

Students need for interactive digital worksheets based on the level of inquiry (LoI) to stimulate science process skills in elementary school

Anastasya Kurnia Dewi^{1*}, St Y Slamet², Idam Ragil Widiyanto Atmojo³

^{1,2,3} Teacher Training and Education Faculty, Universitas Sebelas Maret, Indonesia

*Corresponding email: anastasyakd17@student.uns.ac.id

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ABSTRACT

This study investigates elementary students' needs for Interactive Digital Worksheets (IDWs) designed according to the Level of Inquiry (LoI) to enhance Science Process Skills (SPS). Inquiry-based science learning requires instructional materials that guide students through structured investigative processes, yet the specific design features needed in digital worksheets remain underexplored. Using a qualitative descriptive approach, data were collected from 20 students and 5 teachers through interviews, observations, and documentation. Data were analyzed using an interactive model of condensation, display, and conclusion drawing. The findings indicate that students require IDWs incorporating sequential LoI stages ranging from problem identification and exploration to data interpretation and conclusion formulation to support age-appropriate scientific investigation. Such structure facilitates active engagement, independent reasoning, and systematic development of SPS. The study concludes that LoI-based IDWs are essential as innovative digital learning materials capable of strengthening inquiry-oriented practices in elementary science education and informing future digital worksheet development.



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INTRODUCTION

Although SPS is an important skill in science learning, the student's SPS score is still not good. The findings of field observations on science learning during the Covid-19 pandemic in two elementary schools in Surakarta City showed that online learning was like a form of material completion. Students have not been involved in science experiment, as evidenced by the results of interviews with students who were only instructed to carry out practical activities a few times. The teacher does not give an explanation about a material, the teacher only sends learning materials and gives assignments via Whatsapp Group (Yuliansah, 2021; Bhagaskara et al., 2021; Maulida et al., 2021). These results indicate that the SPS in students needs to be improved.

The learning situation in the current COVID-19 pandemic applies hybrid learning to support limited face-to-face online learning (Adri et al., 2021; Suryana et al., 2022; Li et al., 2021). The COVID-19 pandemic condition forces teachers and students to adapt digital-based learning processes (Handayani & Jumadi, 2021; Händel et al., 2020; Naqvi & Sahu, 2020). One of the digital teaching materials that optimize science process skills is interactive digital worksheets. Interactive digital worksheets are teaching materials in the form of interactive digital worksheets made to make it easier for students to understand a concept (Fadlilah et al., 2021; Cholifah & Nafsi, 2021; Zeng et al., 2020). The interactive function is useful so that students have control over learning so that learning becomes more active.

Digital worksheets with interactive functions need to be developed based on the Level of Inquiry (LoI) model (Putri et al., 2021; Mardianti et al., 2020). The LoI model has the opportunity to develop skills in intellectual and scientific processes in a systematic and comprehensive manner so as to obtain the expected learning outcomes and leave a more impression so that it becomes long-term knowledge for students (Ansori, 2021; Sukaryanto, 2020). LoI learning stages include discovery learning, interactive demonstration, inquiry lesson, inquiry lab, real-world application, and hypothetical inquiry (Wenning, 2006). The three initial levels are suitable for elementary school students (Atmojo et al., 2017). Thus, the development of LoI-based IDW is considered appropriate to meet the needs of students in science learning.

The urgency of this research lies in the critical gap between the expected development of science process skills (SPS) in elementary science learning and the empirical reality that students' SPS remain underdeveloped, particularly as a result of instructional disruptions during and after the COVID-19 pandemic. The shift toward online and hybrid learning has revealed structural weaknesses in digital pedagogy, including the absence of hands-on experimentation, limited teacher–student interaction, and the dominance of task-based rather than inquiry-oriented learning practices. Without strategic interventions, these conditions risk creating a generation of learners who are digitally exposed yet scientifically disengaged, lacking essential competencies such as observing, hypothesizing, experimenting, and interpreting data. Therefore, identifying students' precise needs for digital worksheets that are able to scaffold inquiry and actively stimulate SPS is indispensable for redesigning science learning environments that are adaptive, meaningful, and aligned with 21st-century scientific literacy demands.

