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A Needs Analysis for Scratch-Based Digital Media in Junior High Coding and Artificial Intelligence Education

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Abstract

The development of interactive digital learning media is essential to support coding and Artificial Intelligence (AI) education at the junior high school level. This study aims to analyze the needs for developing scratch-based interactive digital learning media that can enhance student engagement and facilitate a more practical understanding of coding and AI concepts. This research employed a qualitative descriptive approach. The subjects included an informatics teacher and eighth-grade students at a public junior high school. Data were collected through classroom observations, in-depth interviews with teachers, and an analysis of school facilities and learning conditions. The instruments used were observation sheets and interview guides that had been validated by experts. The results of the needs analysis indicate that coding and AI learning remain predominantly theoretical, lack interactive digital media support, and have not yet optimized the use of computer laboratory facilities. Both teachers and students require digital learning media that are visual, easy to use, and capable of providing project-based learning experiences. Based on these findings, the development of interactive digital learning media using Scratch is necessary to align with the characteristics of junior high school students and to support the achievement of learning competencies in coding and artificial intelligence.

Keywords: Artificial Intelligence, Coding, Digital Learning Media, Junior High School, Needs Analysis, Scratch.

1. Introduction

The development of digital technology in the 21st century demands that educational institutions equip students with new literacy competencies: data literacy, technological literacy, and human literacy (Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi, 2022). One increasingly relevant form of technological literacy is coding skills and a basic understanding of Artificial Intelligence (AI). Learning coding and AI is not only about introducing students to programming but also training them in computational thinking, problem-solving, creativity, and logical reasoning, which are essential competencies in the Merdeka Curriculum. In line with this vision, previous research by Taufiqulloh et al. (2025) emphasizes the importance of a systematic approach to analyzing students' learning strategies, which is relevant to understanding the need for digital teaching media in coding and AI learning. However, the process of teaching coding and AI at the junior high school level still faces significant challenges. In many schools, learning remains theoretical, lacking interactive digital teaching media, and rarely offers project-based learning experiences (Purnama, 2020; Wahyudi, 2023). This situation makes it difficult for students to grasp abstract concepts such as algorithms, programming logic, and the basic workings of AI. On the other hand, available computer laboratory facilities in schools are not yet optimized to support hands-on learning.

The constructivist approach emphasizes that knowledge is actively built by students through real experiences (Bada, 2015). In this context, Scratch is a visual programming platform suitable for junior high school students because it uses drag-and-drop code blocks, reducing the cognitive load in understanding programming syntax (Resnick et al., 2009). This platform has great potential to be an effective learning medium, as explained in the Technological Pedagogical Content Knowledge (TPACK) framework, which integrates technology, pedagogy, and content knowledge harmoniously (Mishra & Koehler, 2006). Scratch allows students to create interactive projects such as animations, simulations, and simple games, making it highly suitable as a medium for teaching coding and introducing AI. Furthermore, according to Park and Shin (2021), Scratch extensions can be used to introduce big data and AI concepts to elementary and secondary school students, demonstrating their relevance to AI literacy goals. Despite this potential, structured, Scratch-based interactive digital teaching media tailored to the needs of students and teachers are still limited.

There exists a research gap between the potential of the Scratch platform and the availability of structured teaching media that address the contextual needs of Indonesian schools. Brennan and Resnick (2012) emphasize that developing computational thinking requires a learning environment that supports exploration, design, and testing of ideas. However, initial observations indicate that many junior high schools have not fully established such environments for coding instruction. To ensure that media development is appropriate, a needs analysis is essential as the preliminary stage of research and development. As highlighted by Batni et al. (2025), a thorough needs analysis is critical for identifying specific patterns and requirements in Scratch-based education. It serves to examine actual learning conditions, teacher and student challenges, facility readiness, and the types of teaching media needed. This study aims to address this gap by conducting a comprehensive needs analysis in junior high schools to design interactive Scratch-based media aligned with the Merdeka Curriculum and student characteristics.

A well-conducted needs analysis provides empirical data as a foundation for designing relevant and effective digital learning media. Therefore, the primary aim of this study is to describe the requirements for developing Scratch-based interactive digital learning media for coding and Artificial Intelligence (AI) education among junior high school students. The analysis was conducted through classroom observations, in-depth interviews with teachers, and a contextual study of the use of computer laboratory facilities in schools. Specifically, the operational objectives of this study include identifying the gap between actual and ideal conditions in coding and AI learning at the junior high school level, analyzing student characteristics and their readiness for digital media, examining key coding and AI concepts appropriate for junior high school students, and formulating learning objectives to guide media development. The results of this needs analysis will serve as a foundation for designing digital learning media that align with student characteristics, curriculum requirements, and school conditions, thereby contributing to the enhancement of technological literacy and computational thinking among students.

