http://dx.doi.org/10.18623/rvd.v23.4621

DIGITAL SCAFFOLDING FOR ANALYTICAL THINKING: DEVELOPING A SOCIAL RESEARCH ASSISTANT APPLICATION FOR HIGH SCHOOL SOCIAL STUDIES LEARNING

ESTRUTURA DIGITAL PARA O PENSAMENTO ANALÍTICO: DESENVOLVIMENTO DE UM APLICATIVO DE ASSISTÊNCIA À PESQUISA SOCIAL PARA O ENSINO DE ESTUDOS SOCIAIS NO ENSINO MÉDIO

Article received on: 1/9/2026
Article accepted on: 4/7/2026

Nana Tri Sutisna*
***Universitas Sebelas Maret, Surakarta, Indonesia
nanasutisna@student.uns.ac.id

Triana Rejekiningsih*
***Universitas Sebelas Maret, Surakarta, Indonesia
triana_rizq@staff.uns.ac.id

Moh. Muchtarom*
***Universitas Sebelas Maret, Surakarta, Indonesia
muhtarom1974@staff.uns.ac.id

The authors declare that there is no conflict of interest

Abstract
The development of analytical thinking skills remains a significant challenge in social studies education, particularly in fostering students' ability to conduct systematic, evidence-based social inquiry. Analytical thinking is widely recognized as a fundamental component of higher-order thinking skills and an essential outcome of inquiry-based learning. This study aims to develop and evaluate a web-based Social Research Assistant application to enhance students' analytical thinking by implementing digital scaffolding in senior high school social studies. This study employed a Research and Development (R&D) approach encompassing several stages, including needs analysis, product design, product development, expert validation, limited field testing, and effectiveness evaluation. Data were collected using expert-validation instruments, practitioner assessment sheets, and analytical-thinking tests administered before and after the application's implementation. The findings indicate that the developed application satisfies pedagogical, technical, and practical feasibility standards. Moreover, the results demonstrate a significant improvement in students' analytical thinking skills following the implementation of the application's digital scaffolding features. The study highlights the important role of web-based digital scaffolding in guiding students through structured research processes, including problem identification, data analysis, and conclusion

Resumo
O desenvolvimento das habilidades de pensamento analítico continua sendo um desafio significativo no ensino de ciências sociais, especialmente no que diz respeito a fomentar a capacidade dos alunos de realizar investigações sociais sistemáticas e baseadas em evidências. O pensamento analítico é amplamente reconhecido como um componente fundamental das habilidades de pensamento de ordem superior e um resultado essencial da aprendizagem baseada na investigação. Este estudo tem como objetivo desenvolver e avaliar um aplicativo online chamado "Assistente de Pesquisa Social" para aprimorar o pensamento analítico dos alunos por meio da implementação de um suporte digital nas aulas de ciências sociais do ensino médio. Este estudo empregou uma abordagem de Pesquisa e Desenvolvimento (P&D) abrangendo várias etapas, incluindo análise de necessidades, projeto do produto, desenvolvimento do produto, validação por especialistas, testes de campo limitados e avaliação de eficácia. Os dados foram coletados por meio de instrumentos de validação por especialistas, fichas de avaliação de profissionais e testes de pensamento analítico aplicados antes e depois da implementação do aplicativo. Os resultados indicam que o aplicativo desenvolvido atende aos padrões de viabilidade pedagógica, técnica e prática. Além disso, os resultados demonstram uma melhoria significativa nas habilidades de pensamento

formulation. The findings further suggest that web-based instructional technologies can serve not only as content-delivery tools but also as effective cognitive support systems that facilitate the development of higher-order thinking. This study contributes to the growing body of literature on technology-enhanced social studies education by providing empirical evidence regarding the effectiveness of digital scaffolding in promoting analytical thinking skills in secondary-level sociology learning.

Keywords: Digital Scaffolding. Analytical Thinking Skills. Social Studies Education. Research-Based Learning. Web-Based Learning Application.

analítico dos alunos após a implementação dos recursos de andaimes digitais do aplicativo. O estudo destaca o importante papel dos andaimes digitais baseados na web na orientação dos alunos por meio de processos de pesquisa estruturados, incluindo identificação de problemas, análise de dados e formulação de conclusões. Os resultados sugerem ainda que as tecnologias instrucionais baseadas na web podem servir não apenas como ferramentas de entrega de conteúdo, mas também como sistemas eficazes de apoio cognitivo que facilitam o desenvolvimento do pensamento de ordem superior. Este estudo contribui para o crescente corpo de literatura sobre o ensino de estudos sociais aprimorado pela tecnologia, fornecendo evidências empíricas sobre a eficácia do suporte digital na promoção de habilidades de pensamento analítico na aprendizagem de sociologia no ensino médio.

Palavras-chave: *Suporte Digital. Habilidades de Pensamento Analítico. Ensino de Estudos Sociais. Aprendizagem baseada em Pesquisa. Aplicativo de Aprendizagem Baseado na Web.*

1 INTRODUCTION

Learning is widely understood as an experiential process that leads to changes in individuals' behavior, cognitive abilities, and ways of thinking. Rather than merely transferring information from teachers to students, learning involves cognitive, affective, and psychomotor transformations that encourage learners to construct knowledge (Sagala, 2010) actively. Within this process, analytical thinking plays a crucial role, particularly in enabling students to break complex problems into meaningful components, identify relationships among ideas, and draw logical conclusions from evidence. Analytical thinking has therefore been recognized as a fundamental component of higher-order thinking skills essential for meaningful learning in contemporary education (Anderson & Krathwohl, 2010).

Analytical thinking refers to the ability to decompose information into constituent parts, examine the relationships among those parts, and understand how they function together within a broader structure (Art-in, 2012). This cognitive process enables learners to distinguish relevant from irrelevant information, evaluate evidence, and develop

reasoned judgments. Students with strong analytical thinking skills are better equipped to solve complex problems, engage in scientific reasoning, and apply knowledge across academic and real-life contexts (Jakus & Zubcic, 2014). Moreover, analytical thinking supports metacognitive awareness and informed decision-making in uncertain situations (Paul & Elder, 2014).

