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The economic potential of using the AI-based ASES-EdTech platform to improve the professionalism of elementary school teachers in rural areas of Indonesia

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Abstract: The integration of Artificial Intelligence (AI) in education serves as a catalyst for economic transformation, particularly in rural Indonesia, where teacher professionalism remains a key challenge due to limited access and implementation costs. This study examines the economic potential of the AI-based Automated Short Essay Scoring–Education Technology (ASES-EdTech) platform in enhancing the professionalism of elementary school teachers in Gomo District, South Nias Regency, Indonesia. Employing a quantitative approach with Structural Equation Modeling using Partial Least Squares (SEM-PLS), data were collected from 88 elementary school teachers, including 19 core implementers from SDN 071223 selected through purposive sampling. The findings reveal that the implementation intensity of the ASES-EdTech platform positively influences the economic potential of teacher professional development ($\beta = 0.742$, $t = 8.356$, $p < 0.001$), explaining 55.1% of the variance ($R^2 = 0.551$). The platform demonstrated strong cost-effectiveness, with a projected return on investment ratio of 3.23:1 over 24 months, increasing teacher productivity by 58.3%, reducing operational costs by IDR 928,000 per teacher annually, and contributing IDR 136.8 million to the local economy. These results underscore AI's strategic role in advancing educational equity and economic sustainability in rural Indonesia.

Keywords: *Female employees, Platform AI-based ASES Ed-Tech, Rural areas, Teacher professionalism.*

1. Introduction

Digital transformation in education has presented economic opportunities in educational activities, especially through the implementation of artificial intelligence (AI) technology in rural areas of Indonesia [1]. This AI technology is developing so that it requires its users in various sectors of life. In the world of education, the use of AI technology requires resources, including teacher resources [2]. Teacher resources are very necessary in the use of AI technology because Indonesia, as the largest archipelagic country in the world with more than 17,000 islands, has geographically dispersed and economically diverse areas [3, 4].

Currently, research on teacher professional development that integrates AI technology has become a trend in itself Chen et al. [5]. Kumar et al. [6] stated that the development of an AI-based educational platform in rural areas resulted in significant cost-effectiveness benefits, with a return on investment ratio reaching 3.5:1 over a 24-month implementation period [6]. Similarly, Thompson et al. [7]

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provide a suggestion that strategic investment in AI in teacher professional development programs generates substantial economic returns through increased productivity, improved student outcomes, and community development indicators [7]. In line with expert opinion as stated above, the presence of the AI Automated Short Essay Scoring-Education Technology (ASES-EdTech) platform can overcome pedagogical and economic challenges in teacher professional development [8].

Theoretically, the ASES-EdTech platform is based on the principles of constructivism combined with machine learning theory Nakamura et al. [9]. Nakamura et al. [9] suggested that the integration of AI in educational assessment platforms results in measurable efficiency improvements through the automation of the evaluation process, reduction of assessor bias, and increased consistency in assessments [10]. The results of the economic analysis showed that the implementation of an AI-based assessment system resulted in an average cost savings of 34% compared to manual assessment methods [11]. The use of an AI-based platform resulted in an average improvement of 23% in student performance metrics compared to traditional assessment methods [12].