2. Literature Review

2.1. Theoretical Foundations of Digital Media and Coding Education

The integration of technology into education requires a robust theoretical framework to ensure its effectiveness. The Technological Pedagogical Content Knowledge (TPACK) model by Mishra and Koehler (2006) and Nurwinanda and Khalik (2023) provides a crucial lens, positing that meaningful technology integration occurs at the intersection of technological knowledge, pedagogical knowledge, and content knowledge. This framework is particularly relevant when designing digital learning media, as it moves beyond mere technical proficiency to consider how technology can transform teaching and learning processes for specific subjects like coding. In the context of junior high school education, a constructivist approach is highly applicable. According to Bada (2015) and Pratiwi et al. (2025), constructivism posits that learners actively construct their own understanding through experiences and reflection. This theory aligns perfectly with project-based and exploratory learning, which are central to coding education.

Digital learning media, therefore, should not be passive delivery tools but interactive platforms that facilitate construction, experimentation, and discovery. Joyce et al. (2015) and Ramadhani (2024) further support this by elaborating on various models of teaching that promote active learning, including inquiry-based and simulation models, which can be effectively mediated through digital tools. The Indonesian government's Merdeka curriculum also emphasizes competency-based learning and the development of 21st-century skills, creating a strong policy foundation for adopting such student-centered, technology-enhanced pedagogies (Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi, 2022). Ultimately, the synthesis of TPACK, constructivism, and supportive curriculum policy forms the essential theoretical bedrock for developing any digital learning media aimed at teaching complex skills like coding and AI.

2.2. Scratch as a Platform for Computational Thinking and AI Literacy

The choice of platform is critical in making coding and AI concepts accessible to young learners. Scratch, developed by the MIT Media Lab, is a visual programming language where users create programs by snapping together code blocks, eliminating syntax errors and lowering the entry barrier (Resnick et al., 2009). Its primary educational value lies in fostering Computational Thinking (CT), which Brennan and Resnick (2012) define as involving three key dimensions: computational concepts (like sequences, loops, and events), computational practices (such as testing and debugging), and computational perspectives (including expressing and connecting with others). Scratch naturally cultivates these dimensions by allowing students to design, create, and share interactive projects.

Recent research has explored its potential beyond basic coding. Park and Shin (2021) developed a Scratch extension called "Tooee" to teach big data and AI concepts using text-based visual blocks, demonstrating that Scratch's adaptable architecture can be extended for advanced topics. Similarly, empirical studies confirm its effectiveness. Panjaitan and Simanjutak (2021) found that interactive learning media using Scratch significantly improved students' computational thinking skills. Further supporting evidence comes from Mahdiyah et al. (2025), who reported improved understanding of algorithms and learning outcomes through Scratch-based media, and from Berlian et al. (2024), who highlighted its role in improving scientific literacy and CT in primary education. A comprehensive systematic review by Batni et al. (2025) on current research trends in Scratch-based programming for K-12 underscores its widespread adoption and positive impact across various educational contexts and subjects, confirming its established position as a versatile and effective pedagogical tool for foundational digital literacy.

2.3. Gaps in Contextual Media Development and Needs Analysis

Despite the proven potential of Scratch and the clear theoretical rationale for its use, a significant gap exists between its general capabilities and the availability of structured, context-specific digital learning media tailored for the Indonesian junior high school classroom. Many studies focus on the platform's general efficacy or its application in specific project-based interventions. For instance, Purnama (2020) extensively reviewed the benefits of project-based learning for creativity and problem-solving, and Thomas (2000) provided an early, broad review of project-based learning research. However, as noted by Wahyudi (2023) in his analysis of digital media development needs for 21st-century learning, a common shortfall is the lack of a thorough needs analysis conducted prior to development. This initial stage is crucial for ensuring the final product is relevant, usable, and addresses real classroom challenges. A needs analysis systematically investigates the learning environment, user characteristics, task requirements, and contextual constraints.

Miles et al. (2014) and Creswell and Creswell (2018) provide robust methodological frameworks for such qualitative inquiry, emphasizing processes like data reduction, display, and conclusion drawing. Without this foundational step, developed media risk being misaligned with local curriculum goals, student readiness levels, or the available technological infrastructure in schools. Studies like that of Nurhalizah and Jayanti (2023), who developed Scratch-based media for biology topics, show successful subject-specific application, but also highlight the necessity of a tailored design process. Furthermore, while the infrastructure study by Bakri et al. (2022) discusses school facility management, their connection to the pedagogical integration of specific digital tools like Scratch remains underexplored. Therefore, this literature review identifies a clear need: to bridge the gap between the generic potential of Scratch and the specific requirements of Indonesian junior high schools teaching coding and AI by first conducting a detailed, multi-faceted needs analysis, which this present study aims to undertake.