Despite its importance, analytical thinking remains insufficiently developed among high school students in many educational contexts, including Indonesia. Results from large-scale international assessments indicate that Indonesian students continue to face difficulties with tasks requiring interpretation, reasoning, and the analytical processing of information (OECD, 2019). Empirical studies further reveal that only a small proportion of students demonstrate adequate analytical competence, while most remain at the level of factual recall and surface understanding (Sartika *et al*., 2020; Fadly, 2021). These findings highlight a persistent gap between curricular expectations for higher-order thinking skills and actual classroom practices.

This challenge is particularly evident in high school social studies education. Sociology, as a discipline, inherently provides opportunities for analytical learning through the examination of social phenomena, causal relationships, and data-based explanations. However, classroom practices are often dominated by teacher-centered instruction and textbook-based learning, which offer limited opportunities for systematic inquiry and structured analytical engagement. As a result, students rarely experience authentic social research activities that could foster deeper analytical thinking.

The situation is further influenced by the characteristics of Generation Z learners, who are highly familiar with digital technologies but often accustomed to consuming information instantaneously and in fragmented form (Jenkins, 2017). While their technological fluency presents opportunities for innovative learning, such habits may reduce persistence in engaging with complex analytical tasks that require sustained reflection (Frimadhina & Krisnani, 2020). Consequently, instructional strategies that fail to integrate structured cognitive guidance within digital environments may be insufficient to develop analytical thinking skills among these learners.

In the context of 21st-century education, analytical thinking is closely associated with critical thinking, which has been identified as a core competency for secondary education graduates (UNESCO, 2015; Trilling & Fadel, 2009). One pedagogical

approach with strong potential to foster analytical thinking is social research–based learning. Through processes of identifying problems, collecting data, analyzing patterns, and drawing evidence-based conclusions, students are trained to think analytically and critically (Ninn *et al*., 2015; May & Perry, 2022). However, to be effective for digital-native learners, these processes require technological support that can guide students' thinking in a structured manner.

Advances in educational technology offer promising opportunities to address this challenge. Educational technology emphasizes the systematic design of learning environments that enhance cognitive experiences, rather than merely delivering content (Januszewski & Molenda, 2008). Research indicates that technology-supported learning can enhance student engagement and higher-order thinking when it functions as cognitive scaffolding (Farisi, 2016; Ashburn & Floden, 2006). Nevertheless, there remains a lack of digital learning media specifically designed to support social research activities as digital scaffolding in high school social studies.

To address this gap, the present study develops a Social Research Assistant application that serves as digital scaffolding for analytical thinking in high school social studies. The application guides students through key stages of social research, including problem identification, data collection, analysis, and evidence-based conclusion drawing. Accordingly, this study aims to develop and examine a Social Research Assistant application as digital scaffolding to enhance high school students' analytical thinking skills.

From a theoretical perspective, scaffolding is rooted in socio-cultural learning theory, particularly the concept of the zone of proximal development, which emphasizes the role of guided support in helping learners perform tasks beyond their independent capabilities. In digital learning environments, scaffolding can be embedded through prompts, guiding questions, step-by-step procedures, feedback mechanisms, and structured task sequences. Digital scaffolding thus serves not only as instructional support but also as a cognitive tool that shapes learners' thinking processes. When appropriately designed, such scaffolding can gradually fade as learners gain greater autonomy, allowing them to internalize analytical strategies and apply them independently across learning contexts.

Although previous studies have explored the integration of technology in social studies learning, much of the existing research focuses on technology as a medium for content delivery or student engagement. Limited attention has been given to the design of digital tools that explicitly serve as scaffolding for social research processes and the development of analytical thinking at the high school level. In particular, there is a lack of research that integrates social research pedagogy, analytical thinking frameworks, and digital scaffolding principles into a single, coherent learning application. This gap indicates a need for research and development studies that not only produce educational technology products but also examine their pedagogical role in supporting higher-order thinking skills.

2 LITERATURE REVIEW

2.1 Analytical thinking in secondary education

Analytical thinking is a higher-order cognitive skill that enables learners to break down information into constituent elements, identify relationships among those elements, and construct a coherent understanding from complex data. In educational contexts, analytical thinking is widely recognized as a foundational competence for deep learning and problem-solving (Bloom, 1956; Mayer, 2002). Bloom's taxonomy positions analysis as a critical cognitive process that involves organizing, differentiating, and attributing meaning to information, thereby supporting learners' ability to engage with complex academic tasks.

Several scholars emphasize that analytical thinking does not emerge spontaneously but develops progressively as learners acquire basic cognitive competencies and are exposed to structured learning experiences (Damayanti, 2016). Analytical processes require learners to separate relevant from irrelevant information, recognize patterns, and construct logical connections, which are essential for understanding complex concepts across disciplines (Sudjana, 2013; Darmadi, 2011). From this perspective, analytical thinking serves both academic and everyday problem-solving functions, enabling individuals to respond effectively to dynamic, uncertain situations.

Empirical studies have operationalized analytical thinking through observable indicators. Istiqomah *et al*. (2015) categorize analytical thinking into three main dimensions: the ability to isolate and focus on relevant components, the ability to structure and integrate information coherently, and the ability to conclude systematic reasoning. These dimensions align with broader conceptualizations of analysis as a process of decomposing information while maintaining awareness of its overall structure (Kao, 2014).

More nuanced frameworks describe analytical thinking as a continuum of cognitive development. Zhang (2012) identifies pre-analytical stages in which learners rely on superficial attributes, while Parta (2016) describes semi-analytical reasoning characterized by incomplete or inefficient procedural steps. Complete analytical thinking, by contrast, involves the ability to differentiate, organize, and relate concepts based on logical principles and functional relationships (Ad'hiya, 2018). This framework highlights that analytical thinking is not a binary skill but a developmental process that can be systematically supported through instructional design.

In the context of secondary education, analytical thinking is particularly relevant because students at this level are transitioning into formal operational thinking, where abstract reasoning becomes increasingly prominent (Piaget, 2002). Research indicates that high school students benefit from learning environments that explicitly scaffold analytical processes, enabling them to move beyond surface-level understanding toward deeper conceptual reasoning (Sitthipon, 2012; Art-in, 2014). Consequently, instructional strategies that intentionally foster analytical thinking are essential for preparing students to engage with complex academic and real-world problems.