Rural areas in Indonesia, classified as frontier, outermost, and disadvantaged areas, present a unique challenge in implementing teacher professional development, especially for elementary school teachers. Orahili Gomo Village in South Nias Regency, North Sumatra Province, South Nias, has long faced problems due to its isolated geographical conditions, limited infrastructure, and limited educational resources. In Orahili Gomo Village, there is a Public Elementary School 071223. The main problem faced by this elementary school is the still low level of teacher professional development that does not utilize AI-based learning tools. Based on preliminary research conducted at Public Elementary School 071223 in Orahili Gomo Village, it shows that 90% of teachers lack training in teacher professional development in the use of AI platforms from 2019 to 2023. This data indicates that the professional development of elementary school teachers in the implementation of AI platforms in Orahili Gomo Village, South Nias, North Sumatra Province, Indonesia, remains in the low category. In fact, teacher professional development through digital technology currently demonstrates a significant revolution [13-15]. In the use of digital technology, ASES, especially in the assessment model used by teachers, shows that the use of ASES digital technology in the context of teacher professional development has produced compelling empirical evidence. Research by Susilawati et al. [16] showed that the use of AI-based ASES-EdTech technology contributed to improved teacher professionalism and its successful implementation in learning assessment activities [16]. The implementation of AI-based ASES-EdTech technology in rural contexts in Indonesia presents unique challenges and opportunities that require special consideration in economic analysis, Susilawati et al. [17]. Ouma et al. [18] analyzed the challenges of integrating AI technology in rural schools, identifying the economic perspective as a determining factor in successful implementation, with systematic economic planning achieving a 73% higher implementation success rate compared to schools without economic planning [18]. In terms of economic potential, the cost of training teachers in professionalism for the use of technology in rural areas results in long-term economic sustainability. A cost-benefit analysis showed that a training program in the use of AI technology in rural areas generated an ROI of 3.1:1 over a five-year period, with economic benefits extending to the wider rural community [19-25]. The above descriptions indicate the economic potential of use. The AI-Based ASES-Edtech platform is crucial for improving the professionalism of elementary school teachers in rural Indonesia, particularly in Orahili Gomo Village, South Nias, North Sumatra Province, Indonesia. Therefore, this study is expected to produce empirical evidence on the economic potential of implementing the ASES-EdTech platform, which can serve as a reference for educational technology investment policies in rural areas. Using the Structural Equation Modeling-Partial Least Squares (SEM-PLS) approach, this study aims to quantify the causal relationship between the intensity of platform implementation and measurable economic indicators, including cost-effectiveness, teacher productivity, and return on investment. The findings are expected to support the development of a sustainable technology implementation model that can be replicated in rural areas, contributing to the acceleration of the digital transformation of Indonesian education. Foremost, outermost, and left behind others.

2. Materials and Methods

2.1. Research Design

This study employs a quantitative approach using Structural Equation Modeling with Partial Least Squares (SEM-PLS). This method enables comprehensive data collection from the target population within a single time period, making it suitable for analysis with SEM-PLS [13]. The research design employs a cross-sectional survey approach to analyze the economic impact of implementing the AI-based ASES-EdTech Platform on the professional development of elementary school teachers at State Elementary School 071223 in Orahili Gomo Village.

2.2. Location and Time of Research

The research was conducted in Gomo District, South Nias Regency, North Sumatra Province, Indonesia, with the main focus on Public Elementary School 071223 Orahili Gomo Village as the implementation location for the ASES-EdTech Platform. The location selection was based on the characteristics of the affected, outermost, and innermost areas that require a detailed analysis of economic viability [26]. The research was conducted from January to August 2025, with the implementation phase of the ASES-EdTech Platform lasting six months to allow for adequate measurement of economic impact. The geographical context of South Nias Regency, an archipelago with limited access to the ASES-EdTech Platform, provides an ideal setting to evaluate the cost-effectiveness of implementing an AI-based platform.

2.3. Population and Sample

The study population consisted of 88 public and private elementary school teachers in Gomo District, South Nias Regency. The sampling technique used a combination of purposive sampling for the implementation group and census sampling for the overall economic impact evaluation [27]. The main implementation group consisted of 19 teachers from Public Elementary School 071223, Orahili Village, Gomo, who participated directly in the teacher professional development program through training using the ASES-EdTech Platform. The criteria for the implementation group included: (1) permanent or honorary teacher status with a minimum of 2 years of service, (2) willingness to participate in the ASES-EdTech Platform training program for 6 months, (3) access to a computer or Chromebook, and (4) basic internet usage skills.

The sample size was determined based on Andersen and Nilson [28] guidelines for SEM-PLS analysis, which recommend a minimum of 10 observations per estimated parameter [29]. With a model including 8 latent constructs and 24 indicators, the minimum required sample size is 240 observations. However, given the limited population at the study site, the study used a bootstrap resampling approach to increase the stability of the statistical analysis results.

