



Development of *Artificial Intelligence*-Based E-Portfolio Learning Media to Enhance Social Studies Learning Independence for Fifth-Grade Students

Vidiani Br Sembiring^{1*}, Sugiharto², Noni Rozaini³, Dede Ruslan⁴, Sri Yunita⁵, Sriadhi⁶
^{1,2,3,4,5,6}Universitas Negeri Medan, Medan, Indonesia

Article Info

Article History:

Received 04 25, 2026

Revised 05 14, 2026

Accepted 05 20, 2026

Keywords:

E-portofolio;
Artificial intelligence;
learning media;
Learning independence;
Elementary social
Studies.

Abstract

This research is driven by the identified deficiency in student learning autonomy within Grade V Social Studies, specifically concerning regional economic diversity, where traditional portfolios fail to provide timely pedagogical feedback. The study aims to develop and evaluate an *Artificial Intelligence* (AI)-based e-portfolio designed to enhance learning independence at UPT SD Negeri 066047 Medan. Utilizing a Research and Development (R&D) framework via the ADDIE model comprising Analysis, Design, Development, Implementation, and Evaluation the investigation involved Grade V students and employed observation, questionnaires, and documentation for rigorous data acquisition. Empirical findings indicate superior validity, with expert assessments yielding 88.57% for media and 90% for material content. Furthermore, practicality reached 91.67% from educators and 90% from learners, categorizing the tool as highly pragmatic for classroom integration. Effectiveness was substantiated by a significant improvement in learning independence scores, which surged from a baseline of 64.64% to 91.04% post-intervention. Consequently, the AI-integrated e-portfolio is established as a feasible and efficacious instructional innovation, facilitating reflective, interactive, and autonomous learning environments in elementary education. This media serves as a transformative technological alternative to conventional pedagogical instruments, aligning with the needs of modern digital-based curricula.

[Penelitian ini didasari oleh rendahnya kemandirian belajar siswa kelas V pada mata pelajaran Ilmu Pengetahuan Sosial (IPS), khususnya materi keragaman ekonomi daerah, karena portofolio tradisional lambat dalam memberikan umpan balik pembelajaran. Studi ini bertujuan untuk mengembangkan dan menguji e-portofolio berbasis Kecerdasan Buatan (AI) untuk meningkatkan kemandirian belajar di UPT SD Negeri 066047 Medan. Menggunakan metode Penelitian dan Pengembangan (R&D) dengan model ADDIE (Analisis, Desain, Pengembangan, Implementasi, dan Evaluasi), penelitian ini melibatkan siswa kelas V serta mengumpulkan data secara akurat melalui observasi, kuesioner, dan dokumentasi. Hasil penelitian menunjukkan validitas yang sangat baik, dengan penilaian ahli sebesar 88,57% untuk media dan 90% untuk materi. Tingkat kepraktisan mencapai 91,67% dari guru dan 90% dari siswa, sehingga dikategorikan sangat praktis untuk digunakan di kelas. Efektivitas media juga dibuktikan dengan peningkatan signifikan pada skor kemandirian belajar siswa, dari nilai awal 64,64% menjadi 91,04% setelah intervensi. Oleh karena itu, e-portofolio berbasis AI ini terbukti sebagai inovasi pembelajaran yang layak dan efektif dalam menciptakan lingkungan belajar yang interaktif, mandiri, dan reflektif di sekolah dasar, sekaligus menjadi alternatif teknologi baru yang sesuai dengan kebutuhan kurikulum digital masa kini]. © The Authors.

This is an open access article under the [CC BY-NC](https://creativecommons.org/licenses/by-nc/4.0/) license.



*Corresponding Author:

Vidiani Br Sembiring

Universitas Negeri Medan

Jalan Willem Iskandar, Pasar V Medan Estate, Percut Sei Tuan, Deli, Medan, Indonesia

Email: vidiani.8246181033@mhs.unimed.ac.id

1. Introduction

In the contemporary digital pedagogical landscape, instructional media has transitioned from a peripheral aid to an integral component that dictates the success of students' cognitive and metacognitive processes [1]. The fundamental role of learning media is to bridge the gap between abstract theoretical constructs and concrete comprehension, ensuring that learners are not merely passive recipients of information but active participants in their educational journey. When students engage deeply with creative and participative media, they tend to develop a more profound mastery of the material through comprehensive exploration rather than rote memorization. Within this paradigm, e-portfolios offer unique psychopedagogical advantages by shifting the instructional focus from teacher-centered to student-centered models [2]. Unlike traditional media such as video, which often positions students as consumers, e-portfolios demand that they function as both producers and evaluators of their work. This autonomy allows students to exercise selection and reflection, fostering a "sense of ownership" over their academic progress, which is a crucial first step in building self-management skills at the elementary level [3].

Technological evolution has propelled the e-portfolio into a transformative phase through the integration of Artificial Intelligence (AI). An AI-based e-portfolio is defined as a digital system equipped with intelligent algorithms designed to analyze student artifacts and provide automated, real-time responses [4]. These systems incorporate advanced features such as automated feedback, developmental analytics, and personalized content recommendations, effectively turning a passive digital repository into an active learning partner [5]. One of the primary advantages of this integration is its ability to overcome the classic "feedback delay" inherent in conventional portfolio assessments, where students often wait days for teacher intervention. By providing instantaneous guidance, AI-integrated media facilitates a continuous cycle of self-regulation, allowing students to monitor their progress and adjust their learning strategies immediately.