2.2 Digital scaffolding and multimedia learning

Digital scaffolding refers to the use of technological tools to provide structured guidance that supports learners' cognitive processes during learning activities. Rooted in socio-constructivist theory, scaffolding emphasizes guided support that enables learners to perform tasks beyond their independent capabilities, gradually transferring responsibility as competence increases (Vygotsky, 1978). In digital learning

environments, scaffolding can be embedded through prompts, feedback, structured task sequences, and interactive features that guide learners' thinking processes.

Multimedia learning theory provides a strong conceptual foundation for the design of digital scaffolding. According to Mayer (2009), meaningful learning occurs when learners actively integrate verbal and visual information through well-designed multimedia presentations. The integration of text, images, animation, and narration can reduce cognitive load and enhance conceptual understanding when aligned with cognitive principles such as coherence, signaling, segmentation, and modality (Mayer, 2009; Cheng *et al*., 2015).

Empirical evidence supports the effectiveness of interactive multimedia in fostering higher-order thinking skills. Wang *et al*. (2019) found that interactive multimedia environments promote active learning while maintaining moderate cognitive load, compared to text-based or video-only formats. Similarly, Syawaludin *et al*. (2019) demonstrated that interactive multimedia enhanced students' analytical and critical thinking skills through augmented reality–based learning experiences. These findings suggest that interactivity plays a crucial role in engaging learners cognitively and supporting analytical reasoning.

Digital scaffolding embedded in multimedia applications enables learners to engage in analytical processes, such as identifying variables, organizing data, and drawing conclusions. By providing step-by-step guidance and visual representations, multimedia scaffolding can support learners' transition from guided analysis to independent reasoning (Azevedo, 2012; Schunk, 2012). As a result, multimedia-based scaffolding is increasingly recognized as an effective approach for developing analytical thinking in secondary education.

2.3 Social research learning in high school contexts

Social research learning in secondary education aims to equip students to investigate social phenomena systematically and ethically. Social research emphasizes inquiry, evidence-based reasoning, and the interpretation of social data, making it a suitable pedagogical context for developing analytical thinking skills (Burns, 2000;

Creswell, 2017). Through research activities, students learn to formulate questions, collect and analyze data, and construct reasoned conclusions.

Engaging students in social research projects aligns with constructivist learning principles, which emphasize active knowledge construction through inquiry and interaction with real-world contexts (Slavin, 2006). Research-based learning encourages students to decompose complex social issues, identify patterns, and evaluate relationships among social variables, thereby fostering analytical reasoning (Leedy & Ormrod, 2015).

However, previous studies indicate that students often experience difficulties conducting social research independently, particularly in structuring the research process and analyzing data systematically (Nurdin & Hartati, 2019). These challenges highlight the need for instructional support mechanisms that guide students through the research process while maintaining cognitive engagement. Digital learning environments offer opportunities to embed such support through interactive research tools and guided inquiry frameworks.

2.4 Research gap and conceptual framework

Although prior studies have examined multimedia learning and the development of analytical thinking, limited research has focused on explicitly integrating digital scaffolding within social research learning contexts at the high school level. Existing studies tend to address either multimedia effectiveness or analytical thinking outcomes independently, without examining how digital scaffolding can function as a cognitive support system within social research activities. Therefore, there is a need for research and development studies to design and validate digital applications that scaffold students' analytical thinking through structured social research processes.

Based on this gap, the present study develops a Social Research Assistant application designed to support high school students' analytical thinking through interactive multimedia and guided research scaffolding. The conceptual framework integrates analytical thinking theory, multimedia learning principles, and social research pedagogy to create a coherent digital learning environment.

3 METHODOLOGY

3.1 Research design

This study employed a Research and Development (R&D) approach to design, develop, and evaluate a web-based Social Research Assistant application, aiming to enhance high school students' analytical thinking skills in social studies. R&D was selected because the primary objective of the study was not theory testing, but the production and validation of an educational digital product that addresses concrete instructional needs in social research learning (Borg & Gall, 2003; Gay *et al*., 2012).

The development process followed the multimedia development model proposed by Alessi and Trollip (2001), which consists of three main phases: planning, design, and development. This model was considered appropriate because it provides a systematic framework for educational media development while emphasizing usability, instructional coherence, and iterative evaluation.

3.2 Research setting and participants

The study was conducted in public senior high schools (SMA) located in Surakarta, Indonesia, from April 2024 to April 2025. The selection of schools in Surakarta was based on several empirical considerations.

First, the schools have implemented the Merdeka Curriculum, which emphasizes inquiry-based learning and student-centered pedagogies, making them suitable contexts for social research instruction.

Second, the diverse academic backgrounds of students provided a representative learning environment to examine the effectiveness of the developed application across varying analytical skill levels.

Third, institutional support for educational innovation and digital learning facilitated the implementation of the development and testing phases.

Participants included Grade XI Social Studies students, social studies teachers, media experts, and subject-matter experts who were involved in validation and evaluation stages.

3.3 Development model and procedures

The development process adopted the model by Alessi and Trollip (2001), consisting of the following stages.

3.3.1 Planning phase

The planning phase focused on identifying instructional needs and defining the scope of product development. Preliminary studies were conducted through classroom observations, document analysis of lesson plans, and semi-structured interviews with social studies teachers to identify challenges in fostering students' analytical thinking skills. These activities aimed to understand existing instructional practices, media usage, and students' difficulties in conducting social analysis.

In addition, a needs analysis questionnaire was administered to students to examine their learning preferences, familiarity with digital tools, and perceived challenges in social research learning. The results of this phase informed the formulation of learning objectives, content scope, and functional requirements of the Social Research Assistant application.

3.3.2 Design phase

During the design phase, the conceptual and technical structure of the application was developed. This phase involved creating flowcharts and storyboards to represent the application's navigation structure, user interaction flow, and embedded learning sequences. Learning materials were aligned with curriculum objectives and analytical thinking indicators, ensuring conceptual coherence between content and instructional goals.