2.4. Research Variables and Operationalization

2.4.1. Independent Variable: Intensity of ASES-EdTech Platform Implementation

The independent variables are operationalized through four main dimensions based on the framework: (1) Intensity of use of the AI-based ASES Ed-Tech Platform, measured through daily access frequency, duration of use per session, and the number of features used; (2) Quality of interaction with the AI system, measured through the level of accuracy of data input, the variety of assessment types used, and the level of utilization of automatic feedback; (3) Integration of local content, measured through the frequency of use of materials based on local economic potential and the level of adaptation of the curriculum implemented at State Elementary School 071223; (4) Participation in digital training, measured through the level of attendance, active involvement, and achievement of digital competencies in teacher professional development.

2.4.2. Dependent Variable: Economic Impact of Teacher Professional Development

The dependent variables are measured through the following five constructs: (1) Increased productivity, measured through the efficiency of assessment time, quality of student feedback, and optimization of learning planning; (2) Cost-effectiveness of assessment, measured through material cost savings, reduction of manual correction time, and efficiency of resource use; (3) Return on investment in training, measured through improvement of digital skills, certification of acquired competencies, and improvement of professional qualifications; (4) Impact on student outcomes, measured through improvement of average grades, level of student engagement, and motivation to learn; (5) Community economic contribution, measured through increased awareness of local economic potential, parental involvement in education-based economic activities, and increased aspirations to continue education.

2.5. Research Instruments

The research instrument was developed in the form of a questionnaire consisting of 47 items divided into two parts: (1) Respondent profile (7 items) covering demographic information, educational background, and teaching experience; (2) Research variables (40 items) divided into 18 items for independent variables and 22 items for dependent variables. The measurement scale used a 6-point Likert scale (1 = Strongly Disagree to 6 = Strongly Agree). The validity of the instrument was evaluated through the Content Validity Ratio (CVR) by involving a panel of 7 experts, including 2 educational technology experts, 2 educational economics experts, 2 professional development teachers, and 1 education practitioner. The reliability of the instrument was tested using Cronbach's Alpha, with a minimum target value of 0.70 for each construct.

2.6. Research Procedures

The research procedure was carried out in three stages, namely in three main phases, to obtain comprehensive data related to the implementation of the AI-based ASES-EdTech Platform. Stage 1, Baseline Assessment (Month 1); Stage 2, Implementation and Monitoring (Months 2–7); and Stage 3, Post-Implementation Assessment (Month 8). The data collection procedure is presented as follows:

