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Bridging the Digital Divide in Elementary Science Education: A Needs Analysis for Developmentally Appropriate E-Learning Media

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Abstract
The integration of technology-enhanced learning in elementary education remains challenging due to limited developmentally appropriate digital media. This study examines stakeholder needs for GlideApps-based e-learning development in elementary IPAS education, specifically for the five senses topic. A convergent parallel mixed-methods design was employed, collecting data from 608 fifth-grade students and 32 teachers across 18 elementary schools in Jejawi District through validated questionnaires utilizing five-point Likert scales. Data were analyzed using descriptive percentages and thematic analysis across six dimensions: pedagogical, technical, cognitive, aesthetic, sociocultural, and evaluative. All stakeholder groups demonstrated high needs (79-91%), with evaluation aspects achieving the highest priority (91.10%), followed by cognitive support (87.20%) and aesthetic design (86.60%). Students exhibited holistic need patterns with minimal variance across dimensions (2.4 percentage points), while teachers prioritized cognitive aspects (85.38%). Sociocultural integration, though still needed (79.30%), ranked relatively lower across all groups. Findings reveal that elementary learners approach technology-mediated learning more holistically than older students, requiring balanced attention to evaluation systems, multimedia content, visual appeal, technical accessibility, pedagogical alignment, and cultural relevance. The study provides a replicable framework for needs analysis in elementary educational technology contexts and offers evidence-based priorities for developing interactive digital learning media that authentically serve elementary students' developmental characteristics while supporting Indonesian science education goals.

INTRODUCTION

The rapid advancement of information and communication technology (ICT) has fundamentally transformed educational paradigms, reshaping both pedagogical approaches and the instructional media employed in contemporary learning environments (Fonseca & García-Peñalvo, 2019; Lawrence & Tar, 2018). In this digital era, e-learning has emerged as a strategic alternative to enhance the effectiveness and flexibility of educational processes, particularly in fostering active and independent student engagement (El-Sabagh, 2021; Hwang et al., 2015; Katawazai, 2021). The integration of technology into instructional practices has become an indispensable component of 21st-century education, wherein learners are expected to develop critical thinking, communication, collaboration, and creativity competencies (Abrami et al., 2015; Care et al., 2020; Thornhill-Miller et al., 2023). However, despite the recognized potential of e-learning, its implementation at the elementary school level continues to encounter substantial challenges, including the limited availability of developmentally appropriate learning media and insufficient technological integration in teaching and learning activities (Cavus et al., 2021; Hew & Brush, 2007; Inan & Lowther, 2010; So et al., 2019).

Within the framework of Indonesia's Merdeka Curriculum, educational practices are oriented toward holistic competency development through contextual and project-based learning approaches (Agung, 2025). One of the subjects that embody these principles is IPAS (Integrated Natural and Social Sciences), which aims to cultivate students' understanding of the interconnections between natural and social phenomena in their immediate environment (Suru & Septiliana, 2023). The five senses topic, a fundamental component of IPAS curriculum, holds particular relevance as it directly relates to students' experiential reality and requires multisensory engagement and concrete visualization (Dimopoulos et al., 2003; Lehrer & Schauble, 2000). Consequently, effective IPAS instruction necessitates engaging, interactive pedagogical approaches that align with children's cognitive developmental stages (Kusmiati et al., 2023). Nevertheless, current instructional practices in elementary schools remain predominantly teacher-centered and conventional, thereby limiting opportunities for deeper conceptual exploration and comprehension (Borba et al., 2016; Tang, 2023).