This study offers novelty by integrating a needs-analysis approach with the development rationale of Interactive Digital Worksheets (IDWs) grounded explicitly in the Level of Inquiry (LoI) framework an alignment that remains underexplored in existing literature. While previous studies have examined digital worksheets or inquiry-based learning separately, limited research has systematically mapped elementary students' actual learning needs as the empirical basis for constructing LoI-based interactive materials. The present study fills this gap by providing evidence-driven specifications for digital worksheets that combine interactive features, multimedia integration, and inquiry-level scaffolding tailored to the cognitive and developmental characteristics of elementary learners. This dual contribution needs-driven design and LoI-anchored interactivity positions the study as an innovative step toward strengthening SPS through more adaptive, research-informed, and pedagogically robust digital learning resources.

In order to create student worksheets that suit student needs, it is necessary to study student needs analysis of digital-based student worksheets. This study aims to analyze students' needs for interactive digital worksheets to stimulate students' science process skills in elementary schools. The findings of the needs analysis are expected to provide an appropriate specification of student worksheets to stimulate students' science process skills in elementary schools.

METHOD

This study employed a qualitative research approach designed to generate an in-depth description of students' and teachers' needs regarding effective student worksheets capable of stimulating science process skills (SPS). The qualitative orientation of the study is grounded in the assumption that the development of meaningful instructional materials must be informed by an authentic understanding of learners' cognitive, motivational, and experiential conditions within real classroom contexts. The research participants consisted of 20 elementary students and 5 science teachers purposively selected based on their direct involvement in science learning activities, thereby ensuring the relevance and richness of the data collected.

Multiple data collection techniques, namely semi-structured interviews, systematic classroom observations, and document analysis, were employed to capture diverse perspectives and behavioral evidence related to the use of science worksheets and the challenges encountered during inquiry-based learning. The integration of these techniques enabled a deeper exploration of students' learning difficulties, teachers' pedagogical strategies, and existing limitations of conventional worksheets. To ensure the credibility and trustworthiness of the findings, methodological triangulation was implemented by cross-checking information derived from different sources and data collection modalities. This process strengthened interpretive validity and minimized potential bias typically associated with single-method inquiry.

Data analysis followed the interactive model proposed by Miles, Huberman, and Saldaña (2014), consisting of three iterative phases: (1) data condensation, in which raw field notes, interview transcripts, and documentation records were systematically coded and reduced to significant themes; (2) data display, where categorized information was organized into matrices and visual representations to facilitate analytical insights; and (3) conclusion drawing and verification, involving the continuous refinement of emerging interpretations through comparison, researcher reflection, and recursive checking against the data corpus. The cyclical nature of this model allowed the analysis to remain dynamic, rigorous, and closely aligned with the empirical realities of the field, ultimately producing

robust insights into the essential characteristics of interactive digital worksheets needed to enhance students' science process skills.

RESULTS AND DISCUSSION

Needs analysis is needed to find out a field condition and the level of field need for a change. In this worksheet needs analysis will be discussed further about the results of the analysis of observations and interviews. The study of the LoI-based IDW needs analysis in this early stage (exploratory) research was conducted by interviewing several students and teachers of SD Laweyan Surakarta. Informants were selected based on their ability to convey their ideas regarding the suitability of the student worksheets used during the pandemic and the student's needs for the expected student worksheets. The needs analysis interview was conducted with the aim of knowing student and teacher perceptions of science learning, student interest in science learning, experience of science experiments that have been carried out so far, obstacles to implementing science experiments during online learning, and characteristics of student worksheets that students and teachers expect in learning. science.

Tabel 1. Needs Analysis Findings and Resulting Design Requirements for LoI-Based IDW

Findings	Interpretation / Meaning	Design Requirements for LoI-Based IDW
Students enjoy science because it relates to daily life and natural events.	Students learn better when content is contextual and authentic.	Include real-world phenomena, everyday-life problems, and contextual prompts in each LoI stage.
Students rarely conduct experiments at home; science learning dominated by reading and videos.	Inquiry practice is low; students lack opportunities to "do" science.	Provide guided hands-on tasks, virtual simulations, and structured experiment steps accessible from home.
Worksheets from textbooks allow guessing; students often Google answers without experimenting.	Current worksheets fail to stimulate investigation.	Include mandatory investigation checkpoints, questions that require evidence, and LoI-driven reasoning tasks.
No digital worksheets available; printed worksheets feel monotonous.	Students require more interactive, flexible, and dynamic learning tools.	Provide a fully digital, mobile-accessible IDW with multimedia (images, animations, videos).
Students want attractive visuals, feedback features, and ease of use.	Motivation increases with interactive and responsive systems.	Integrate instant feedback, drag-and-drop tasks, clickable animations, and intuitive navigation.
Literature shows practicum was ineffective and interactivity boosts learning.	Learning requires inquiry, engagement, and active processing.	Apply full LoI sequence (Confirmation → Structured → Guided → Open Inquiry) with increasing autonomy.