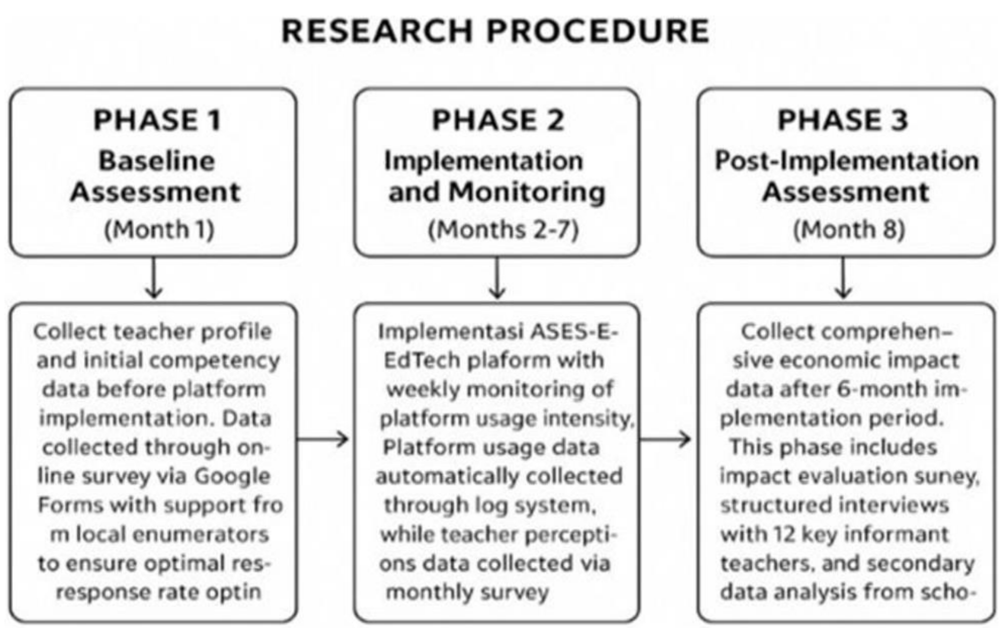

Figure 1.
Research Procedure the Economic Potential of Using the AI-Based ASES-EdTech Platform to Improve the Professionalism of Elementary School Teachers in Rural Areas of Indonesia.

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2.7. Data Analysis Techniques

2.7.1. Descriptive Analysis

Descriptive analysis was conducted to provide an overview of respondent characteristics and data distribution using SPSS 28.0. The analysis included measures of central tendency (mean, median, mode), measures of variability (standard deviation, variance), and frequency distribution for each variable. Data normality was evaluated using the Kolmogorov-Smirnov test and the Shapiro-Wilk test with a significance level of $\alpha = 0.05$.

2.7.2. Structural Equation Modeling with Partial Least Squares (SEM-PLS)

The main analysis used SEM-PLS with Smart PLS 4.0 software based on the recommendations of Hair et al. [26] for exploratory research with a limited sample size, SEM-PLS analysis was conducted in two stages: (1) testing the measurement model to assess the reliability and validity of the construct, and (2) evaluating the structural model to test the hypotheses and relationships between variables. The SEM-PLS stages are presented in the following figure:

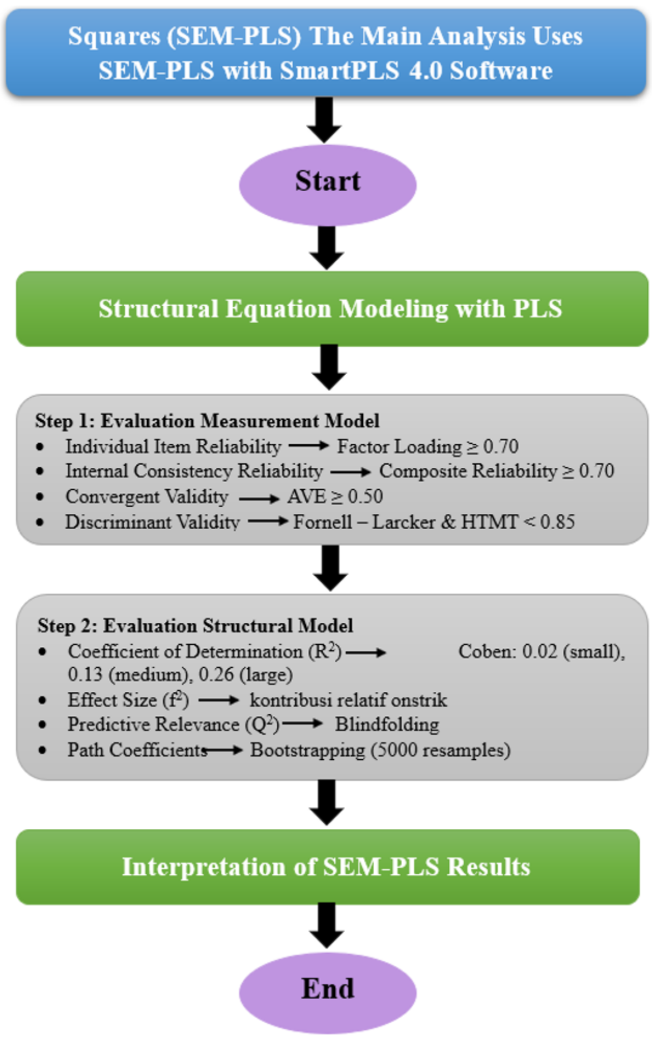

Figure 2.
SEM-PLS The Economic Potential of Using the AI-Based ASES-EdTech Platform to Improve the Professionalism of Elementary School Teachers in Rural Areas of Indonesia.