Existing literature acknowledges that learning effectiveness is significantly influenced by the availability of instructional resources that correspond to students' developmental needs and content characteristics (Chisunum & Nwadiokwu, 2024; Pane et al., 2017). This recognition has prompted calls for innovation in digital learning media to create meaningful, visual, and contextual learning experiences (Kelly et al., 2010; Linn et al., 2006; Mason et al., 2013; Raharjo & Safitri, 2024; Ryoo & Linn, 2012). GlideApps, a web-based platform enabling the development of interactive e-learning applications without programming expertise, represents a promising technological solution (Agustina et al., 2025). This platform offers accessible features for creating engaging educational applications that can be readily accessed via mobile devices and customized according to learners' specific requirements (Fitriana et al., 2024; Mutmainna et al., 2024). Despite these affordances, a critical knowledge gap persists regarding the specific needs and requirements of elementary school stakeholders—students, teachers, and institutional contexts—for GlideApps-based e-learning implementation in IPAS instruction (Aldabbus, 2018; Budiarto et al., 2024; Zuo et al., 2021).

Previous studies have demonstrated the effectiveness of various digital learning platforms in elementary education contexts and the importance of interactive visualizations in science learning (Al-Balushi et al., 2017; Pallant et al., 2025; Saraç & Şekerci, 2018). However, research examining comprehensive needs analysis prior to e-learning development, particularly for GlideApps-based applications in IPAS instruction, remains limited. While existing literature has explored general e-learning adoption challenges and the importance of instructional media alignment with learner characteristics (Adeoye et al., 2024; Dick et al., 2015; Morrison et al., 2019; Rothwell & Kazanas, 2015), few studies have systematically investigated the multidimensional needs encompassing pedagogical, technical, cognitive, aesthetic, sociocultural, and evaluative aspects from the perspectives of both teachers and students simultaneously.

The present study addresses this knowledge gap by conducting a comprehensive needs analysis to inform the development of GlideApps-based e-learning for the five senses topic in elementary IPAS education. This investigation is justified by several considerations. First, systematic needs analysis constitutes an essential foundational step in instructional design, ensuring that developed media align with authentic field conditions and stakeholder requirements. Second, the increasing emphasis on technology-enhanced learning in Indonesian elementary education necessitates empirical evidence regarding specific pedagogical and technical requirements for successful implementation (Ertmer et al., 2012; Jakubek, 2023; Ottenbreit-Leftwich et al., 2010). Third, understanding stakeholder needs across multiple dimensions will enable the development of e-learning media that effectively bridges the gap between technological capabilities and elementary-level learning characteristics (Bedenlier et al., 2020; Haleem et al., 2022).

The primary objective of this research is to analyze user needs regarding the development of GlideApps-based e-learning for IPAS instruction in elementary schools, specifically focusing on the five senses material. The significance of this study lies in its potential to provide empirical foundations for designing relevant and effective digital learning media that can enhance student engagement,

strengthen conceptual understanding, and support independent learning (Lei et al., 2018; Sergis et al., 2018; Yu et al., 2021). Furthermore, this research contributes to educational technology literature by offering a systematic framework for needs analysis in e-learning development, enabling contextual, engaging, and meaningful IPAS learning experiences that align with contemporary educational imperatives while respecting the distinctive characteristics of elementary education (Fatimah, 2024; Rahmani et al., 2025).

METHODS

This study employed a convergent parallel mixed-methods research design (Creswell & Plano Clark, 2018; Schoonenboom & Johnson, 2017), combining quantitative and qualitative approaches to obtain comprehensive understanding of stakeholder needs regarding GlideApps-based e-learning development. This design was selected because it enables triangulation of data from multiple sources, providing a more complete picture of the phenomenon under investigation than either method alone (Johnson & Onwuegbuzie, 2004; Wisdom & Creswell, 2013). In convergent designs, both quantitative and qualitative data are collected concurrently and analyzed independently before being integrated during the interpretation phase to validate findings and enhance credibility (Fetters et al., 2013). The quantitative component measured the magnitude of needs through numerical analysis and percentage calculations, while the qualitative component explored patterns and tendencies in respondents' narrative answers to provide contextual depth and explanatory insights.

The research population comprised fifth-grade students and teachers from elementary schools in Jejawi District. The target population included 28 elementary schools, from which 18 schools were selected through random sampling to ensure equal representation and minimize selection bias (Creswell, 2012). The sample consisted of 608 students and 32 teachers, determined using Slovin's formula with a 95% confidence level and 5% margin of error (Ryan, 2013; Yamane, 1967). This formula was deemed appropriate for this exploratory needs analysis as it provides a practical method for determining adequate sample size when population parameters are known but detailed variability information is limited (Guilford & Frucher, 1973). The relatively large sample size ensured sufficient statistical power to detect meaningful patterns in stakeholder needs across the six dimensions examined (pedagogical, technical, cognitive, aesthetic, sociocultural, and evaluative).