Instructional components, such as learning texts, visual materials, videos, and guided research activities, were designed according to multimedia learning principles, including coherence, segmentation, and signaling (Mayer, 2009). This phase also included preparing supporting materials, such as user guidelines and instructional prompts, to facilitate learners' engagement with the research process.

3.3.3 Development phase

The development phase involved the technical production and validation of the application. The Social Research Assistant application was developed using a web-based learning platform, enabling broader accessibility and cross-device compatibility. Multimedia elements—including text, graphics, audio, and video—were integrated into an interactive interface designed to guide students through stages of social research, such as problem identification, data collection, analysis, and conclusion drawing.

3.4 Alpha testing (expert validation)

Alpha testing was conducted to evaluate the application's content accuracy, instructional quality, and technical functionality. Content validation was performed by subject-matter experts specializing in social research and social studies education, while media validation was conducted by instructional media experts and practicing teachers. Evaluation instruments assessed aspects such as content relevance, instructional clarity, usability, multimedia design, and alignment with analytical thinking objectives.

Feedback from alpha testing informed iterative revisions to improve the application's quality and usability before student trials.

3.5 Beta testing (user trials)

Beta testing involved student-centered trials conducted in three stages:

- One-to-one trials, involving a small number of students representing high, medium, and low analytical ability levels.
- Small group trials, conducted within selected classes to gather broader feedback on usability and learning experience.
- Expanded field trials, in which the revised application was implemented in regular classroom settings.

These trials aimed to examine the practicality of the application and identify potential issues related to learner interaction and instructional flow.

3.6 Instrument and data collection

Data were collected using multiple instruments, including:

- Interview protocols for teachers during the preliminary study,
- Questionnaires for needs analysis and expert validation,
- Observation sheets to document classroom implementation,
- Analytical thinking tests are administered as pre-tests and post-tests.

The analytical thinking test measured indicators such as identifying assumptions, analyzing relevant information, constructing arguments, making inferences, and evaluating implications. The use of multiple data sources allowed for methodological triangulation to enhance data credibility (Sugiyono, 2012).

3.7 Data analysis

Qualitative data obtained from interviews, observations, and expert feedback were analyzed using descriptive qualitative techniques to identify recurring themes and inform product revisions. Quantitative data from pre-test and post-test results were analyzed to evaluate the effectiveness of the application.

Prior to hypothesis testing, prerequisite tests for normality and homogeneity were conducted to ensure statistical assumptions were met. The effectiveness of the Social Research Assistant application was analyzed using:

- Paired-sample t-tests to examine differences between pre-test and post-test scores, and
- Normalized gain (N-gain) analysis to measure the magnitude of improvement in students' analytical thinking skills.

3.8 Ethical considerations

Ethical approval was obtained from the participating schools, and informed consent was secured from teachers and students prior to data collection. Participation was voluntary, and all data were anonymized to ensure confidentiality.

4 RESULT

4.1 Expert validation results

4.1.1 Context expert validation (material expert)

Content experts validated the relevance, accuracy, depth, and pedagogical alignment of the Social Research Assistant application with the senior high school Social Studies curriculum. The evaluation instrument covered indicators of clarity of instructions, conceptual accuracy, coherence, alignment with learning objectives, and suitability of research-based learning activities.

The validation results indicate that the application achieved a mean feasibility score of 86.4%, placing it in the highly valid category. Experts particularly emphasized the application's strengths in guiding students through the systematic social research stages, including problem identification, data collection, analysis, and conclusion drawing. Minor revisions were suggested to improve terminology consistency and to simplify several instructional texts to better suit students' cognitive levels.

Overall, content experts concluded that the Social Research Assistant application was conceptually sound and pedagogically appropriate, and therefore suitable for classroom implementation with minor refinements.

4.1.2 Media expert validation

Media expert validation focused on the technical quality, usability, visual design, navigation structure, and system responsiveness of the web-based application. The assessment also examined compatibility across devices and clarity of user interaction flows.

The validation results show a mean score of 84.1%, indicating very feasibility. Media experts highlighted the application's intuitive navigation, logical sequencing of learning activities, and effective integration of multimedia elements, including visuals and instructional videos. The web-based design was considered accessible and appropriate for Generation Z learners, who are accustomed to digital environments.

Recommendations from media experts included improving the loading efficiency of multimedia components and refining color contrast across several interface sections to enhance readability. Despite these suggestions, the application was deemed technically reliable and suitable for instructional use.

4.1.3 Practitioner validation (teachers)

Senior high school Social Studies teachers conducted practitioner validation to assess the practicality of instruction, classroom applicability, and alignment with teaching practices. Teachers evaluated the application from the perspective of real classroom implementation.

The practitioner validation yielded a mean score of 88.2%, indicating a high level of practicality and instructional feasibility. Teachers reported that the application effectively supports inquiry-based learning and facilitates students' engagement in analytical thinking processes. The structured scaffolding embedded in the application was perceived as particularly helpful in guiding students who typically struggle with abstract analysis.

Teachers also noted that the application could serve as both a primary instructional tool and a complementary learning resource, especially in project-based or research-oriented learning scenarios.

4.2 Effectiveness test result

4.2.1 Pre-test and post-test comparison

The effectiveness of the Social Research Assistant application was examined through a pre-test–post-test design involving students in Grade XI Social Studies classes. The test instruments measured key dimensions of analytical thinking, including problem identification, information analysis, argument construction, inference, and evaluation of implications.

The results indicate a clear improvement in students' analytical thinking skills after using the application. The mean pre-test score was 58.3, reflecting a moderate

baseline level of analytical ability. After the intervention, the mean post-test score increased to 74.6, representing a substantial improvement.

This increase suggests that students demonstrated stronger abilities to analyze social phenomena, interpret data, and formulate evidence-based conclusions after engaging with the web-based research assistant.

4.2.2 N-gain analysis

To further examine learning improvement, an N-Gain analysis was conducted. The calculated mean N-Gain value was 0.39, which falls within the medium improvement category.

This result indicates that the application contributed to a meaningful yet realistic enhancement of students' analytical thinking skills. The moderate N-Gain score suggests that while the application significantly supports learning, the development of analytical thinking remains a gradual process influenced by instructional duration, student readiness, and learning context.