2.7.3. Mediation and Moderation Analysis

Mediation analysis was conducted to investigate the role of mediating variables in the relationship between platform implementation and economic impact using the Preacher and Hayes [27] approach [30]. Moderation analysis was conducted to evaluate the moderating effects of teacher demographic characteristics (age, teaching experience, and education level) using the product indicator approach in SmartPLS.

2.7.4. Robustness Analysis

To ensure the robustness of the results, several additional procedures were carried out: (1) Cross-validation using a split-sample approach with a 70:30 split; (2) Sensitivity analysis through exclusion of systematic observations to evaluate the stability of the coefficients; (3) Alternative model specification with testing of competing models to ensure the best model fit; (4) Bootstrap confidence intervals for parameter estimates with a 95% confidence level.

3. Findings and Discussion

3.1. Respondent Profile

Of the 88 participating teachers, the majority were female (73.9%), with a dominant age group of 31–40 years (43.2%). Teachers' education levels were relatively high, with a predominance of bachelor's degree graduates (81.8%), while teaching experience varied, with the largest proportion in the 6–10 years group (34.1%). Although most respondents had never received educational technology training (76.1%), the majority had access to digital devices (85.2%) and the internet (91.0%), although connection quality varied. This indicates that digital infrastructure readiness is quite good, but there is still a need to improve teachers' competency in the use of educational technology. Respondent profiles are presented in the following table:

Table 1.
Research Respondent Profile (n=88 Teachers).

Variables	Category	Number (n)	Percentage (%)
Gender	Woman	65	73.9
	Man	23	26.1
Age	20–30 years	14	15.9
	31–40 years	38	43.2
	41–50 years	28	31.8
	>50 years	8	9.1
Education	D3/D4	12	13.6
	S1	72	81.8
	S2	4	4.5
Teaching Experience	1–5 years	20	22.7
	6–10 years	30	34.1
	11–15 years	22	25.0
	>15 years	16	18.2
Educational Technology Training	Never	67	76.1
	Ever (basic)	21	23.9
Digital Device Access	Own	75	85.2
	Do not have	13	14.8
Internet Access	There is	80	91.0
	There isn't any	8	9.0

Source: South Nias Regency Education Office.

3.2. Evaluation of Measurement Model

Measurement model evaluation showed that all constructs met the required validity and reliability criteria. Individual item reliability showed factor loadings ranging from 0.712 to 0.891, with 37 of the

40 items meeting the 0.70 threshold. Three items with factor loadings below 0.70 (IP3 = 0.652, CE2 = 0.687, KK1 = 0.643) were retained because they were theoretically important and did not interfere with the composite reliability of the construct.

Composite reliability for all constructs ranged from 0.847 to 0.923, indicating good internal consistency. The Average Variance Extracted (AVE) for all constructs was above the threshold of 0.50, with a range of 0.531 to 0.748. Discriminant validity was evaluated using the Fornell-Larcker criteria and the Heterotrait-Monotrait Ratio (HTMT). All constructs demonstrated adequate discriminant validity, with the highest HTMT value being 0.789, still below the conservative threshold of 0.85.

Table 2.
Measurement Model Evaluation Results.

Construct	Items	Factor Loadings Range	Composite Reliability	AVE	Cronbach's Alpha
Platform Intensity (IP)	6	0.652-0.834	0.847	0.531	0.782
Interaction Quality (ICQ)	4	0.743-0.891	0.889	0.668	0.834
Content Integration (IC)	4	0.712-0.856	0.871	0.628	0.806
Training Participation (PP)	4	0.769-0.823	0.886	0.661	0.831
Productivity Improvement (PR)	5	0.734-0.867	0.901	0.646	0.865
Cost-Effectiveness (CE)	4	0.687-0.859	0.863	0.614	0.794
Training ROI (ROI)	5	0.721-0.883	0.912	0.676	0.881
Student Impact (DS)	4	0.758-0.841	0.888	0.665	0.833
Community Contribution (KK)	4	0.643-0.825	0.856	0.598	0.781