Data were collected through an online questionnaire distributed via Google Forms, a method chosen for its efficiency in reaching geographically dispersed respondents, reducing data entry errors, and facilitating rapid data compilation (Wright, 2005). The instrument utilized a five-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree) to measure respondents' level of agreement with need-related statements (Kusmaryono et al., 2022). The five-point format was selected because empirical evidence demonstrates it provides optimal balance between response discrimination and reliability, with internal consistency coefficients typically ranging from 0.88 to 0.90 (Croasmun & Ostrom, 2011; Taherdoost, 2019). The questionnaire comprised three sections addressing student needs (20 items), teacher needs (19 items), and media characteristics needs (20 items), distributed across the six analytical dimensions framework for educational media evaluation.

To ensure instrument validity and reliability, a rigorous development and testing process was conducted. Content validity was established through expert review by three educational technology specialists who evaluated item relevance, clarity, and representativeness of the construct domains (Taherdoost, 2016). Face validity was assessed through cognitive interviews with five teachers and ten students to identify ambiguous wording or confusing items (Bolarinwa, 2015). Following refinement based on expert feedback and cognitive interviews, the instrument was pilot tested with 30 respondents (20 students and 10 teachers) from schools not included in the main study. Reliability analysis using Cronbach's alpha coefficient yielded values above 0.80 for all six dimensions, indicating strong internal consistency and confirming that items within each dimension measured cohesive constructs (Tavakol & Dennick, 2011). Cronbach's alpha is widely recognized as the most appropriate

reliability measure for Likert-scale instruments, with values above 0.70 considered acceptable and values above 0.80 indicating good reliability (Gliem & Gliem, 2003).

Quantitative data analysis employed descriptive statistics, specifically percentage calculations to determine need levels for each dimension and respondent category. Raw scores from all respondents were summed and converted to percentages using the formula: Percentage = (Total Score / Maximum Possible Score) × 100%. The resulting percentages were then interpreted using predetermined criteria: 76-100% (Very Needed), 51-75% (Needed), 26-50% (Less Needed), and 0-25% (Not Needed). This percentage-based categorization provides clear, actionable benchmarks for decision-making in media development (Arikunto, 2013). Qualitative data from open-ended questionnaire responses were analyzed thematically to identify recurring patterns, explanations for quantitative findings, and contextual factors influencing needs (Braun & Clarke, 2006). The integration of quantitative and qualitative findings occurred during the interpretation stage, where qualitative insights were used to explain, contextualize, and enrich quantitative patterns—a hallmark of convergent mixed-methods designs (Creswell & Plano Clark, 2018). This analytical approach enabled identification of not only what stakeholders need but also why these needs exist and how they might be addressed in media development. All data collection and analysis procedures adhered to ethical research standards, including informed consent from participants, voluntary participation, confidentiality protection, and institutional approval from relevant educational authorities.

RESULTS AND DISCUSSION

Results

The needs analysis was conducted through comprehensive questionnaires administered to 608 fifth-grade students and 32 teachers across 18 elementary schools in Jejawi District. Data were analyzed using descriptive percentages to determine stakeholder needs for GlideApps-based e-learning media across six dimensions: pedagogical, technical, cognitive, aesthetic, sociocultural, and evaluative. The findings are presented sequentially for students, teachers, and learning media characteristics, followed by an integrated analysis.

Student Needs Analysis

Figure 1 presents the percentage distribution of student needs across the six analytical dimensions. The results reveal that all aspects fall within the "highly needed" category, with average percentages exceeding 84%. The aesthetic aspect obtained the highest score at 86.60%, indicating that elementary students strongly require learning media with attractive visual presentations, harmonious color combinations, and appealing interface designs. This finding suggests that visual appeal serves as a critical entry point for engaging young learners and sustaining their attention during instruction. The sociocultural aspect achieved 86.40%, demonstrating students' desire for learning materials that connect to their local environment, cultural traditions, and real-life experiences, thereby facilitating contextual learning that resonates with their daily lives.