4.2.3 Hypothesis testing (t-test)

A paired-sample t-test was conducted to determine whether the difference between pre-test and post-test scores was statistically significant. The analysis revealed a t-value of 6.21 with a significance level (p) < 0.001, indicating a statistically significant difference between students' analytical thinking performance before and after using the application.

These findings confirm that the observed improvement was not due to chance, but rather associated with the implementation of the Social Research Assistant application as a digital scaffolding tool in social studies learning.

4.3 Summary of result

Overall, the results demonstrate that:

1. The Social Research Assistant application is highly valid in terms of content, media design, and instructional practicality.
2. The application effectively improves students' analytical thinking skills, as evidenced by significant gains in post-test scores.
3. The moderate N-Gain value reflects realistic learning progress, consistent with the development of analytical thinking in educational settings.

These findings provide empirical support for the use of web-based digital scaffolding tools to enhance analytical thinking in senior high school social studies education.

5 DISCUSSION

5.1 Interpretation of finding based on learning theory

The findings of this study demonstrate that the Social Research Assistant application enhances students' analytical thinking skills. The significant improvement observed between pre-test and post-test scores indicates that structured digital support can facilitate higher-order cognitive processes when integrated into social studies learning.

From a cognitive learning perspective, this improvement aligns with constructivist learning theory, which emphasizes that learners actively construct knowledge through meaningful engagement with problems and data rather than passively receiving information (Piaget, 1972; Vygotsky, 1978). The application guides students through sequential stages of social research—problem identification, data collection, analysis, and conclusion—which mirrors the cognitive processes involved in analytical thinking as defined by Anderson and Krathwohl (2001).

Moreover, the moderate N-Gain value (0.39) reflects a realistic learning progression rather than an inflated outcome. Analytical thinking is recognized as a complex skill that develops gradually through repeated exposure to structured problem-solving tasks (Paul & Elder, 2014). Therefore, the observed improvement suggests that the application effectively supports cognitive growth without oversimplifying the learning process.

5.2 Digital scaffolding and the development of analytical thinking

The effectiveness of the Social Research Assistant application can be explained through the concept of digital scaffolding. Scaffolding refers to temporary instructional support that enables learners to perform tasks they would not be able to complete independently (Wood, Bruner, & Ross, 1976). In digital contexts, scaffolding is embedded within technological tools that provide prompts, guidance, feedback, and structured learning pathways (Azevedo & Hadwin, 2005).

In this study, digital scaffolding was operationalized through interactive research steps, guiding questions, data analysis templates, and reflective prompts embedded within the web-based application. These features supported students' movement from surface-level factual recall toward deeper analytical reasoning. This finding supports previous research indicating that digital scaffolding enhances students' ability to organize information, identify relationships, and construct evidence-based arguments (Belland, Walker, Olsen, & Leary, 2015).

Importantly, the application aligns with the characteristics of Generation Z learners, who tend to prefer interactive, visually supported, and technology-mediated learning environments (Seemiller & Grace, 2016). By embedding scaffolding within a familiar digital interface, the application reduces cognitive overload while maintaining analytical rigor, as suggested by Cognitive Load Theory (Sweller, Ayres, & Kalyuga, 2011).

5.3 Comparison

The findings of this study are consistent with international research on the use of digital tools to enhance higher-order thinking skills. Previous studies have shown that inquiry-based digital learning environments significantly improve students' analytical and critical thinking abilities when compared to traditional instruction (Hmelo-Silver, Duncan, & Chinn, 2007; Lazonder & Harmsen, 2016).

For example, Belland *et al*. (2017) found that digital scaffolding in problem-based learning environments had a moderate but significant effect on students' higher-order thinking skills, particularly when scaffolding focused on reasoning processes rather than

content delivery alone. Similarly, Kramarski and Michalsky (2015) reported that technology-supported inquiry learning improved students' ability to analyze data and justify conclusions in social science contexts.

Compared to these studies, the results of the present research demonstrate comparable effect sizes, reinforcing the argument that moderate gains are pedagogically meaningful in the development of analytical thinking. The web-based nature of the Social Research Assistant also extends previous findings by demonstrating that effective scaffolding does not require complex or expensive software, but can be achieved through well-designed instructional frameworks embedded in accessible digital platforms.

5.4 Pedagogical implications for social studies and sociology education

The results of this study have several important implications for social studies and sociology education at the senior high school level. First, the findings suggest that analytical thinking skills can be systematically developed when learning activities are structured around authentic social research processes. This supports the argument that sociology education should move beyond content transmission toward inquiry-oriented and problem-based pedagogies (Trilling & Fadel, 2009).

Second, the Social Research Assistant application demonstrates the potential of technology to serve not merely as a content-delivery tool but as a cognitive partner that guides students through complex reasoning processes. This aligns with UNESCO's emphasis on critical and analytical thinking as core competencies for 21st-century learners (UNESCO, 2015).

Third, for teachers, the application offers a practical solution to common instructional challenges, such as limited time, diverse student abilities, and the difficulty of facilitating research-based learning in conventional classroom settings. By providing structured digital scaffolding, teachers can focus more on facilitating discussion, reflection, and contextualization of social phenomena.

Finally, the study highlights the importance of integrating local social contexts into digitally supported learning environments. By encouraging students to analyze real social issues within their communities, sociology learning becomes more meaningful,

contextual, and relevant, thereby strengthening students' analytical engagement and civic awareness.

6 CONCLUSION

This study concludes that the development and implementation of a web-based Social Research Assistant application provides meaningful support for enhancing analytical thinking skills among senior high school social studies students. By embedding structured research processes into a digital learning environment, the application enables students to engage more deeply with social phenomena through systematic inquiry, analysis, and reflection.

The findings directly address the study's objectives. First, the research confirms that prior to the development of the application, learning practices tended to emphasize content delivery with limited opportunities for structured analytical engagement. Second, the development process—guided by a research and development framework—resulted in a digital learning tool that is pedagogically sound, technically feasible, and aligned with curriculum demands. Third, the application demonstrated effectiveness in fostering students' analytical thinking skills by supporting their ability to identify problems, analyze information, and construct evidence-based conclusions.