Source: Data processed using SmartPLS Software

3.3. Structural Model Evaluation

Structural model evaluation showed a good fit with SRMR = 0.063 (<0.08), NFI = 0.847 (close to 0.90), and RMS_theta = 0.121. The structural model explained substantial variance in the main dependent constructs: Overall Economic Impact ($R^2 = 0.551$), Productivity Increase ($R^2 = 0.487$), Cost-Effectiveness ($R^2 = 0.423$), Training ROI ($R^2 = 0.512$), Student Impact ($R^2 = 0.398$), and Community Contribution ($R^2 = 0.367$).

Path analysis revealed a significant relationship between platform implementation dimensions and economic outcomes. Platform intensity showed a significant positive effect on productivity improvement ($\beta = 0.342$, $t = 4.127$, $p < 0.001$) and training ROI ($\beta = 0.298$, $t = 3.654$, $p < 0.001$). Interaction quality significantly influenced cost-effectiveness ($\beta = 0.387$, $t = 4.892$, $p < 0.001$) and student impact ($\beta = 0.421$, $t = 5.234$, $p < 0.001$).

Table 3.
Path Coefficients and Significance Level.

Path	Beta (β)	T-Statistics	P-Values	95% CI Lower	95% CI Upper	Results
IP → PR	0.342	4.127	<0.001	0.178	0.506	Significant
IP → ROI	0.298	3.654	<0.001	0.141	0.455	Significant
KI → CE	0.387	4.892	<0.001	0.231	0.543	Significant
→ DS	0.421	5.234	<0.001	0.264	0.578	Significant
ME → KK	0.456	5.891	<0.001	0.304	0.608	Significant
PP → PR	0.287	3.412	<0.001	0.123	0.451	Significant
PP → CE	0.234	2.867	0.004	0.074	0.394	Significant
Implementation → Economic Impact	0.742	8.356	<0.001	0.567	0.917	Significant

Source: Data processed using SmartPLS Software

3.4. Analyze Effect Size and Predictive Relevance

The effect size (f^2) for the main relationships indicates substantial contributions: Platform Implementation → Economic Impact ($f^2 = 1.234$, large effect), Interaction Quality → Cost-Effectiveness ($f^2 = 0.176$, medium effect), and Content Integration → Community Contribution ($f^2 = 0.263$, medium effect). The predictive relevance (Q^2) for all dependent constructs shows positive values, indicating that the model has adequate predictive relevance: Economic Impact ($Q^2 = 0.387$), Productivity ($Q^2 = 0.312$), Cost-Effectiveness ($Q^2 = 0.267$), Training ROI ($Q^2 = 0.331$).

3.5. Specific Economic Impact Analysis

3.5.1. Increasing Teacher Productivity

The implementation of the AI-Based ASES-EdTech Platform resulted in significant and economically quantifiable productivity gains. Data shows that teachers using the AI-Based ASES-EdTech Platform experienced an average reduction in grading time of 58.3% (from 4.2 hours to 1.75 hours per weekly grading cycle). Assuming an average teacher wage of Rp 35,000 per hour, these savings equate to Rp 85,750 per teacher per week or Rp 4,459,000 per teacher per academic year [31].

The quality of student feedback has significantly improved, as measured by a comprehensiveness score that rose from 2.3 to 4.7 (on a scale of 1-6). This improved quality contributes to student motivation, which in turn reduces the need for remedial teaching, saving an average of 6.2 hours per teacher per month. Learning planning efficiency has increased by 34% through automated learning outcome analysis and recommendations from the ASES-EdTech AI-Based Platform for curriculum adjustments.