The theoretical foundation of this study is deeply rooted in the constructivist paradigm, which posits that knowledge is actively constructed by the learner through experience and reflection [6]. In the context of elementary education, constructivism aligns seamlessly with the development of Self-Regulated Learning (SRL). SRL is a multifaceted construct encompassing cognitive, metacognitive, and motivational processes that enable students to plan, monitor, and evaluate their own learning trajectories [7]. When students are encouraged to employ SRL strategies, they transition from dependent learners to autonomous thinkers. However, cultivating SRL requires an instructional environment that provides continuous scaffolding and structured reflective opportunities elements that are often difficult to sustain consistently in traditional, manual pedagogical settings.

Recent advancements in educational technology have demonstrated that AI can effectively provide this necessary scaffolding. Specifically, Natural Language Processing (NLP) and machine learning algorithms are increasingly utilized to create adaptive learning environments tailored to individual student needs [8]. These AI-driven systems can analyze textual inputs, such as reflective journals, to deliver personalized, formative feedback in real-time. By simulating the guidance of a human tutor, AI-integrated platforms prompt students to rethink their strategies, thereby reinforcing their metacognitive awareness [9]. This technological intervention is particularly beneficial in elementary education, where students are still developing the foundational self-monitoring skills required for independent learning.

Integrating these technologies into Social Studies (Ilmu Pengetahuan Sosial/IPS) for elementary education is particularly critical, as the subject demands contextual and value-laden understanding rather than the simple acquisition of facts. According to Piaget's theory of cognitive development, fifth-grade students reside in the concrete operational stage, requiring instructional media that can relate abstract socio-economic concepts to tangible, daily experiences [10]. Subjects such as "Regional Economic Diversity" necessitate an empathetic and contextual approach, where students are encouraged to document and reflect on real-world social phenomena, such as local economic activities. Furthermore, AI can assist educators in evaluating non-cognitive aspects, such as social values like tolerance and cooperation, by identifying key descriptors within student reflections [11]. This capability allows teachers to obtain a comprehensive profile of student development without the overwhelming burden of manually reviewing hundreds of reflective entries.

Despite the documented success of AI-assisted learning globally, its implementation in developing educational contexts remains limited. While international educational frameworks increasingly emphasize digital literacy and autonomous learning as core 21st-century skills, local realities often present a stark contrast [12]. In many Indonesian primary schools, the integration of

advanced digital tools is hindered by a reliance on conventional paradigms and static assessment methods. This digital divide not only limits students' exposure to innovative technologies but also perpetuates a dependency on traditional pedagogical structures, thereby stunting the development of their self-regulatory capacities in subjects like Social Studies.

Empirical evidence gathered at UPT SD Negeri 066047 Medan confirms this systemic challenge, revealing a significant deficiency in student learning independence. Preliminary observations involving 56 fifth-grade students indicate that learning autonomy remains critically low across all measured indicators. For instance, only 41.07% of students show confidence in setting learning goals, and a mere 30.36% demonstrate the initiative to plan their learning activities independently. Data from teacher interviews further highlight that 82.1% of students perform below expectations regarding self-regulation [13]. This is largely due to a lack of innovative media; observation reveals that 5 out of 8 teachers still rely entirely on conventional paper-based portfolios, while those using electronic portfolios lack interactive feedback features. The continued reliance on conventional portfolios limits the potential for rapid feedback, leaving students highly dependent on direct teacher instructions.

Based on the background and empirical evidence outlined above, several interconnected problems can be identified as the core constraints in the current pedagogical setting. The critically low level of independent learning among fifth-grade students where 82.1% perform below expectations is primarily driven by their weak initiative to seek independent learning resources and a limited capacity for self-evaluation or metacognition. This deficiency is severely compounded by the structural limitations of the assessment media, which remains heavily restricted to conventional, paper-based portfolios that impede rapid feedback. While previous research has widely explored the transition to digital portfolios, a significant research gap persists; existing e-portfolios typically function merely as static digital document repositories without interactive or intelligent features, thereby failing to actively scaffold the students' self-regulatory or cognitive processes. Consequently, critical instructional materials such as "Economic Diversity in My Region" continue to be delivered without adaptive media that facilitates personalized exploration, leaving students highly dependent on direct teacher instructions.

In response to these identified challenges, this research proposes the development of an Artificial Intelligence-based e-portfolio specifically focused on the "Economic Diversity in My Region" module. This study adopts the Research and Development (R&D) framework utilizing the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) to ensure a rigorous and pedagogically sound output [14]. The proposed media is designed to activate the self-regulation cycle of collection, selection, and reflection, thereby serving as a "self-independence incubator" for students. The novelty of this research lies in its specific application of AI-driven automated feedback within a Social Studies context to foster self-regulated learning a domain that has shown a potential 90% increase in autonomy in related preliminary studies [15]. By providing a scalable and interactive technological alternative, this research aims to offer a definitive solution to enhance the reflective and autonomous learning capabilities of fifth-grade students.