3. Methods

This study employed a qualitative research method with a descriptive approach to provide a comprehensive picture of the needs for developing Scratch-based interactive digital learning media for coding and Artificial Intelligence (AI) instruction in junior high schools. This design was chosen because it allows for an in-depth exploration of phenomena within their natural setting, focusing on understanding participants' experiences, perspectives, and the contextual conditions of the learning environment (Creswell & Creswell, 2018; Yin, 2018). The research subjects consisted of an Informatics teacher and eighth-grade students from a public junior high school within the Komwil 5 Tegal Region. The selection of participants was conducted using a purposive sampling technique, where subjects were chosen based on specific criteria: direct involvement in the teaching and learning process of coding or AI-related topics, and accessibility for in-depth data collection. This approach ensures that the data gathered comes from informants who are most relevant to the research problem (Fraenkel et al., 2019).

Data collection was carried out using a triangulation strategy, combining multiple sources and methods to enhance the validity and depth of findings. The primary techniques included classroom observations in the computer laboratory, in-depth interviews with the Informatics teacher, and a documentation study of learning materials, lesson plans, and the condition of school facilities and infrastructure. The observation sessions focused on capturing the dynamics of ongoing learning, student interactions with technology, and the utilization of existing media. Simultaneously, semi-structured interviews were conducted with the teacher to explore challenges, expectations, and perceived needs regarding digital media for coding and AI. The research instruments comprised observation sheets and interview guidelines, which were first validated by experts in educational technology and pedagogy to ensure their content validity and appropriateness for the research objectives (Sugiyono, 2022).

To ensure the trustworthiness (credibility) of the data, several verification procedures were rigorously implemented throughout the study. Method triangulation was applied by cross-checking information from observations, interviews, and documents. Source triangulation was conducted by comparing insights from the teacher with those from students. Furthermore, a member check was performed by presenting preliminary findings to the participating teacher for feedback and confirmation, and peer debriefing sessions were held with fellow researchers to scrutinize the analysis process and interpretations. Data analysis followed the interactive model by Miles et al. (2014), which consists of three concurrent flows of activity: data reduction, data display, and conclusion drawing/verification. This systematic process involved condensing the raw data, organizing it into structured formats like matrices and narrative texts, and continuously verifying emerging themes against the original data to build a coherent and well-supported description of the needs for digital learning media development.

4. Results

4.1. Analysis of the Learning Environment and Student Characteristics

The initial analysis focused on understanding the existing conditions of the learning environment and the profile of the student users. The findings reveal a significant gap between the ideal learning scenario envisioned by the curriculum and the current, predominantly theoretical, implementation. Classroom observations confirmed that while basic computer facilities were available and functional, their use was limited to simple tasks like typing or internet browsing, rather than for immersive coding practice. This underutilization of infrastructure aligns with broader administrative challenges noted in school management literature. For instance, studies on School Operational Assistance (SOA) grants, such as those by Abdullah et al. (2022) and Bakri et al. (2022), highlight that effective facility management is crucial for supporting innovative learning, yet operational hurdles often prevent optimal use. In this context, the computer lab existed as an under-leveraged asset rather than a dynamic learning studio.

A deeper dive into student characteristics was essential to design media that aligns with their cognitive and motivational states (Rianawati et al., 2024). As summarized in Table 1, the analysis combined observational data and teacher interviews to build a composite profile of the eighth-grade students. The table illustrates a cohort with varied basic ICT skills but almost no prior coding experience, high interest in digital and visual learning, and a dominant reliance on visual and kinesthetic learning styles. This profile strongly indicates that students are at a concrete operational to early formal operational stage, requiring learning tools that are highly visual, interactive, and manipulative to bridge abstract concepts. The teacher consistently reported that students showed markedly higher engagement and curiosity when presented with digital animations or exploratory tasks, yet they still required step-by-step guidance when attempting new technology-based activities. This combination of high interest and low self-guided proficiency underscores the need for scaffolded, project-based digital media that can provide both inspiration and structured support.