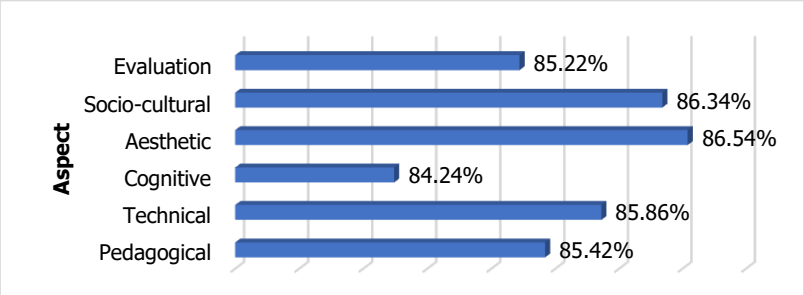


Figure 1. Student Needs Analysis Chart

The pedagogical aspect scored 86.40%, revealing that students need media capable of accommodating diverse learning styles and helping them understand IPAS concepts in enjoyable and accessible ways. Meanwhile, the technical aspect reached 85.70%, indicating students require media that are simple to operate, easily accessible, and compatible with commonly available devices, particularly Android smartphones. The evaluation aspect obtained 85.10%, illustrating students' need for interactive assessment features with varied question formats and immediate feedback mechanisms that enable them to monitor their learning progress in real time. The cognitive aspect received 84.20%, though still categorized as "highly needed," suggesting students require learning media that present meaningful content through videos, images, illustrations, and interactive activities that support deeper conceptual understanding rather than merely transmitting information passively.

An unexpected finding emerged in the relatively small variance (2.4 percentage points) across all six dimensions, suggesting that elementary students perceive these aspects as equally important rather than prioritizing certain features over others. This holistic need pattern differs from typical adult learner preferences, where technical ease often dominates other considerations, and may reflect children's integrated approach to learning experiences.

Teacher Needs Analysis

Figure 2 illustrates teacher needs across the six analytical dimensions. Results indicate that all aspects fall within the "needed" to "highly needed" categories, with percentages ranging from 81.02% to 85.38%. The cognitive aspect received the highest score at 85.38%, demonstrating that teachers prioritize media capable of presenting material clearly, supporting conceptual understanding, and strengthening students' ability to construct knowledge independently. This finding underscores teachers' recognition that effective digital media must go beyond superficial presentation to facilitate genuine cognitive engagement and meaningful learning.

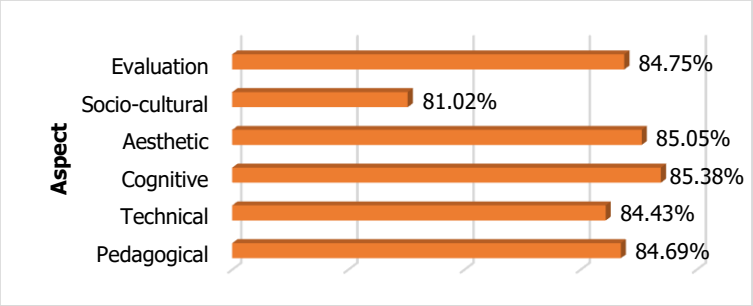


Figure 2. Teacher Needs Analysis Chart

The aesthetic aspect achieved 85.05%, revealing teachers' awareness of the importance of visually appealing media with neat, communicative interface designs that can increase student attention and engagement during learning sessions. The pedagogical aspect obtained 84.69%, indicating teachers need digital media that assist in designing effective and varied learning activities aligned with student characteristics and curriculum objectives. The evaluation aspect scored 84.75%, illustrating teachers' need for practical and efficient digital assessment systems that can provide immediate feedback to both students and teachers, thereby supporting formative assessment practices. The technical aspect received 84.43%, showing teachers require learning media that are easily accessible, user-friendly, and operable using devices commonly available in schools without requiring extensive technical expertise or specialized infrastructure.