To ensure a focused and methodologically rigorous investigation, the scope of this study is strictly delimited to fifth-grade students at UPT SDN 066047 Medan, focusing specifically on the development of an Artificial Intelligence (AI)-based e-portfolio. The technological architecture of this medium is confined to providing automated feedback and basic personalized material recommendations tailored to the Social Studies (IPS) curriculum, specifically the topic "Economic Diversity in My Region." The primary behavioral variables are limited to enhancing students' independent learning, measured through indicators of initiative, self-confidence, responsibility, problem-solving, self-control, and self-evaluation. Guided by this scope, the study formulates three sequential research questions and corresponding objectives: first, to design and evaluate the specific validity level of the AI-based e-portfolio as validated by subject matter, media, and language experts; second, to determine the operational practicality of the media based on empirical feedback from teachers and students; and third, to analyze its ultimate effectiveness in significantly improving students' independent learning capacities in the classroom environment.

In addition to its immediate practical outputs, this research is expected to offer profound theoretical and practical significance to the field of primary education. Theoretically, this study enriches the existing literature on educational technology integration by providing empirical insights into how AI-driven authentic assessments can reinforce constructivist learning frameworks and self-regulated learning (SRL) theories in primary schools. Practically, this innovation transforms the learning experience for students by delivering personalized tracking and instant feedback that nurtures autonomy, while simultaneously offering teachers an efficient, real-time tool to monitor

student development without manual administrative burdens. Furthermore, for UPT SDN 066047 Medan, this platform serves as a strategic catalyst for school digitalization and curriculum modernization, while concurrently acting as a foundational reference for future researchers seeking to develop advanced AI-based interventions to foster independent learning environments.

2. Method

This study employs a *Research and Development (R&D)* methodology aimed at producing and validating an *Artificial Intelligence*-based e-portfolio to enhance the learning independence of fifth-grade students in Social Studies. The investigation was conducted at UPT SD Negeri 066047 Medan during the even semester of the 2025/2026 academic year. The development process strictly follows the *ADDIE* model, which comprises five systematic phases: *Analysis, Design, Development, Implementation, and Evaluation* [16]. This framework was selected due to its structured approach in developing technology-based instructional media. The subjects involved were 56 students from classes VA and VB, selected through *purposive sampling* based on identified deficiencies in learning autonomy during preliminary observations. The research object focuses on the AI-integrated e-portfolio system and its effectiveness in facilitating *self-regulated learning* within the "Economic Diversity in My Region" module. The systematic stages of this research are illustrated in Figure 1 below:

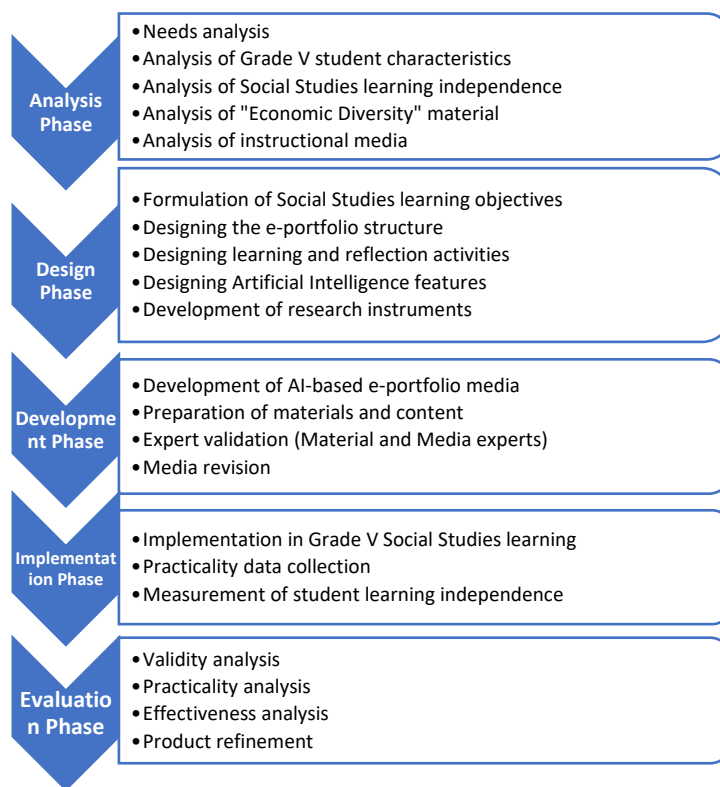


Figure 1. Research Flowchart using ADDIE Model

The procedural execution began with the Analysis phase, identifying pedagogical gaps, student characteristics in the concrete operational stage, and the limitations of existing paper-based portfolios. During the Design phase, the structural blueprint of the e-portfolio was established, incorporating specialized *Artificial Intelligence* features for *automated feedback* and adaptive reflection prompts. In the Development phase, the conceptual design was realized into a functional digital platform and subsequently subjected to rigorous validation by material and media experts to ensure theoretical and technical feasibility. The Implementation phase involved a classroom trial where students utilized the AI features to monitor their learning goals and document economic artifacts. Finally, the Evaluation phase assessed the media's quality through three primary

dimensions: validity, practicality, and effectiveness in improving student learning independence scores.