Table 1. Student Analysis Results Based on Observation and Interview

Aspect Analyzed	Observation Results	Interview Results
Basic ICT Skills	Most students could perform basic computer operations (login, open applications, type), but were slow in menu navigation.	The teacher stated that students' ICT skills varied, with about 30–40% still needing intensive guidance.
Coding Experience	The majority of students had never used any coding platform, including Scratch.	The teacher stated that coding learning was not yet integrated into regular learning activities, but was only briefly introduced in extracurricular sessions.
Interest in Digital Learning	Students looked enthusiastic when shown examples of digital teaching media and showed high curiosity.	The teacher confirmed that students liked learning involving visuals, animations, and exploratory activities.
Readiness for Independent Learning	Students still needed step-by-step guidance when trying new technology-based activities.	The teacher conveyed that students would learn more easily if provided with practical, project-based guides.
Dominant Learning Style	Students were more responsive to visual displays like moving images, color, and audio.	The teacher stated that project-based and hands-on practical approaches were more effective than lectures.
Device & Internet Access	The computer laboratory was available and functioning well; all students had their own computers.	The teacher conveyed that school facilities supported the optimal use of interactive digital media.

Furthermore, the analysis of the school's contextual readiness, beyond just hardware, revealed important nuances. While physical access to devices was not a barrier, the pedagogical integration of these tools was. This echoes findings from Syamsuddin et al. (2023), who studied the influence of digital applications on ICT learning performance, emphasizing that the mere presence of technology does not guarantee learning gains; its pedagogical design and integration are paramount. The teacher expressed a strong desire for ready-to-use, curriculum-aligned digital resources that could reduce the burden of creating interactive content from scratch and allow more focus on facilitating student exploration. Therefore, the required media must not only be student-friendly but also teacher-friendly, serving as a practical bridge between curriculum goals and engaging classroom practice.

4.2. Analysis of Learning Concepts, Tasks, and Formulated Objectives

Building on the understanding of the users and context, the next phase of the needs analysis dissected the specific conceptual content and practical tasks that the learning media must address. Document analysis of the informatics module and in-depth discussion with the teacher identified several core concepts that students find challenging. These key concepts include fundamental programming logic such as algorithms, sequencing, loops (iteration), conditional statements (if/else), event handling, and basic AI principles like data patterns and simple decision-making. The teacher highlighted that students often struggle with logical flow and abstract procedures because these concepts are typically presented statically through text or diagrams, without dynamic visualization. This gap between abstract logic and concrete understanding is a central problem that interactive media must solve (Nafiati, 2011).

The task analysis further broke down the competencies students need to demonstrate into manageable learning activities. Observations in the computer lab showed that students were unfamiliar with the process of designing an algorithm, structuring command sequences, or building a simple digital project from start to finish. This lack of procedural experience points to a need for media that structures complex coding projects into smaller, sequential tasks. Scratch inherently supports this through its block-based interface, allowing tasks to be decomposed into activities like selecting and customizing sprites, designing motion sequences, setting conditional triggers, and creating logical systems for simple games or stories. The analysis confirmed that students require a digital guide that provides not just final examples but incremental, step-by-step scaffolding that helps them understand the "how" and "why" behind each step in the coding process, thereby building both skill and confidence (Mazlan et al., 2023).

Synthesizing the findings from the environmental, learner, conceptual, and task analyses allowed for the precise formulation of learning objectives that will directly guide the media's design. These objectives were crafted to be specific, achievable, and aligned with both the Merdeka Curriculum's competencies and the identified student needs. The primary objectives are that students can understand basic algorithm concepts and programming logic through interactive visualization, create simple coding projects using Scratch by following structured, project-based guides, apply concepts of loops, conditionals, and events within a digital project, and recognize simple patterns as a foundation for artificial intelligence through exploratory activities in Scratch. These objectives move beyond theoretical recall to focus on applied, constructive learning, which is essential for developing true computational thinking (Brennan & Resnick, 2012). This comprehensive needs analysis provides a clear, evidence-based blueprint. It confirms the necessity for a visually rich, step-by-step, and project-based interactive digital medium built on Scratch, designed to translate abstract coding and AI concepts into tangible, engaging learning experiences for junior high school students.

5. Discussion

The findings from this needs analysis paint a clear picture: while the necessity for coding and AI literacy in junior high schools is firmly established by policy Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi (2022), the translational gap between curriculum intent and classroom reality is significant. This study's results strongly resonate with and extend the existing body of literature on digital learning and computational thinking. The observed dominance of theoretical instruction and underutilized computer labs directly aligns with the challenges identified by Wahyudi (2023), who highlighted the frequent mismatch between 21st-century learning goals and the available, yet inadequately leveraged, digital tools in schools. This gap is not merely technological but pedagogical, underscoring the critical importance of the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006). The teachers' expressed need for media that can visualize abstract concepts suggests a gap at the intersection of technological knowledge (how to use Scratch) and pedagogical content knowledge (how to effectively teach programming logic). Therefore, the proposed Scratch-based media must serve as a bridge, explicitly designed to strengthen this TPACK nexus for educators.