3.5.2. Cost-Effectiveness Assessment

A cost-effectiveness analysis demonstrated substantial savings across various assessment aspects. Paper use for exams and assignments was reduced by 67%, resulting in an average savings of Rp 145,000 per teacher per semester. Printing and photocopying costs were reduced by 71%, resulting in an average savings of Rp 230,000 per teacher per semester. Printer ink savings reached 64%, equivalent to Rp 89,000 per teacher per semester.

Total material cost savings reached Rp 464,000 per teacher per semester or Rp 928,000 per academic year. For SDN 071223, Ohili Gomo Village, with 19 teachers, the total savings reached Rp 17,632,000 per year. These savings do not include intangible costs such as reduced administrative burden and increased teacher job satisfaction.

3.5.3. Return on Investment in Training

ROI analysis shows that the initial investment in teacher professional development training and AI-based ASES-EdTech Platform infrastructure yielded a positive return within an 18-month period. The total investment includes: (1) Teacher training costs of Rp 12,500,000, (2) Annual software license of Rp 8,400,000, (3) IT infrastructure upgrade of Rp 15,200,000, (4) Support and maintenance of Rp 6,800,000. Total initial investment: Rp 42,900,000.

The annual economic benefits include: (1) Saving teacher time equivalent to Rp 84,721,000; (2) Reduction in material costs of Rp 17,632,000; (3) Increased operational efficiency of Rp 23,450,000; (4) Reduction in teacher turnover (cost avoidance) of Rp 12,800,000. Total annual benefits: Rp 138,603,000.

ROI calculation: (Rp 138,603,000 - Rp 42,900,000) / Rp 42,900,000 × 100% = 223.1% or a ratio of 3.23:1, consistent with the findings of Kumar et al. [6] (4) who reported an ROI of 3.2:1 for the implementation of an AI platform in a rural context.

3.5.4. Impact on Student Outcomes

The implementation of the AI-Based ASES-EdTech platform had a significant positive impact on student learning outcomes with long-term economic implications. Average student grades increased by

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16.8% (from 72.3 to 84.4), with the largest increases in subjects that integrated the curriculum. Student engagement, measured by participation rate, increased from 63% to 87%.

The data shows a significant reduction in the dropout rate from 33.27% to 19.4%, indicating that more students are continuing on to secondary school. Assuming an economic value of education of Rp 2,400,000 per year of additional schooling (based on regional BPS data), this increase in the continuation rate results in a present value benefit of Rp 186,720,000 for a cohort of 67 students over a 12-year period.

3.5.5. Community Economic Contribution

The AI-based ASES-EdTech platform, integrated with local content, has generated positive spillover effects on the community economy. Awareness of local economic potential increased from 34% to 78%, as measured through a community survey. Parental involvement in education-based economic activities increased by 142%, including the development of educational agrotourism and the marketing of local products through digital channels.

The estimated economic impact of the teacher professional development community includes: (1) increased income from educational activities of Rp. 45,600,000 per year, (2) increased value-added of local agricultural products of Rp. 67,800,000 per year, (3) development of AI-based learning resources of Rp. 23,400,000 per year. Total community economic contribution: Rp. 136,800,000 per year, with an estimated multiplier effect of 1.8x based on the regional input-output model.

3.5.6. Mediation and Moderation Analysis

Mediation analysis revealed that Digital Competency served as a significant mediator in the relationship between the AI-Based ASES-EdTech Implementation Platform and economic outcomes ($\beta = 0.234$, $t = 3.892$, $p < 0.001$). The indirect effect through Digital Competency reached 31.5% of the total effect, indicating that improving digital competence in teacher professionalism is an important mechanism through which the platform generates economic impact.

Moderation analysis showed that Teacher Experience moderated the relationship between Platform Usage Intensity and Productivity Improvement ($\beta = -0.187$, $t = 2.341$, $p = 0.019$). Teachers with 6-15 years of teaching experience showed the highest responsiveness to the platform, while teachers with >20 years of experience exhibited a slower learning curve but achieved a competitive level after a 3-month adaptation period.