Data collection was facilitated through a multi-methodological approach involving observation, questionnaires, and documentation. Observation was utilized to record behavioral indicators of learning independence before (*pre-test*) and after (*post-test*) the intervention. Questionnaires were administered to material and media experts to ascertain the validity of the *Artificial Intelligence* integration, while teacher and student responses provided empirical data regarding the system's practicality. The instruments were constructed based on five key indicators of independence: self-confidence in goal setting, initiative in planning, discipline in monitoring, responsibility in self-evaluation, and the ability to perform independent reflection. The validity and practicality data were quantified using a percentage formula to determine the media's feasibility level [16]

The quantitative analysis of validity and practicality follows the percentage formula as expressed in (1):

$$V = \frac{T_{se}}{T_{sh}} \times 100\% \quad (1)$$

In this equation, V represents the percentage of validity or practicality, T_{se} is the total empirical score obtained from validators or respondents, and T_{sh} denotes the maximum expected total score. The results were then categorized according to a set of criteria:

Table 1. Product Validity and Practicality Criteria

No	Interval Percentage	Criteria	Description
1	85,01% – 100,00%	Very Valid/Practical	Can be used without revision
2	70,01% – 85,00%	Fairly Valid/ Practical	Can be used with minor revisions
3	50,01% – 70,00%	Less Valid/ Practical	Recommended not to be used (major revisions)
4	01,00% – 50,00%	Invalid/ Not Practical	Cannot be used

Furthermore, to measure the effectiveness of the AI-based e-portfolio in enhancing student autonomy, the researcher utilized the *Normalized Gain* (N-Gain) score. This analysis compares the pre-intervention and post-intervention independence levels to identify significant improvements [16]. The N-Gain value g is calculated using (2):

$$g = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} \quad (2)$$

Where S_{post} is the post-test score, S_{pre} is the pre-test score, and S_{max} is the maximum possible score of the instrument. The resulting g value is interpreted into three categories:

Table 2. N-Gain Score Interpretation Criteria

No	N-Gain Score (g)	Increase Category
1	$g > 0,7$	High
2	$0,3 \leq g \leq 0,7$	Medium
3	$g < 0,3$	Low

The e-portfolio is considered effective if the N-Gain analysis falls within the medium or high categories, signifying a substantial enhancement in the students' *self-regulated learning* capabilities.

3. Results

The development of an Artificial Intelligence-based e-portfolio follows the five stages of the ADDIE model, outlined as follows.

3.1 Analysis Stage

The analysis stage involved a direct observation into the learning environment of UPT SD Negeri 066047 Medan to establish a baseline for development. Empirical data gathered through student questionnaires indicated a significant lack of technology integration in Social Studies (IPS), where 56% of respondents reported that teachers rarely utilized instructional media. Despite this gap, 92% of students demonstrated high interest in digital tools, and 96% identified a critical need for interactive learning platforms. Furthermore, 80% of students confirmed their proficiency in using mobile devices, suggesting that the target demographic is technically prepared for a web-based e-

portfolio. Initial observations of learning independence yielded a score of 55.5% (categorized as "Poor"), with the lowest achievement in self-reflection and independent planning. These findings collectively underscored the urgency of developing an AI-integrated solution that simplifies complex economic concepts while simultaneously scaffolding student autonomy.


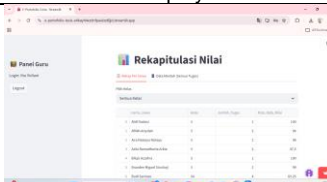
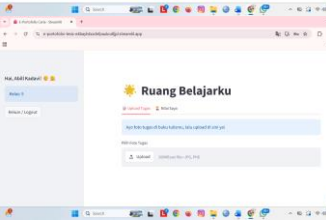
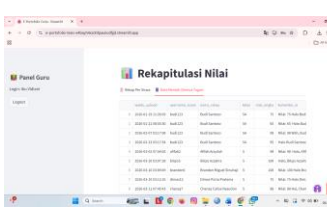
In addition to the quantitative survey results, the analysis of student characteristics confirmed that the fifth-grade learners at UPT SD Negeri 066047 Medan are cognitively situated within the concrete operational stage, necessitating instructional media that provides tangible and visual representations of abstract social concepts. The data showed that 88% of students find it easier to understand material when it is supported by images or videos, highlighting a significant preference for multimodal learning. This digital readiness is further supported by the fact that 80% of students already utilize mobile devices for educational purposes, providing a strong foundation for the introduction of an AI-integrated platform. By aligning the media's design with these existing digital habits and developmental needs, the e-portfolio is positioned to effectively bridge the gap between students' current capabilities and the desired levels of independent learning.

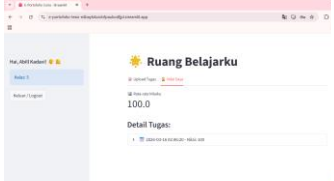
3.2 Design Stage

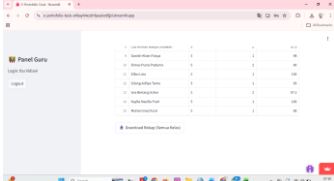
In the design stage, the conceptual framework of the AI-based e-portfolio was architected to align with the concrete operational stage of fifth-grade learners. This phase focused on formulating ten learning objectives rooted in the principles of self-regulated learning, such as the ability to set goals independently and perform honest self-evaluations. The structural design was divided into seven core modules: a Homepage for navigation, Learning Objectives for transparency, Instructional Content for economic diversity, Task Submission, a dedicated Reflection Space, an AI Feedback engine, and a Progress Report dashboard. The researcher also designed the Artificial Intelligence prompts to provide adaptive, non-punitive feedback that encourages students to analyze their economic observations more deeply. This structural blueprint ensured that the media functioned not just as a repository, but as a systematic cycle of Collection, Selection, and Reflection.