The sociocultural aspect, while scoring lowest at 81.02%, still falls within the "needed" category, suggesting that teachers recognize the value of presenting content relevant to local contexts but may prioritize pedagogical and technical functionality over cultural integration. This finding warrants further investigation, as it contrasts with students' relatively high sociocultural needs

(86.40%) and may indicate a gap between teacher perceptions and student preferences regarding cultural relevance in learning materials.

Learning Media Needs Analysis

Figure 3 presents the comprehensive needs analysis for learning media characteristics. Results demonstrate that all aspects fall within the "needed" to "highly needed" categories, with percentages ranging from 79.30% to 91.10%. Notably, the evaluation aspect achieved the highest percentage at 91.10%, indicating an exceptionally strong need for automatic evaluation features, interactive quizzes, and instant assessment capabilities. This finding reflects stakeholders' recognition that effective digital assessment systems are crucial for providing timely feedback, reducing teacher workload, and enabling students to monitor their progress independently.

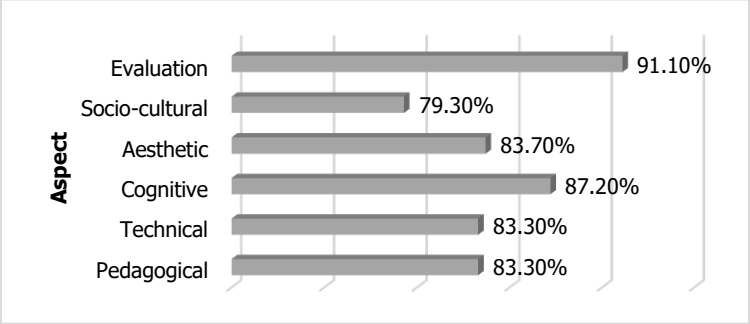


Figure 3. Learning Media Needs Analysis Chart

The cognitive aspect obtained 87.20%, reinforcing the importance of media that support conceptual understanding by presenting information accessibly and enriching content with images, animations, videos, and interactive features that help students construct meaning independently. The aesthetic aspect achieved 83.70%, confirming that visually appealing designs with harmonious color combinations, communicative icons, and well-organized content layouts significantly influence learning motivation and engagement. Both the pedagogical and technical aspects scored 83.30%, indicating balanced needs for media that are curriculum-aligned, support structured learning processes, and function practically on mobile devices such as smartphones.

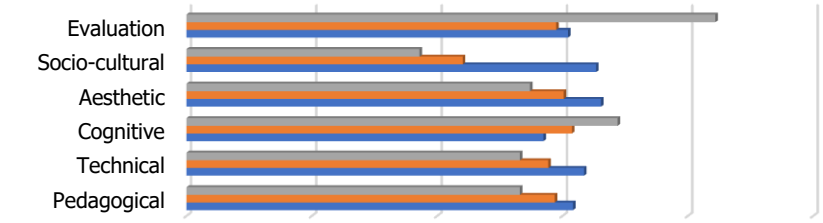
The sociocultural aspect, while receiving the lowest percentage at 79.30%, still falls within the "needed" category, suggesting that integrating local values and cultural context into learning content remains important for relevance and contextual learning, though perhaps not as urgently as evaluation and cognitive support features. This lower priority for sociocultural elements, observed across both teacher and media analyses, represents an intriguing pattern that may reflect pragmatic concerns about immediate instructional effectiveness over cultural considerations.

Overall Needs Analysis

Figure 4 synthesizes the overall needs analysis across all three respondent categories (students, teachers, and media characteristics). The integrated analysis reveals consistent patterns of high need across all dimensions, with the evaluation aspect emerging as the highest priority (averaging approximately 87%), followed by cognitive aspects (approximately 85.6%) and aesthetic aspects (approximately 85.1%). Technical and pedagogical aspects demonstrate similarly high needs (approximately 84.5%), while sociocultural aspects, despite scoring lowest (approximately 82.2%), remain firmly within the "needed" category across all stakeholder groups.

