environmental understanding and digital engagement suggests that the challenge is not only to strengthen knowledge but also to help students use ICT as a tool to support environmental action. Such cross-variable comparison highlights the need for instructional approaches that connect the two domains rather than treating them separately. These findings are consistent with the discussions by Roberts and Patel (2021) and Green and Marcus (2022), who argue that environmental literacy in school contexts often remains at a theoretical level unless students are given chances to practise real environmental behaviour. Thompson and Davis (2023) also emphasise that digital tools can help activate behavioural change when used through interactive, student-centred strategies. When interpreted together, these studies support the idea that environmental knowledge alone is not enough; students need meaningful digital experiences that encourage participation, communication, and reflection.

For the CG2G Digital Module, this means that content must go beyond simple explanations of environmental issues. Instead, the module should integrate communication-oriented activities, small collaborative tasks, and digital storytelling so students can express their ideas and experiences in an engaging way. Features such as peer-sharing spaces, guided reflection prompts, and problem-based missions can transform environmental literacy from passive awareness into active participation. By designing activities that allow students to apply their knowledge through digital tools, the CG2G Module can bridge the gap between understanding and action, helping learners develop both ICT competence and environmental responsibility in a connected and meaningful manner.

4.5. Learning Styles and Implications for Instruction

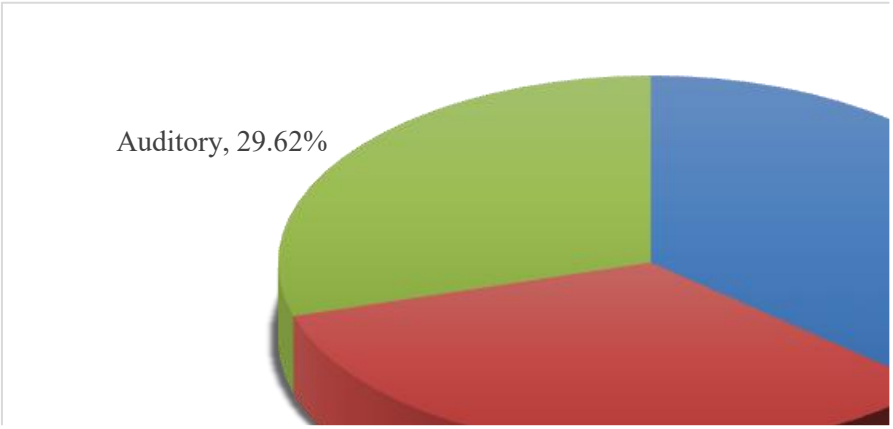

Fig. 1. Pie Chart Students' Learning Styles.

Figure 1 illustrates the distribution of students' learning styles based on the VAK model, showing a relatively balanced spread between kinesthetic, visual, and auditory preferences. Although kinesthetic learners form the largest group, the

differences between the three categories are not very large. This pattern suggests that students in the rural context do not rely on a single dominant learning mode but instead demonstrate diverse ways of processing information. Rather than viewing these percentages only as numerical differences, the more important implication is that instructional planning must avoid a one-size-fits-all approach. A multimodal digital environment is necessary because relying only on visual videos or text-heavy materials, for example, would disadvantage learners who depend more on movement or listening to understand a concept.

This distribution also becomes meaningful when interpreted together with students' ICT and environmental literacy profiles. Earlier findings showed that students have stronger environmental awareness but weaker ICT competencies, especially in tasks requiring structured digital navigation. Kinesthetic learners, who make up the largest group, may struggle more when ICT activities are too text-based or technically complex. At the same time, their hands-on orientation offers an opportunity to design environmental tasks that involve exploration, manipulation, and interactive challenges. In contrast, visual and auditory learners may engage more easily with digital explanations but still require guidance when environmental content is presented through unfamiliar websites or apps. Therefore, learning styles interact with ICT readiness and can influence how effectively students participate in digital environmental learning.These interpretations align with Pratama et al. (2023), who emphasise that kinesthetic learners tend to respond well to game-like interactions in science education. Choi, Choi and Park (2022) also argued that the ASSURE model supports teachers in selecting media that accommodate different learner preferences. Following this perspective, the CG2G Digital Module should embed specific features that match each learning style: kinesthetic activities such as drag-and-drop sorting, movement-based simulations, and interactive missions; visual elements like diagrams, icons, animations, and simplified infographics; and auditory supports including narration, explanation clips, and sound cues.