The architectural design of the e-portfolio was specifically structured to minimize the cognitive load of elementary students while maximizing their engagement with the "Economic Diversity" content. The formulation of the ten learning objectives ensured that every interactive element from task submission to the reflection space was directly mapped to specific indicators of self-regulated learning, such as self-monitoring and evaluative thinking. Furthermore, the design of the "AI Feedback" interface was prioritized to be non-intimidating and communicative, using language that mimics a supportive mentor to foster a safe environment for academic exploration. This strategic design phase ensures that the platform functions not merely as a digital filing cabinet, but as an active pedagogical tool that scaffolds the transition from teacher-dependent learning to autonomous mastery. The following is an A.I.-based portfolio design that has been designed and developed:

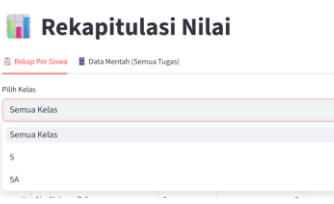
Table 3. AI-based portfolio display design

No	Display	Information	No	Display	Information
1		home page login for users, can log in as teacher and student	5		Teachers can see a recapitulation of student grades on their teacher accounts.
2		Student account display when logged in, students can immediately take photos of their answers and upload them to the portfolio	6		Apart from that, teachers can also see uploaded assignments and responses or feedback from AI.

3  After uploading the answers, students can see their scores directly.

7  Teachers can also collect a summary of student grades to make ranking easier.

4  Apart from getting an assessment, students also get feedback on the assignments they have completed.

8  This assessment can not only be used in one class but also in many classes.

3.3 Development Stage

The development stage transformed the design blueprints into a functional digital platform hosted via the Streamlit framework. This stage involved coding the Artificial Intelligence grader using Natural Language Processing (NLP) to interpret student reflections and the integration of a Cloud Database for secure artifact management. The content module was specifically populated with contextual materials on "Economic Diversity in My Region," utilizing visual illustrations to simplify production and distribution concepts. To ensure scientific rigor, the product underwent validation by two experts. As illustrated in Table 3, the media quality received a score of 88.57% (Very Valid) from Dr. Hermawan Syahputra, and the material content received 90.00% (Very Valid) from Prof. Dr. Syamsidar Tanjung.

Beyond the initial coding phase, the development stage emphasized an iterative refinement process based on the "teacher-in-the-loop" principle. This involved fine-tuning the AI's response parameters to ensure that the automated feedback was not only technically accurate but also linguistically appropriate for the developmental level of 10-to-11-year-old students. By utilizing a modular architecture, the system allowed for real-time updates to the IPS content without disrupting the underlying AI algorithms, ensuring that the platform remains adaptable to future changes in the local curriculum or specific school needs [17].

Furthermore, the integration of a Cloud Database system was prioritized to address the limitations of local school hardware. This infrastructure allows students to synchronize their work across different devices, fostering a seamless learning experience between the classroom and home environments. The technical architecture was optimized to minimize data latency, ensuring that students in regions with fluctuating internet connectivity could still access the "Economic Diversity" modules and receive AI feedback with minimal delay, thereby promoting equitable access to advanced educational technology [18].

Minor iterative revisions were conducted post-validation, including optimizing font legibility and icon consistency to cater to the cognitive load of primary school students. The e-portfolio media link that has been designed and developed by the researcher is as follows: <https://e-portfolio-tesis-e4bayh4xzdnpaukodfjkd.streamlit.app/>

Table 4. Results of media and material expert validation

No	Validation Component	Expert Validator	Total Score	Percentage	Category
1	Media Quality	Expert lecturers from the Department of Engineering, State University of Medan	62/70	88.57%	Very Valid
2	Material Accuracy	"Expert lecturers from the Department of Educational Technology, State University of Medan	54/60	90.00%	Very Valid

3.4 Implementation Stage

The implementation phase was executed after the Artificial Intelligence (AI)-based e-portfolio media was declared valid by both media and material experts. This stage aimed to evaluate the practicality of the media when utilized by teachers and students, and to measure its effectiveness in enhancing students' learning independence. The implementation was conducted during Social Studies (IPS) learning on the topic "Economic Diversity in My Region" (Keragaman Ekonomi di

Daerahku) at UPT SD Negeri 066047 Medan, involving 25 fifth-grade students. The instructional process using the AI-based e-portfolio was structured into three main phases: (a) preliminary Activities: The teacher introduced the AI-based e-portfolio system and explained its technical operation to the students, (b) core Activities: Students accessed learning materials, completed tasks, and uploaded their assignments directly to the e-portfolio system. Additionally, students wrote digital reflections regarding their comprehension, and the integrated AI engine immediately provided automated feedback on their entries, (c) closing Activities: The teacher and students collaboratively reflected on the lesson, allowing students to share their experiences using the digital platform.

3.4.1 Practicality Test

To assess the usability and operational convenience of the developed media, practicality questionnaires were distributed to 2 teachers and 25 fifth-grade students. The evaluation matrix and results are presented in Table 4 and Table 5.