The convergence of needs across different stakeholder perspectives provides strong validation for the development of comprehensive GlideApps-based e-learning that addresses multiple dimensions simultaneously. Notably, students consistently reported slightly higher needs across most dimensions compared to teachers, suggesting that learners themselves recognize the potential of technology-enhanced learning to address their educational requirements. The universally high percentages (all

above 79%) indicate widespread readiness and enthusiasm for implementing digital learning solutions in elementary IPAS education.



	Pedagogical	Technical	Cognitive	Aesthetic	Socio-cultural	Evaluation
MEDIA	83.30%	83.30%	87.20%	83.70%	79.30%	91.10%
GURU	84.69%	84.43%	85.38%	85.05%	81.02%	84.75%
SISWA	85.42%	85.86%	84.24%	86.54%	86.34%	85.22%

Figure 4. Overall Needs Analysis for E-Learning Chart

Discussion

The findings of this comprehensive needs analysis provide robust empirical evidence that GlideApps-based e-learning development is both necessary and timely for enhancing IPAS education in elementary schools. The consistently high need levels across students, teachers, and media characteristics—all exceeding 79%—demonstrate strong stakeholder convergence regarding the value of interactive digital learning media. These results align with contemporary educational technology literature while offering context-specific insights that extend current understanding of elementary-level technology integration.

The particularly high student need for aesthetic aspects (86.60%) corroborates recent research demonstrating that visual design significantly influences elementary learners' motivation and engagement. Norman's (2004) seminal work on emotional design established that aesthetic appeal evokes positive emotional and cognitive responses, a principle subsequently validated in educational contexts by Lidwell et al. (2010) and David and Glore (2010). More recent studies have confirmed these effects specifically for elementary learners, with Katona et al. (2023) demonstrating that visual media focus student attention on subject matter, while Ghai and Tandon (2022) found that layout and visual elements motivate learners to engage with and continue web-based learning. Our finding that elementary students prioritize aesthetics higher than any other dimension (86.60%) suggests that for this age group, visual appeal serves as a critical gateway to learning engagement, potentially more so than for older learners.

However, our results offer a nuanced perspective on aesthetic design that enriches existing debates in multimedia learning theory. While Mayer's (2009) coherence principle cautions against using visuals merely for decorative purposes, our findings support the position articulated by researchers who argue that aesthetic appeal serves functional purposes in elementary education beyond simple decoration (Alsudani & Casey, 2009; Tractinsky et al., 2000). The high aesthetic needs expressed by both students (86.60%) and teachers (85.05%) suggest that in elementary contexts, attractive design is not merely cosmetic but fundamentally supports engagement and learning motivation. This finding resonates with Morrison et al.'s (2008) culturally relevant teaching framework, which emphasizes creating nurturing physical spaces where students feel motivated to perform optimally. For elementary IPAS learning, where abstract scientific concepts must be made concrete and accessible, aesthetic design may play an essential scaffolding role that Mayer's principles, developed primarily for older learners, do not fully address.

The exceptionally high need for evaluation features (91.10%) represents perhaps the most striking finding of this study and warrants careful interpretation. This result aligns with recent

literature emphasizing the critical importance of formative assessment in technology-enhanced learning environments (Black & Wiliam, 1998; Stiggins & Chappuis, 2005). However, the magnitude of this need—exceeding all other dimensions by significant margins—reveals context-specific factors that extend beyond general assessment principles. Teachers face substantial workload pressures in Indonesian elementary schools, where class sizes often exceed 30 students and administrative demands are considerable. Automatic evaluation systems promise to alleviate these burdens while simultaneously providing students with immediate feedback—a key principle of effective learning identified by Hattie and Timperley (2007). The high evaluation need may also reflect teachers' increasing awareness of digital assessment competencies as essential professional skills, as articulated in the Teacher Assessment Literacy in Digital Environments (TALiDE) framework proposed by recent research (Zhang et al., 2025).