In addition, integrating gamification across these modalities strengthens engagement for all learner types. Points, badges, and progressive challenges can encourage participation among students who may lack confidence in ICT use or who usually engage with environmental issues only at the conceptual level. By adopting multimodal and gamified design principles, the CG2G module becomes more inclusive for rural learners and supports the dual goals of strengthening both ICT literacy and environmental literacy. Such an approach reflects the core intention of the ASSURE model, which positions learner characteristics as the foundation for instructional decision-making.

4.6. Integrating Findings with the ASSURE Model

The findings of this needs analysis provide a clearer and more comprehensive understanding of the Analyse Learners stage in the ASSURE model. Instead of viewing students' characteristics separately, the results show that their socioeconomic background, ICT competencies, environmental literacy, and learning styles influence one another in meaningful ways. For example, limited household resources contribute to weaker ICT skills, yet these same students demonstrate strong environmental awareness because environmental issues are often embedded in their daily life. This contrast between digital weakness and environmental strength indicates that instructional planning cannot assume equal readiness across domains. The CG2G module must therefore position environmental content as a familiar entry point while providing structured digital support to gradually develop ICT abilities. Such integration ensures that instructional decisions remain grounded in the actual realities of rural learners rather than in idealised assumptions.

This study also contributes to existing literature by explicitly linking ICT literacy and environmental education, two areas that are often discussed independently. Previous work has tended to focus on improving digital competence (Johnson & Smith, 2020) or promoting sustainability values (Roberts & Patel, 2021), but rarely on how these domains interact in practice. The present findings suggest that students may understand environmental concepts but lack the ICT skills required to explore, communicate, or apply this knowledge through digital tools. This mismatch shows why a dual-focus approach is necessary, especially in rural schools where technological disadvantages can limit opportunities for deeper environmental learning. By acknowledging this intersection, the study supports a more holistic interpretation of learner needs within the ASSURE framework. The implications for the CG2G Digital Module are therefore multi-layered. Because students vary in their learning preferences as shown by the distribution of kinesthetic, visual, and auditory styles multimodal design elements are essential for accessibility. At the same time, low ICT proficiency requires the inclusion of scaffolded navigation, simple interface structures, and progressive digital tasks. Gamification features such as challenges, feedback, and rewards not only appeal to kinesthetic learners but also help students maintain motivation when performing unfamiliar ICT activities. When these design elements are aligned with the Analyse Learners findings, the CG2G module becomes more than a digital resource; it evolves into a structured, evidence-based intervention that addresses the dual challenges of ICT readiness and environmental literacy. Within the ASSURE model, this integrated approach demonstrates that learner analysis is not merely the first step of instructional design but a guiding principle for all subsequent decisions. By grounding the module in the actual needs, limitations, and strengths

of rural students, the CG2G initiative holds strong potential to enhance both digital competence and environmental understanding in a sustainable and equitable way.

5. Conclusion

This study carried out a comprehensive needs analysis to understand the readiness of rural primary students for a digital module that integrates ICT literacy and environmental education. The results showed that while students demonstrated only moderate ICT competence, they possessed a relatively strong understanding of environmental issues. At the same time, their learning styles were distributed across kinesthetic, visual, and auditory preferences, indicating that they do not rely on a single dominant mode of learning. When these variables are examined together, a clearer picture emerges: students enter the learning environment with strengths in environmental knowledge but face limitations in applying digital tools to explore or express that knowledge. This imbalance highlights the importance of designing instructional materials that strengthen ICT skills without overwhelming learners who already face socioeconomic and technological constraints. The findings also reinforce the relevance of the ASSURE instructional design model, especially the Analyse Learners stage. By systematically evaluating the students' background, competencies, and preferences, the study demonstrates how instructional planning can become more responsive to real classroom conditions. The need for multimodal materials, scaffolded digital tasks, and gamification features becomes more evident when learners' characteristics are interpreted holistically rather than as isolated factors. These insights are crucial for guiding the development of the CG2G Digital Module, ensuring that it promotes active engagement, accessibility, and meaningful connections between digital learning and environmental responsibility. Overall, this study offers both practical and theoretical contributions. Practically, it provides a data-driven foundation for designing a module suitable for rural learners. Theoretically, it advances discussion on how digital literacy and environmental literacy can be addressed together through structured instructional design. In doing so, the study supports wider efforts to reduce educational inequality and promote sustainable, future-oriented learning in under-resourced settings.