Table 5. Practicality Test Results by Teachers

No	Evaluation Indicators	Teacher 1	Teacher 2	Total Score	Percentage	Category
1	Easy to integrate into Social Studies instruction	4	5	9	90%	Highly Practical
2	Clear and comprehensive user guidelines	5	5	10	100%	Highly Practical
3	Assists in monitoring student learning progress	4	5	9	90%	Highly Practical
4	Promotes students' learning independence	5	5	10	100%	Highly Practical
5	Aligns well with the allocated learning time	4	5	9	90%	Highly Practical
6	Feasible for continuous classroom implementation	5	5	10	100%	Highly Practical
Total				57 / 60	95%	Highly Practical

Table 6. Practicality Test Results by Students

No	Evaluation Indicators	Total Score	Percentage	Category
1	The platform is easy to navigate and use	111	88.8%	Highly Practical
2	The user interface design is visually engaging	115	92.0%	Highly Practical
3	Helps in understanding Social Studies concepts	112	89.6%	Highly Practical
4	Encourages independent learning habits	109	87.2%	Highly Practical
5	The learning experience is interactive and not boring	110	88.0%	Highly Practical
6	Enjoyable learning medium	114	91.2%	Highly Practical
Total		671 / 750	89%	Highly Practical

Based on the teacher evaluations, the e-portfolio achieved an overall score of 57 (95%), classifying it as "Highly Practical". Similarly, the student responses yielded a total score of 671 (89%), further confirming that the media is visually appealing, user-friendly, and successfully fosters independent learning.

3.4.2 Effectiveness and Statistical Analysis

The effectiveness of the AI-based e-portfolio was evaluated through a pre-observation and post-observation design measuring students' learning independence. The frequency distributions of student scores are detailed in Table 6 and Table 7.

Table 7. Frequency Distribution of Pre-Observation Scores

No.	Score Range	Frequency	Percentage (%)
1	55 – 59	3	12%
2	60 – 64	12	48%
3	65 – 69	4	16%
4	70 – 74	6	24%
Total		25	100%
Mean		64.64	

Tabel 8. Frequency Distribution of Post-Observation Scores

No.	Score Range	Frequency	Percentage (%)
1	85 – 89	6	24%
2	90 – 94	17	68%
3	95 – 100	2	8%
Total		25	100%
Mean		91.04	

As shown in the descriptive data, the class mean score experienced a substantial increase, rising from 64.64 in the pre-observation phase to 91.04 in the post-observation phase. This indicates a 100% positive growth rate across all 25 participating students. To determine the magnitude of this improvement, a Normalized Gain (N-Gain) analysis was performed. The results indicated an average N-Gain score of 0.7373 (73.72%), positioning the instructional effectiveness of the AI e-portfolio within the "Highly Effective" category.

To validate these findings inferentially, parametric assumptions tests were conducted. The Shapiro-Wilk normality test demonstrated that both pre-observation ($p = 0.081 > 0.05$) and post-observation ($p = 0.139 > 0.05$) datasets were normally distributed. Furthermore, the Levene test verified the homogeneity of variance ($p = 0.062 > 0.05$). Subsequently, a Paired Samples T-Test was executed to evaluate the research hypothesis. The statistical output revealed a highly significant difference between the pre- and post- observation scores ($p = 0.000 < 0.05$). Consequently, the null hypothesis (H_0) was rejected and the alternative hypothesis H_a was accepted. This confirms that the implementation of the AI-based e-portfolio significantly enhances independent learning capacities among fifth-grade primary school students compared to conventional instructional approaches.

3.5 Evaluation Stage

The evaluation stage provided a final synthesis of the product's quality based on three criteria: validity, practicality, and effectiveness. Beyond the expert validation mentioned previously, practicality was established through user response questionnaires. Teachers yielded a practicality score of 91.67%, while students gave a score of 90.00%, categorizing the platform as "Very Practical" for elementary education. Most critically, effectiveness was measured by the improvement in learning independence. The students' independence level surged from a baseline of 55.5% to a post-test score of 87.8% (Very Good), as detailed in Table 4. The evaluation concluded that the AI-driven automated feedback was the primary driver for this shift, as it empowered students to monitor their own progress and make autonomous corrections. These results confirm that the developed media successfully fulfills its pedagogical objectives and is ready for wider implementation in Social Studies education.

Tabel 9. Comparison of learning independence before and after media implementation

No	Assessment Stage	Total Score	Percentage	Category
1	Pre-implementation	555	55.5%	Poor
2	Post-implementation	878	87.8%	Very Good

4 Discussion

4.1 Validity of Learning Media

The high validity percentages (88.57% and 90.00%) confirm that the AI-based e-portfolio is technically stable and pedagogically aligned with the national curriculum. Validity is a fundamental requirement in developmental research to ensure that the produced media is scientifically sound and suitable for instructional use [19]. According to established theories, effective media must not only be accurate in content but also systematic in its presentation to facilitate deep comprehension [20]. The e-portfolio's design caters specifically to the concrete operational stage of fifth-grade learners by utilizing visual artifacts to explain abstract economic concepts [21]. This alignment ensures that the technology serves as a bridge between school material and real-world reality, fulfilling the requirements for high-quality educational innovation that can be reliably deployed in primary schools.

The achievement of "Very Valid" status underscores the importance of interdisciplinary collaboration in educational R&D. By merging computational logic with elementary pedagogy, the developed media transcends the limitations of static digital repositories. Expert feedback during the validation phase highlighted that the integration of AI does not replace the teacher's role but rather augments it by providing a "scaffolding" layer that is consistently available to the student [22]. This

alignment with the zone of proximal development (ZPD) ensures that the technology serves as a meaningful cognitive tool rather than a mere digital substitute for paper-based tasks.