Nevertheless, we must critically examine whether this overwhelming emphasis on evaluation features might inadvertently reinforce assessment-driven learning at the expense of exploratory, inquiry-based approaches that contemporary science education advocates promote (Pellegrino & Hilton, 2012). The challenge lies in developing evaluation systems that assess genuine conceptual understanding rather than merely testing recall—a distinction particularly crucial in IPAS education, where the five senses topic lends itself naturally to experiential, hands-on exploration rather than traditional testing formats.

The cognitive aspect's consistently high rankings across all stakeholder groups (84.20% for students, 85.38% for teachers, 87.20% for media) validates extensive research demonstrating that multimedia presentation significantly enhances science learning when properly designed (Linn et al., 2006; Ryoo & Linn, 2012). Our findings particularly resonate with studies showing that elementary students benefit substantially from interactive visualizations and concrete representations of abstract concepts (Dimopoulos et al., 2003; Lehrer & Schauble, 2000). The five senses topic, central to elementary IPAS curriculum, requires students to understand biological structures (eyes, ears, skin, tongue, nose) and their functions—concepts that benefit immensely from visual representations, animations, and interactive simulations. Al-Balushi et al.'s (2017) work on spatial ability development through scientific animations and Saraç and Şekerci's (2018) research on multimedia-assisted applications both support our finding that cognitive support through rich media is essential for elementary science education.

However, an intriguing gap emerged between the high cognitive needs expressed by teachers (85.38%) and the relatively lower cognitive needs reported by students (84.20%). This reversal—where teachers perceive greater cognitive support needs than students themselves—may indicate that teachers possess greater metacognitive awareness of learning challenges that students have not yet explicitly recognized. Alternatively, it might reflect teachers' professional emphasis on conceptual understanding over students' more immediate concerns with engagement and usability. This finding invites further qualitative research to explore the underlying reasons for this perceptual difference.

The relatively lower sociocultural needs across all groups (students 86.40%, teachers 81.02%, media 79.30%), while still within the "needed" category, presents a paradoxical finding that challenges assumptions about culturally responsive pedagogy's universal prioritization. This result contrasts with extensive literature emphasizing the importance of culturally relevant education (Gay, 2018; Ladson-Billings, 1995) and suggests that in the specific context of technology-based IPAS learning, stakeholders may prioritize functional effectiveness over cultural integration. Several interpretations merit consideration. First, the five senses topic may possess inherently universal characteristics that transcend cultural specificity, as all humans share similar sensory biology regardless of cultural background. Second, stakeholders may perceive technical and evaluative functionality as prerequisites that must be established before cultural customization can be meaningfully addressed—a sort of hierarchical need structure. Third, this finding may reflect limited awareness among stakeholders about how cultural integration might enhance learning, suggesting

opportunities for professional development that helps teachers recognize and implement culturally responsive approaches within digital environments.

Nevertheless, we must resist dismissing sociocultural needs based solely on their relative ranking, as percentages above 79% still indicate substantial stakeholder interest. Fatimah's (2024) work on contextual IPAS learning and Sergis et al.'s (2018) research on self-determination theory in flipped classrooms both emphasize that meaningful learning occurs when content connects to students' lived experiences. Future media development should investigate how sociocultural elements can be integrated seamlessly without compromising the technical and evaluative priorities that stakeholders have so clearly articulated.

The convergence of high needs across pedagogical (84-86%) and technical (83-86%) dimensions reflects a sophisticated understanding among stakeholders that effective educational technology requires both sound pedagogical design and practical usability. This finding aligns with contemporary frameworks such as the Technological Pedagogical Content Knowledge (TPACK) model (Mishra & Koehler, 2006), which emphasizes the intersection of technological, pedagogical, and content knowledge as essential for effective technology integration. Teachers' recognition that media must accommodate diverse learning styles while remaining technically accessible suggests growing digital literacy among Indonesian elementary educators, a trend documented in recent assessments of teacher digital competence (Lucas et al., 2021; Benali et al., 2018).