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References

Baek, C., Saito-Stehberger, D., Jacob, S., Nam, A., & Warschauer, M. (2023). A computer science framework to teach community-based environmental literacy and data literacy to diverse students. *IEEE Transactions on Learning Technologies*. https://doi.org/10.1109/TLT.2023.

Choi, E., Choi, Y., & Park, N. (2022). Development of blockchain learning game-themed education program targeting elementary students based on ASSURE model. *Sustainability, 14*(7), 3771. https://doi.org/10.3390/su14073771

Farihah, M. J., Norawi, A. M., & Jahan, A. N. (2021). Game-based STEM module development for KSSM science teachers. *Journal of Turkish Science Education, 18*(2), 249–262.

Green, P., & Marcus, L. (2022). Environmental education and community resilience: A review. *Sustainable Learning Review, 9*(2), 101–115.

Hajj-Hassan, M., Chaker, R., & Cederqvist, A.-M. (2024). Environmental education: A systematic review on the use of digital tools for fostering sustainability awareness. *Sustainability, 16*(9), 3733. https://doi.org/10.3390/su16093733

Hashim, N., Yusof, M. I., & Hamid, R. Z. (2021). Online learning barriers among rural students during COVID-19. *International Journal of Academic Research in Business and Social Sciences, 11*(6), 1200–1212.

Heng, M. A., & Sol, E. H. (2020). Teachers' perspectives on digital learning environments in rural schools. *Malaysian Online Journal of Educational Technology, 8*(3), 19–28.

Hübner, N., Fahrbach, T., Lachner, A., & Scherer, R. (2023). What predicts students' future ICT literacy? Evidence from a large-scale study conducted in different stages of secondary school. *Computers & Education, 203*, 104847. https://doi.org/10.1016/j.compedu.2023.104847

Johnson, A., & Smith, M. (2020). Reframing ICT literacy in digital education. *Journal of Digital Learning, 14*(2), 55–63.

Lee, M., & Wilson, K. (2022). Equity and engagement in digital learning: A study on ICT interventions in rural education. *International Journal of Educational Research, 110*, 101894.

Mustafa, F., Nguyen, H. T. M., & Gao, X. (2024). The challenges and solutions of technology integration in rural schools: A systematic literature review. *International Journal of Educational Research, 126*, 102380. https://doi.org/10.1016/j.ijer.2024.102380

Pratama, W. C., Rahman, E. F., Junaeti, E., Piantari, E., & Muntaharridwan, P. (2023). Implementation of VAK model in interactive learning multimedia based on snakes and ladders game. *AIP Conference Proceedings, 2734*(1). https://doi.org/10.1063/5.0123456

Roberts, L., & Patel, D. (2021). Environmental literacy as a driver for sustainable citizenship: A review of recent practices. *Environmental Education Research, 27*(6), 783–799.

Roberts, T., & Davis, R. (2023). Digital acceleration and environmental awareness during the COVID-19 pandemic. *International Journal of Educational Reform, 32*(4), 203–218.

Sani, M., Yusof, N., & Karim, R. (2020). Enhancing digital competencies across generations in Malaysian society. *Journal of Digital Literacy & Society, 7*(2), 67–78.

Senadheera, V. V., Ediriweera, D. S., & Rupasinghe, T. P. (2024). Instructional design models for digital learning in higher education: A scoping review. *Journal of Learning for Development, 11*(1), 15–26.

Sithole, V. L. (2024). Prospects and challenges to ICT adoption in rural teaching and learning. *Education Review International, 8*(1).

Smaldino, S., Lowther, D., & Russell, J. (2019). *Instructional technology and media for learning* (12th ed.). Pearson.

Sun, Y., Zhu, X., Zhou, X., Yao, B., Wang, D., Chen, J., & He, L. (2024). Who changed the destiny of rural students, and how? Unpacking ICT-mediated remote education in rural China. *arXiv*. https://arxiv.org/abs/2401.13799

Thompson, J., & Davis, R. (2023). The impact of immersive learning environments on students' digital motivation and environmental attitudes. *British Journal of Educational Technology, 54*(2), 303–320.

Yani, F., Bukit, N., & Manurung, S. R. (2020). The effectiveness of natural science modules based on guided inquiry method in elementary school learning. *Journal of Physics: Conference Series, 1485*(1). https://doi.org/10.1088/1742-6596/1485/1/012345