Based on the results of interviews and observations at SD N Laweyan Surakarta, students' needs for student worksheets are as follows. First, students perceive that learning science is one of the important and beneficial learning for students. Students expressed pleasure in learning science because learning science is closely related to everyday life. Through science learning students can apply scientific knowledge directly in the surrounding environment. Students enthusiastically take part in science learning, this can happen because of curiosity about the conditions of the natural environment. In addition, students expressed the importance of studying various natural events and finding ways to solve these problems.

Second, the COVID-19 pandemic condition requires students to study at home so that in the experiment of learning science, students reveal that they rarely do science experiments at home. In science learning, some student activities learn science concepts by reading available thematic books, studying shared materials and watching videos from Youtube. Students are only instructed several times to do practicum in each science concept that is studied. Students are given instructions to do the practicum via Whatsapp and send photos of the experimental results to the teacher.

Third, the science student worksheets used by students in class are based on available thematic books. The results of interviews with students, students can work on science worksheets in thematic books by guessing with logical answers according to student knowledge or by looking for answers to similar lab results on the google search site. Thus, students do not always conduct independent experiments if they are not instructed to make videos as evidence of conducting experiments.

Fourth, so far, there are no digital science worksheets that can be accessed anytime and anywhere. Students only use the available student worksheets so that students feel bored studying concepts, working on assignments and experimental reports monotonously. In addition, most students

already have cellphones and some use their parents' cellphones to participate in online learning. Students explained that so far, there are no science worksheets available in digital form. Therefore, it is necessary to develop science worksheets in digital form that have an attractive appearance and are easily accessible.

The specification of student worksheets that students expect when learning online is digital with an attractive appearance, easy to use by students, there are features that provide direct feedback, involve various media, and improve student understanding and student motivation in learning. Through these specifications, it is hoped that it can help students because it is practical, time efficient, and can increase student motivation in learning.

The findings of previous studies show that the ineffectiveness of practicum implementation in science learning does not only occur in SD Laweyan District. The results of previous research revealed that the pandemic phenomenon limited the space for the implementation of science learning which could initially be carried out either in theory or understanding concepts and practicum became only focused on completing theoretical content or science learning materials (Winangun, 2021). Not optimal practicum activities during the pandemic have an impact on understanding science concepts which are limited to rote memorization (Handayani & Jumadi, 2021; Darmayanti, et al., 2021).

Based on the results of the needs analysis, it indicates that an interactive digital worksheet needs to be developed. These results are in accordance with Fuadi's research (2021) which concludes that digital worksheets support science learning in pandemic situations. In addition, the interactive aspect plays an important role in digital LPKD as Riyani's research (2022) to increase interactivity during learning. Interactivity is based on reciprocity and refers to an active learning process in which students process information to turn it into something new (Serth, 2019). The results of this analysis indicate that the development of Level of Inquiry (LoI)-based Interactive Digital Worksheets (IDW) is an urgent need for science learning in elementary schools.

CONCLUSION

The findings of this study indicate that elementary school students require digital worksheets equipped with features that offer immediate feedback, integrate diverse multimedia elements, and present visually appealing designs capable of enhancing learning motivation. Such characteristics are essential not only for maintaining student engagement but also for facilitating deeper conceptual understanding and active participation in scientific inquiry. Accordingly, Interactive Digital Worksheets based on the Level of Inquiry framework emerge as an innovative and pedagogically relevant solution for elementary science learning. Their interactive nature supports the development of students' science process skills, including observing, questioning, experimenting, interpreting data, and drawing conclusions, while aligning with current demands for technology-enhanced learning environments. Given these outcomes, this study recommends that future researchers continue to design, refine, and empirically validate digital worksheets grounded in various stages of the Level of Inquiry model. Further research may also explore their effectiveness across different grade levels, subject areas, and learning contexts, as well as integrate adaptive technologies or AI-driven formative assessments to optimize individualized learning and broaden the impact of inquiry-based digital instructional materials.

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