This study contributes to educational technology theory by demonstrating that needs analysis in elementary contexts reveals distinct patterns compared to secondary or higher education settings. The holistic, relatively undifferentiated need profile exhibited by students (variance of only 2.4 percentage points across six dimensions) suggests that elementary learners approach technology-mediated learning more integratively than older students who may demonstrate clearer functional preferences. This finding invites theoretical development regarding developmental differences in technology adoption and learning media evaluation across age groups.

For practitioners, these findings provide clear priorities for GlideApps-based media development: (1) prioritize robust, automatic evaluation systems with interactive quizzes and immediate feedback; (2) ensure high-quality visual design with attention to aesthetics, color harmony, and interface appeal; (3) incorporate rich multimedia content (videos, animations, images) that support conceptual understanding; (4) maintain technical simplicity and mobile compatibility; (5) align content with curriculum standards while accommodating diverse learning styles; and (6) integrate local cultural elements where authentic and pedagogically meaningful. The high needs expressed by both teachers and students suggest strong receptivity for implementation, reducing traditional resistance concerns often associated with educational technology adoption.

This study's limitations must be acknowledged. First, needs analysis represents only the initial phase of media development; actual usage patterns and learning outcomes require subsequent investigation through implementation research. Second, data were collected exclusively from Jejawi District, limiting generalizability to other Indonesian contexts with different infrastructure, teacher training levels, or cultural characteristics. Third, the quantitative-dominant approach, while robust for measuring need magnitudes, provides limited insight into the underlying reasons for stakeholder preferences. Future research should employ longitudinal mixed-methods designs that follow media development through implementation and evaluation phases, conduct comparative studies across diverse Indonesian contexts to identify regional variations in needs, investigate the apparent disconnect between high evaluation needs and inquiry-based learning principles to ensure assessment approaches support rather than constrain exploratory learning, explore through qualitative methods why sociocultural needs ranked relatively lower despite their theoretical importance, and examine the student-teacher gap in cognitive needs perception to better understand metacognitive awareness differences. Additionally, research investigating optimal approaches for integrating aesthetic appeal with cognitive load management in elementary contexts would address the tension between Mayer's principles and our findings regarding aesthetic importance.

CONCLUSION

This comprehensive needs analysis establishes robust empirical evidence that GlideApps-based e-learning development is both necessary and timely for enhancing IPAS education in elementary schools. The convergence of consistently high need levels across students (84-87%), teachers (81-85%), and media characteristics (79-91%) demonstrates strong stakeholder alignment regarding interactive digital learning media value. Notably, evaluation aspects emerged as the highest priority (91.10%), followed by cognitive support (87.20%) and aesthetic design (86.60%), while sociocultural integration, though still needed (79.30%), ranked relatively lower across all stakeholder groups. The study contributes theoretically by revealing that elementary learners exhibit holistic, relatively undifferentiated need patterns across six dimensions (variance of only 2.4 percentage points), contrasting with older learners' more selective preferences and suggesting developmental differences in technology adoption warrant further theoretical attention. Practically, findings provide clear development priorities: robust automatic evaluation systems, high-quality visual design, rich multimedia content supporting conceptual understanding, technical simplicity with mobile compatibility, curriculum-aligned pedagogical approaches, and authentic cultural integration. The systematic examination across pedagogical, technical, cognitive, aesthetic, sociocultural, and evaluative dimensions offers a replicable framework for elementary educational technology needs analysis. However, limitations must be acknowledged: data were collected exclusively from one district, limiting generalizability; the quantitative-dominant approach provides limited insight into underlying preference reasons; and needs analysis represents only the initial development phase requiring subsequent implementation research. Future investigations should employ longitudinal designs following media through implementation and evaluation phases, conduct comparative studies across diverse Indonesian contexts, explore the evaluation-inquiry learning tension to ensure assessments support exploratory approaches, investigate why sociocultural needs ranked lower despite theoretical importance, and examine optimal strategies for integrating aesthetic appeal with cognitive load management in elementary contexts. These findings ultimately provide evidence-based guidance for developing learning media that authentically serve elementary students' developmental characteristics while advancing technology integration in Indonesian science education.

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