From a scientific perspective, this study contributes to the growing body of research on digital scaffolding in social studies education. It extends the existing literature by demonstrating how web-based instructional scaffolds can serve as cognitive supports in social research learning, particularly in the context of secondary-level sociology education. The study also reinforces the argument that the development of higher-order thinking skills, such as analytical thinking, is most effective when technology is designed to guide reasoning processes rather than merely deliver instructional content.

In addition, this research offers practical insights for educators and instructional designers by illustrating how accessible web-based applications can be leveraged to support inquiry-oriented learning without requiring complex technological infrastructures. By positioning technology as a facilitator of analytical reasoning, the study underscores the potential of digital tools to bridge the gap between theoretical knowledge and authentic social inquiry in classroom settings.

Overall, the findings affirm that thoughtfully designed digital learning environments can play a crucial role in advancing analytical thinking in social studies education and provide a foundation for further research on technology-enhanced inquiry learning in diverse educational contexts.

6.1 Implications and limitations

6.1.1 Pedagogical and practical implications

The findings of this study offer several important implications for educational practice, particularly in the context of social studies and sociology instruction at the senior high school level. First, the study underscores the potential of web-based digital scaffolding as an effective instructional strategy for supporting analytical thinking. When learning activities are structured around authentic research processes, students are more likely to engage in deeper reasoning, data interpretation, and evidence-based conclusion drawing.

Second, the Social Research Assistant application demonstrates how technology can be positioned as a cognitive support system rather than merely a content-delivery medium. This has implications for teachers, who can leverage such tools to facilitate inquiry-based learning while reducing instructional complexity. By providing guided research steps and analytical prompts, the application allows teachers to focus on mentoring, discussion, and contextual analysis of social issues.

Third, the study contributes to curriculum implementation in the context of 21st-century skills development. Analytical thinking, as a core component of higher-order thinking skills, aligns with national and international educational frameworks that emphasize critical reasoning, problem-solving, and data literacy. The integration of digital research tools into social studies instruction supports these competencies and enhances students' readiness to engage with complex social realities.

Finally, from an institutional perspective, the findings suggest that schools can adopt accessible web-based applications to enhance learning quality without substantial financial or technical barriers. This makes the approach particularly relevant for schools seeking scalable and sustainable instructional innovations.

6.1.2 Theoretical implications

From a theoretical standpoint, this study reinforces and extends existing frameworks related to scaffolding theory and constructivist learning. The results provide empirical support for the argument that digital scaffolding can effectively mediate learners' progression from surface-level understanding to higher-order analytical thinking, especially when scaffolds are embedded within inquiry-oriented tasks.

Additionally, the study contributes to the literature on technology-enhanced social science education by illustrating how digital tools can operationalize abstract analytical processes into concrete learning steps. This supports the view that analytical thinking is not an innate skill but a learnable competence that can be systematically developed through well-designed instructional environments.

6.1.3 Limitations of the study

Despite its contributions, this study has several limitations that should be acknowledged. First, the research was conducted within a specific geographical and institutional context, which may limit the generalizability of the findings to other regions or educational systems with different curricular structures and technological resources.

Second, the intervention's duration was relatively short. Analytical thinking development is a long-term process, and longer implementation periods may yield different or more robust outcomes. Future studies could examine the sustained impact of digital scaffolding over extended instructional cycles.

Third, the assessment of analytical thinking relied primarily on test-based measures. While these instruments provide valuable insights into cognitive outcomes, they may not fully capture students' reflective reasoning, metacognitive growth, or collaborative analytical processes. Complementary qualitative approaches, such as learning journals or discourse analysis, could enrich future investigations.

Finally, the study focused on a web-based application as a standalone instructional tool. Further research could explore how digital scaffolding interacts with other pedagogical strategies, such as collaborative learning or problem-based instruction, to

better understand the conditions under which the development of analytical thinking is optimized.

REFERENCES

A. Suhaenah, Suparno. A.. Suhaenah, Suparno.2001. *Membangun Kompetensi Dasar*. Jakarta: Direktorat Jendral Pendidikan Tinggi Departemen Pendidikan Nasional. (2001). *Membangun Kompetensi Dasar*. Jakarta: Direktorat Jendral Pendidikan Tinggi Departemen Pendidikan Nasional.

Ad'hiya, E. (2018). *Developmental and validation an Interated Assessment Instrument to Assess Students' Analytical Thinking Skills in Chemical Literacy.* International Journal of Instruction, 11(4), 241-256

AECT. (1997). *The Definition of Educational Technology*. Washington: Education of Journal

Agyei, E. D., & Agyei, D. D. (2021). Promoting interactive teaching with ICT: Features of intervention for the realities in the Ghanaian physics senior high school classroom. **International Journal of Interactive Mobile Technologies*, 15(19), 1-25. [DOI: 10.3991/ijim.v15i19.22735]

Airasian P.W., Mills G. dan Gay, L. .. 2012. E*ducational Research: Competencies for Analysis and Application*. USA: Pearson Education.

Aksu, Gokhan and Eser, Mehmet Taha (2020) *Development of Analytical Thinking Tendency Scale: Validity and Reliability Study.* Ilkogretim Online – Elementary Education Online, 19 (4). pp. 2307-2321.

Alessi, S.M., & Trollip, S.R. (2001). Multimedia for learning: methods and development (3rd Edition). Boston: Allyn and Bacon.

Amer, Ayman, *et al*. (2005). *Analythical Thinking.* Cairo: Center for panel Advancement Studies and Research Engineering Science, Faculty of Engineering, Cairo University.

Anderson, L.W. & Krathwohl, D.R. (2010). *Kerangka landasan untuk pembelajaran, pengajaran, dan asesmen.* Yogyakarta: Pustaka Pelajar, 300(300), 0.

Anita Woolfolk. (2009). *Educational Psychology Active Learning Edition.* Diterjemahkan oleh: Helly Prajitno Soetjipto. Boston: Pearson Education, Inc., Publishing.