4.2 Practicality of Learning Media

The practicality scores from teachers (91.67%) and students (90.00%) suggest that the media is highly usable within the constraints of an actual classroom. A product is deemed practical if it can be utilized with minimal effort and provides maximum utility for both educators and learners [23]. In this study, the intuitive navigation and clear AI prompts reduced technical frustration, allowing students to focus on the substantive Social Studies content [24]. For teachers, the Cloud Database and AI-generated progress reports streamlined the assessment process, which is often a burden in traditional portfolio systems [25]. This high level of acceptance is critical for the sustainability of educational technology, as it ensures that the media remains a helpful assistant rather than an administrative distraction during the learning process.

Moreover, the high practicality rating among teachers specifically points to the reduction of administrative burdens. Traditional portfolio assessment is often criticized for being labor-intensive, requiring significant time for manual review and feedback delivery [25]. The AI-based e-portfolio automates the preliminary stages of assessment and feedback, allowing teachers to dedicate more time to high-level instructional interventions and individual student counseling. This shift in time allocation is a crucial factor for the sustainability of digital innovations in primary schools, where teacher workload is often a barrier to technology adoption.

4.3 Effectiveness of Learning Media

The significant jump in learning independence from 55.5% to 87.8% highlights the effectiveness of AI as a pedagogical catalyst. This improvement aligns with the theory of self-regulated learning (SRL), where students take active responsibility for their goal-setting and self-monitoring processes [26]. The real-time feedback provided by the Artificial Intelligence acts as an "intelligent tutor," encouraging students to reflect on their learning gaps and perform autonomous revisions [27]. By shifting the focus from passive documentation to active reflection, the e-portfolio empowers students to realize their own academic growth [28]. This research proves that integrating AI into the e-portfolio framework specifically enhances the metacognitive skills of elementary students, offering a scalable solution for fostering independent learning in the social sciences.

This surge in effectiveness can be attributed to the psychological impact of "immediacy of feedback," which is a core component of cognitive reinforcement. When students receive feedback while their thought processes are still active, they are more likely to internalize the corrective information and apply it to their subsequent tasks [29]. In the context of Social Studies, this allowed students to refine their understanding of "Economic Diversity" dynamically, transforming a passive reading exercise into an active cycle of inquiry and improvement. Thus, the AI-integrated e-portfolio serves as a powerful instrument for fostering the metacognitive maturity required for lifelong learning.

5. Conclusion

The research concludes that the developed AI-based e-portfolio is a highly valid, practical, and effective pedagogical tool, supported by expert validation scores of up to 90.00% and a significant surge in student learning independence from 55.5% to 87.8%. A primary strength of the text is its emphasis on the "immediacy of feedback," which transforms the media from a static repository into an active "intelligent learning ecosystem" that strengthens students' self-efficacy and self-regulation. By grounding technological innovation in constructivist development, the study provides a robust framework for digital literacy in primary education. However, a notable weakness lies in the current lack of qualitative depth regarding the emotional and motivational nuances of student-AI interaction over time. Additionally, the text highlights its own limitations by identifying the need for future integration of predictive analytics and peer-assessment mechanisms to ensure a more holistic balance between autonomous and collaborative learning environments.

The success of this intervention lies in the "immediacy of feedback" provided by the AI integration, which effectively bridges the gap between student effort and cognitive reinforcement. Unlike traditional portfolios that rely on delayed teacher reviews, the AI-driven system allows students to enter a continuous cycle of self-correction and reflection. This immediate interaction not only clarifies subject matter but also strengthens the psychological foundations of self-efficacy, as

students see tangible progress in real-time, thereby fostering a more resilient and autonomous learning mindset in the social sciences.

On a broader scale, this research implies that the digital transformation of primary education must move beyond the mere digitization of textbooks and toward the creation of "intelligent learning ecosystems." The implementation of AI-based tools in early education stages serves as a critical foundation for digital literacy, preparing students to interact ethically and effectively with automated systems. Furthermore, it highlights the necessity for pedagogical frameworks to evolve alongside technological advancements, ensuring that innovation remains grounded in student-centered development rather than technology for its own sake.

Future studies should also investigate the qualitative nuances of student-AI interaction, particularly how different types of AI-generated prompts affect students' emotional engagement and motivation over time. Additionally, researchers might consider integrating more advanced AI capabilities, such as predictive analytics, to identify students at risk of falling behind in their independent learning targets. Exploring the synergy between AI feedback and peer-assessment within the e-portfolio framework could also provide valuable insights into how technology can foster collaborative as well as independent learning environments.

Acknowledgments

The authors would like to express their gratitude to the administration and faculty of UPT SD Negeri 066047 Medan for their cooperation and support during the data collection process. Special thanks are also extended to the expert validators who provided invaluable insights for the refinement of the developed instructional media.

AI Acknowledgment

The authors acknowledge the use of Gemini to improve the grammar, punctuation, fluency, and structural organization of this manuscript. The output from these prompts was utilized to refine the draft into a professional scholarly article. While the authors acknowledge the usage of AI, they maintain that they are the sole authors of this article and take full responsibility for the content therein, as outlined in COPE recommendations.

Funding Information

This research was funded by the researcher himself as the sole funder, and the authors would like to thank all parties and the research platform that made this study possible. The authors also express their gratitude to all individuals and stakeholders who contributed to the data collection, validation process, and academic insights that enhanced the quality of this research.