The detailed profile of students, showing high interest in digital projects but low prior experience and a need for structured guidance, offers crucial design imperatives. This profile validates the choice of Scratch as the foundational platform. As Resnick et al. (2009) argued, Scratch lowers barriers by removing syntax frustration, allowing learners to focus on logical thinking and creativity. Our findings confirm that this is essential for our target group. Furthermore, the students' dominant visual and kinesthetic learning styles, coupled with their stage of cognitive development, demand a constructivist learning environment. As Bada (2015) explained, knowledge is actively constructed through experience. A well-designed interactive media based on Scratch can provide precisely this environment: a digital sandbox for exploration, experimentation, and the construction of personal, meaningful projects like animations or simple games, thereby moving from passive reception to active creation.

The analysis of core concepts and tasks further clarifies the specific role the media must play. The difficulty students face with algorithms, loops, and conditionals is a well-documented hurdle in introductory programming. The proposed media's function to visualize and scaffold these concepts is supported by research on worked examples and cognitive load theory. For instance, the step-by-step, project-based guide derived from our task analysis aligns with effective instructional strategies for complex skill acquisition. Moreover, the aim to introduce basic AI patterns through Scratch finds precedent in innovative extensions of the platform. Park and Shin (2021) demonstrated that Scratch's block-based environment could be extended to teach AI concepts effectively, proving that the platform's simplicity does not preclude engagement with advanced topics. Our study's contribution is in contextualizing this potential, defining the exact conceptual stepping stones (like pattern recognition in data) that are appropriate for the Indonesian junior high school level within the Merdeka Curriculum.

Finally, the identified need for structured, sequential guidance within a project-based framework connects deeply to established pedagogies. Project-Based Learning (PBL) has long been championed for fostering deeper understanding, creativity, and problem-solving skills (Thomas, 2000; Purnama, 2020). The teachers' and students' readiness for this approach, as indicated in our results, suggests that the media should not be a collection of isolated exercises but a coherent journey through progressively challenging projects. Each project would serve as a vehicle to practice and integrate the computational concepts outlined by Brennan and Resnick (2012), moving from basic sequences to incorporating conditions and events. This approach can transform the computer lab from a room of underused machines into a vibrant workshop for computational creation, addressing the facility utilization gap noted alongside administrative studies like those of Bakri et al. (2022).

The needs analysis has two main implications for development and practice. For development, Scratch-based media should be highly visual, interactive, and scaffolded with clear, incremental guides, integrating coding and introductory AI in hands-on activities for diverse ICT skill levels. For practice, teachers need professional development to shift from traditional instruction to facilitation in a PBL environment using digital tools. Proper implementation can boost student engagement, make abstract concepts tangible, and support computational thinking skills aligned with the Merdeka Curriculum, preparing students for the digital era.

5. Conclusion

Based on the results of a comprehensive needs analysis through observation, interviews, and document studies in the junior high school environment, it can be concluded that the development of interactive digital teaching media based on Scratch is an urgent and relevant need to support coding and artificial intelligence learning. The research findings reveal a clear gap between the demands of the Merdeka Curriculum, which emphasizes computational thinking, and the actual learning conditions, which are still dominated by theoretical approaches with minimal supportive media. The analysis of student characteristics reveals a high potential for interest in visual and project-based learning, but this is accompanied by the need for structured and step-by-step guidance. The adequate readiness of school facilities further strengthens the argument that what is currently needed is not merely the availability of technology, but learning media that can transform that technology into meaningful, concrete learning experiences appropriate to the students' level of cognitive development.

The implication of this research is the need to prioritize developing teaching media that are visual, interactive, and project-oriented, using the Scratch platform as a foundation. However, this study has several limitations, including a geographical scope limited to one region and a focus only on the needs analysis stage, it has not yet tested the effectiveness of the developed media. For future research, it is recommended to replicate the needs analysis in more diverse regions and school levels to enrich contextual findings. The next crucial step is to design and develop a media prototype based on this blueprint, and then test its validity, practicality, and effectiveness through experimental research and development. Another suggestion is to explore a deeper integration of artificial intelligence aspects within Scratch projects, as well as develop accompanying training modules for teachers to ensure optimal implementation in the classroom.

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The data that support the findings of this study are available from the corresponding author upon reasonable request.