Art-in, Sitthipon .(2012). *Development of Teachers' Learning Management Emphasizing on Analytical Thinking in Thailand.* Procedia Social and Behavioral Science, 46 (1). pp. 3339-3344. ISSN 1877-1428

Ashburn, E. A., & Floden, R. E. (2006). Technology, Education-Connections The TEC Series Meaningful Learning Using Technology: What Educators Need to Know and Do Using Technology Wisely: The Keys to Success in Schools.

Bloom, Benjamin S., etc. (1956). *Taxonomy of Educational Objectives : The Classification of Educational Goals, Handbook I Cognitive Domain*. New York : Longmans, Green and Co.

Borg, W.R and Gall, M.D. (2003). *Educational Research: An Introduction 4th Edition*. London: Longman Inc.

Brown, James W. & Thornton, James W. (1971). *New Media in Higher Educatiion.* Washington: Association for Higher Education.

Cheng, T. S., Lu, Y. C., & Yang, C. S. (2015). *Using the Multi-display teaching system to lower cognitive load.* Educational Technology & Society, 18(14), 128-140.

Damayanti, D. (2016). *Studi Perbandingan Model Pembelajaran Probing Prompting Dan Model Pembelajaran Cooperative Integrated Reading And Composition (Circ) Dalam Meningkatkan Kemampuan Berpikir Analitis Dengan Memperhatikan Gaya Belajar Siswa Pada Mata Pelajaran Ekonomi Kelas X Sma Negeri 1 Terbanggi Besar Tahun Pelajaran 2015/2016.*

Darmadi, H. 2011. *Metode Penelitian Pendidikan*. Alfabeta. Bandung.

Djiwadono, P. I. (2010). *Kemampuan Analisis sebagai Bekal Bernalar Kritis.* Universitas Ma Chung. 3 (2), 1-2.

Fadly, W. (2021). PROFILE OF STUDENTS ANALYTICAL THINKING SKILLS IN LEARNING STYLE FOR COMPLETING SUBSTANCE PRESSURE PROBLEMS. , 3, 1-15. https://doi.org/10.34312/JPJ.V3I1.9792.

Farisi, M. (2016). *Developing 21st-century social studies skills through technology interaction.* Turkish Online Journal of Distance Education, 19(1), 16-30.

Gagne, Robert M & Briggs, Leslie J. (1979). *Principles Of Instructional Design (2nd Edition).* New York : Holt, Rinehart and Winston.

Hadisaputra, Saprizal and Gunawan, Gunawan and Yustiqvar, Muhammad (2019) *Effects of Green Chemistry Based Interactive Multimedia on the Students' Learning Outcomes and Scientific Literacy*. Journal of Advanced Research in Dynamical and Control Systems (JARDCS), 11 (7). pp. 664-674. ISSN 1943-023X

Harvey, Lee. (2022). *Critical Social Research: Re-examining Quality. Quality in Higher Education.* 28(2), 145-152.

Huang, R., Spector, M.J., & Yang, J. (2019). *Educational technology: A primer for the 21st century*. Springer Singapore. https://doi.org/10.1007/978-981-13-6643-7: Springer Singapore.. TechTrends. 64. 10.1007/s11528-020-00507-2.

Huang, Ronghuai; Spector, J. Michael; Yang, Junfeng. (2019). *Educational Technology: A Primer for the 21st Century. Lecture Notes in Educational Technology*. New York: Springer

Istiqomah, S., Maftukhin, A. and Nurhidayati, N. 2015. *Efektivitas Model Pembelajaran Novick dalam Meningkatkan Daya Serap dan Hasil Belajar Siswa Kelas X SMA Negeri 5 Purworejo Tahun Pelajaran 2014/2015*. Radiasi : Jurnal Berkala Pendidikan Fisika. 7, 1 (Sep. 2015), 47-50.

Jakus, Dalibor and Krsimrr Zubcic. (2014). *Analytical and Critical Thinking Skills in Public Relations*. Croatia. Croatian Public Television Vol. 14 (4).

Januszewski, A., & Molenda, M. (2008). *Educational Technology: A Definition with Commentary*. New York: Lawrence Erlbaum Associates.

Kao, C. Y. (2014). *Exploring the Relationships Between Analogical, Analytical, and. Creative Thinking. Thinking Skills and Creativity*, 13(1), 80–88.

Kemdikbudristek. (2022). Keputusan Kepala BSKAP No. 033/H/K/R/2022 tentang Perubahan atas Keputusan kepala BSKAP Kemdikbudristek No. 008/H/K/R/2022 tentang Capaian Pembelajaran Pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah Pada Kurikulum Merdeka.

Kondakci, Y., Beycioglu, K., Sincar, M., & Ugurlu, C. T. (2017). Readiness of teachers for change in schools. *International Journal of Leadership in Education*, 20(2), 176-197. [DOI: 10.1080/13603124.2015.1023361]

Kytle, J., & Millman, E. (1986). Confessions of two applied researchers in search of principles. *Evaluation and Program Planning*, 9, 167-177. https://doi.org/10.1016/0149-7189(86)90037-6.

Leslie A. Hayduk (1990) Should Model Modifications be Oriented Toward Improving Data Fit or Encouraging Creative and Analytical Thinking?, Multivariate Behavioral Research, 25:2, 193-196, DOI: 10.1207/s15327906mbr2502_7

Lubis, Bertha & Mulianingsih, Sunasih. (2019). *Keterkaitan Bonus Demografi dengan Teori Generasi*. Jurnal Registratie, 1(1), 21-36.

May, Tim & Perry Beth. (2022). *Social Research: Issues, Methods and Process*. London: Open University Press.

Mayer, R. E. (2009). *Multimedia Learning 2nd edition*. Cambridge: Cambridge University Press.

Mayer, R. E., & Simms, V. K. (1994). For Whom Is a Picture Worth a Thousand Words? Extensions of a Dual Coding Theory of Multimedia Learning. Journal of Educational Psychology, 86, 389-401. https://doi.org/10.1037/0022-0663.86.3.389

Mayer, R.E. (2002). *Teaching for meaningful learning*. Upper Saddle River, NJ: Prentice-Hall.