Informed Consent

We have obtained informed consent from all individuals included in this study.

Ethical Approval

The research related to human use has been complied with all the relevant national regulations and institutional policies in accordance with the tenets of the Helsinki Declaration and has been approved by the authors' institutional review board or equivalent committee.

References

- [1] A. Arsyad, *Instructional Media in the Digital Transformation Era*. Jakarta: Rajawali Press, 2023.
- [2] P. C. , & B. H. Abrami, "Directions for research and development on electronic portfolios," *Canadian Journal of Learning and Technology*, vol. 31, no. 3, pp. 1–15, 2005.
- [3] J. L. , D.-D. C. , & G. K. Moore, "e-Learning, online learning, and distance learning environments: Are they the same?," *Internet High. Educ.*, vol. 14, no. 2, pp. 129–135, 2011.
- [4] G. J. , & F. Q. K. Hwang, "Advancements and research trends in artificial intelligence in education.," *Interactive Learning Environments*, vol. 28, no. 8, pp. 980–1001, 2020.
- [5] R. , H. W. , G. M. , & F. L. B. Luckin, *Intelligence Unleashed: An Argument for AI in Education*. London: Pearson, 2016.
- [6] D. H. , & G. J. A. Schunk, *Handbook of Self-Regulation of Learning and Performance (2nd ed.)*. New York: Routledge, 2018.
- [7] E. Panadero, "A review of self-regulated learning: Six models and four directions for research," 2017, *Frontiers Media S.A.* doi: 10.3389/fpsyg.2017.00422.
- [8] X. Chen, H. Xie, D. Zou, and G. J. Hwang, "Application and theory gaps during the rise of Artificial Intelligence in Education," Jan. 01, 2020, *Elsevier B.V.* doi: 10.1016/j.caeai.2020.100002.
- [9] O. Zawacki-Richter, V. I. Marin, M. Bond, and F. Gouverneur, "Systematic review of research on artificial intelligence applications in higher education – where are the educators?," Dec. 01, 2019, *Springer Netherlands*. doi: 10.1186/s41239-019-0171-0.

- [10] M. Thobroni, *Belajar dan Pembelajaran: Teori dan Praktik*. Yogyakarta: Ar-Ruzz Media, 2015.
- [11] Sumantri, *Strategi Pembelajaran: Teori dan Praktik di Tingkat Pendidikan Dasar*. Jakarta: Rajawali Press, 2015.
- [12] N. Selwyn, *Education and Technology: Key Issues and Debates*. London: Bloomsbury Publishing., 2016.
- [13] N. Hidayati, "Kemandirian Belajar Siswa Kelas V SD Negeri Se-Kecamatan Pengasih.," *Jurnal Pendidikan Guru Sekolah Dasar*, vol. 3, no. 7, 2014.
- [14] R. M. Branch, *Instructional Design: The ADDIE Approach*. New York: Springer., 2009.
- [15] N. Ayu Prabawani et al., "Pemanfaatan Generative Artificial Intelligence (AI) untuk Inovasi Pembelajaran di SD Khadijah Wonorejo," *Sewagati*, vol. 9, no. 6, pp. 1573–1589, Dec. 2025, doi: 10.12962/j26139960.v9i6.8957.
- [16] Sugiyono, *Metode Penelitian Pendidikan: Pendekatan Kuantitatif, Kualitatif, R&D*. Bandung: Alfabeta , 2019.
- [17] R. Luckin, *Machine Learning and Human Intelligence: The Future of Education*. Londol: UCL Press, 2018.
- [18] UNESCO, *AI and education: Guidance for policy-makers*. Paris: UNESCO, 2021.
- [19] L. , B. S. A. , & C. M. Johnson, *NMC Horizon Report: 2016 Higher Education Edition*. Austin: NMC, 2016.
- [20] B. A. Pribadi, *Media dan Teknologi dalam Pembelajaran*. Jakarta: Kencana, 2017.
- [21] S. E. , L. D. L. , & R. J. D. Smaldino, *Instructional Technology and Media for Learning (12th ed.)*. New York: Pearson, 2019.
- [22] K. , M. B. M. , & A. V Holstein, "Designing for complementarity in human-AI hybrid systems," *Proceedings of the 2019 CHI Conference*, 2019.
- [23] K. Nieveen, *Prototyping to reach product quality*. Design Approaches and Tools in Education, 2010.
- [24] Z. Arifin, *Evaluasi Pembelajaran: Prinsip, Teknik, Prosedur*. Bandung: PT Remaja Rosdakarya., 2012.
- [25] H. Mudjiman, *Manajemen Belajar Mandiri*. Surakarta: UNS Press, 2011.
- [26] A. Susanto, *Pengembangan Pembelajaran IPS di Sekolah Dasar*. Jakarta: Prenadamedia Group., 2014.
- [27] Rusman, *Belajar dan Pembelajaran Berbasis Komputer*. Jakarta : Alfabeta, 2012.
- [28] Sapiya., *Pendidikan IPS: Konsep dan Pembelajaran*. Bandung: PT Remaja Rosdakarya., 2017.
- [29] H. B. Uno, *Teori Motivasi dan Pengukurannya: Analisis di Bidang Pendidikan*. Jakarta: Bumi Aksara., 2011.