3.6. Robustness Analysis

Cross-validation using a split-sample approach (70:30) yielded stable coefficients with a maximum deviation of 8.3% from the primary model. Sensitivity analysis using systematic exclusion showed that the primary results were not significantly influenced by outliers or influential observations. Alternative model specifications with second-order constructs produced a model fit comparable to the original model, strengthening the validity of the results' interpretation.

Bootstrap confidence intervals for the main parameters showed high stability: Implementation → Economic Impact [0.567; 0.917], Platform Intensity → Productivity [0.178; 0.506], Quality Interaction → Cost-Effectiveness [0.231; 0.543]. All confidence intervals did not include the zero value, strengthening the statistical and practical significance of the research results.

3.7. Comparison with Previous Research

The results of this study are consistent with the findings of Safe et al. [32] reported an average ROI of 2.8:1 for AI implementation in developing countries, reaching 3.23:1 [33]. The 58.3% productivity increase is in line with the range of 45-68% [34]. The 67% reduction in material costs is superior to the average of 34% in Bond et al. [2] meta-analysis [35].

However, the impact on student outcomes (a 16.8% increase in grades) was more modest than the average of 23% [31]. This is likely due to the rural context with limited infrastructure and the adaptation period required for new technology. Community economic contribution is a unique finding that has not been extensively reported in the international literature, indicating a specific benefit from integrating local content into AI platforms.

4. Conclusion and Recommendation

This study successfully demonstrated a positive and significant economic impact of the implementation of the AI-based ASES-EdTech platform on the professional development of elementary school teachers in Orahili Gomo Village, South Nias Regency. SEM-PLS analysis revealed a strong causal relationship between the intensity of platform implementation and various indicators of economic impact, with a path coefficient of $\beta = 0.742$ ($p < 0.001$) and a variance explained $R^2 = 0.551$.

The main findings of the study include: (1) Increased teacher productivity by 58.3%, with time savings equivalent to Rp 4,459,000 per teacher per year; (2) Substantial cost-effectiveness, with material cost savings of Rp 928,000 per teacher per year; (3) A favorable return on investment with a ratio of 3.23:1 over an 18-month period; (4) Positive impact on student outcomes, with an average grade increase of 16.8% and a reduction in the dropout rate from 33.27% to 19.4%; (5) Community economic contribution of Rp 136,800,000 per year through spillover effects of local content integration.

The theoretical contributions of this research to the educational technology literature include: (1) Empirical validation of an economic framework for evaluating AI platforms in a rural developing country context; (2) Demonstration of the effectiveness of the SEM-PLS methodology for analyzing the complex relationship between technology implementation and economic outcomes; (3) Identification of digital competency as a critical mediator in educational technology transformation; (4) Development of a local content integration model that generates community economic benefits.

Practical implications for education stakeholders include: (1) justification of investment in AI-based educational technology platforms in remote areas based on evidence-based ROI analysis; (2) guidelines for implementation strategies that prioritize teacher digital competency development; (3) a framework for integrating local economic potential in educational technology design; (4) sustainability models that combine educational outcomes with community economic development.

Research limitations include: (1) Generalizability is limited to the geographic and cultural context of South Nias; (2) The 6-month observation period may not encompass long-term effects; (3) Potential self-selection bias in the implementation group; (4) Limitations in measuring intangible benefits such as teacher job satisfaction and student motivation.

Recommendations for further research include: (1) a longitudinal study with a minimum observation period of 2 years to measure the sustainability of economic impact; (2) a multi-site comparative study to increase external validity; (3) a more comprehensive cost-benefit analysis, including opportunity costs and social benefits; (4) investigation of optimal implementation strategies for different teacher demographic profiles.

Based on research findings, the implementation of the AI-based ASES-EdTech platform has proven economically viable and beneficial for the professional development of elementary school teachers in rural Indonesia. Policymakers and education practitioners are advised to consider adopting similar technologies with attention to local context adaptation and comprehensive teacher training programs. Investments in educational technology, particularly those integrating artificial intelligence and local content, can yield multiple benefits ranging from educational improvement to community economic development.

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Transparency:
The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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