Nind, M., Kilburn, D., & Luff, R. (2015). The teaching and learning of social research methods: developments in pedagogical knowledge. *International Journal of Social Research Methodology*, 18, 455 - 461. https://doi.org/10.1080/13645579.2015.1062631.

Parta, N. (2016). *Karkateristik Berpikir Analitis Mahasiswa dalam Menyelesaiakan "Masalah Sederhana".* State University of Malang. DOI:10.13140/RG.2.1.4728.2167

Paul.D. Leedy and Jeanne.E. Ormrod. Practical Research: Planning and Design Research Edisi 8 [2005]. Ohio: Pearson Merrill Prentice Hall.

Paul N. McDaniel (2022) Teaching, Learning, and Exploring the Geography of North America with Virtual Globes and Geovisual Narratives. *Journal of Geography*, 121 (4), 125-140. [DOI: 10.1080/00221341.2022.2119597]

Piaget, Jean. (2002). *Tingkat Perkembangan Kognitif.* Jakarta, Gramedia.

Pusat Stanadr dan Kebijakan Pendidikan. (2020). *Gen Z Dominan, Apa Maknanya Bagi Pendidikan Kita?.* Kementerian Pendidikan Kebudayaan Riset dan Teknologi (https://pskp.kemdikbud.go.id/produk/artikel/detail/3133/gen-z-dominan-apa-maknanya-bagi-pendidikan-kita) diakses tanggal 15 Januari 2024).

Praheto, Biya Ebi and Andayani, Andayani and Wardani, Nugraheni Eko (2020) *The Effectiveness of Interactive Multimedia in Learning Indonesian Language Skills in Higher Education.* Rupkatha Journal on Interdisciplinary Studies in Humanities, 12 (1). pp. 1-11. ISSN 0975-2935

Prasetya, Irawan; Aslichati, Lilik (2014). *Metode Penelitian Sosial* (PDF). Tangerang Selatan: Universitas Terbuka.

Qodr, Taufiq Subhanul, & Efendi, Agus (2023) Improving Critical Thinking Skills of High School Students Through the Implementation of Mobile-Based Game Application. *International Journal of Education and Practice*, 11(3), 613-626. [DOI: 10.18488/61.v11i3.3440]

Robert B. Burns, Introduction to Research Methods, 4th Edition, French Forest NSW: Longman, 2000

Sadoski, M., & Paivio, A. (2004). Dual Coding Theory in Reading. Theoretical Models and Processes of Reading, 5, 1329-1362. https://doi.org/10.1598/0872075028.47

Sanaky. 2015. *Media Pembelajaran Interaktif-Inovetif*. Yogyakarta: Kaubana Dipantara.

Sanjaya, Winna. (2008). *Strategi Pembelajaran Berorientasi Standar Proses Pendidikan.* Jakarta: Kencana Prenada Media Group.

Sartika, S., Efendi, N., & Rocmah, L. (2020). Keterampilan Berpikir Analisis Calon Guru IPA melalui Model 4A (Analisis Fenomena, Analisis Informasi, Analisis Data, Analisis Temuan). , 8, 165-170. https://doi.org/10.26714/JPS.8.2.2020.165-170.

Schunk, D. H., *Learning theories an Educational Perspective Sixth Edition.* Pearson.

Seels, B. B., & Richey, R. C. (1994). *Teknologi Pembelajaran: Devinisi dan Kasawasannya.* Penerjemah Dewi S. Prawiradilaga dkk. Jakarta: kerjasama IPTPI LPTK UNJ.

Sigelman, C. K., & Rider, E. A. (2012). *Life-span human development (7th ed.)*. Belmont, CA.: Wadsworth, Cengage Learning.

Slavin, R. E. (2006). *Educational Pshycology, Theory, and Practice (8th Edition).* Boston: Pearson Educational Inc.

Sobel, M., & Manski, C. (1995). Identification Problems in the Social Sciences.. *Journal of the American Statistical Association*, 91, 438. https://doi.org/10.2307/2291433.

Stillman, David & Stillman, Jonah. (2017). *Gen Z @ Work: How the Next Generation is Transforming the Workplace.* HarperCollins.

Sudjana, Nana. 2013. *Dasar-Dasar Proses Belajar Mengajar*. Bandung: Sinar Baru Algensindo.

Sugiyono. (2012). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Bandung: Alfabeta.

Suryani, Nunuk. Ahmad Setiawan dan Aditin Putria. (2018). *Media Pembelajaran Inovatif dan Pengembangannya.* Bandung: Remaja Rosdakarya.

Susanti, R. (2012). Pembelajaran Kimia Menggunakan Siklus Belajar 5E dan Inkuiri Bebas Dimodifikasi Ditinjau dari Kemampuan Berpikir Analisis dan Kreativitas Siswa. Jurnal Inkuiri, 1 (1), 60 - 68.

Syawaludin, A., Gunarhadi, G., Rintayati, P., Prof., T.T., & Dr., T.T. (2019). Development of Augmented Reality-Based Interactive Multimedia to Improve Critical Thinking Skills in Science Learning. *International Journal of Instruction*.

Tulgan, Bruce & RainmakerThinking, Inc. (2013). *Meet Generation Z: The Second Generation Within the Giant "Milenial" Cohort.* New Haven: RainmakerThinking, Inc.

Wang. C., Fang, T., & Gu, Y. (2019). *Learning Performance and Behavioral Patterns of Online Collaborative Learning Impact of Cognitive Load and Affordance of Diferent Multimedia.* Computers & Eductaion, 103683.

Waskita, P.D., Wahyuni, D., Nugroho, P.B. (2019). *Proses Berpikir Analitis Mahasiswa Berkarakter Charismatic Leadership*. Prosiding Seminar Nasional Pendidikan

Fakultas Ilmu Pendidikan Universitas Muhammadiyah Jakarta, 219-225. Universitas Muhammadiyah Jakarta. https://jurnal.umj.ac.id/index.php/SEMNASFIP/index

Zhang, Li-fang, Sternberg, Robert J., Rayner, Stephen. (2012). *Handbook of Intellectual Styles: Preferences in Cognition, Learning, and Thinking.* Springer Publishing Company, LLC: New York.