Students' Perceptions of AINS Effectiveness in Rural Primary Schools in Malaysia

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***Abstract*—This study examined rural primary students' perceptions of the Advanced Integrated NILAM System (AINS) in Malaysia and investigated how five key constructs—Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Internal Factors (IF), External Factors (EF), and Behavioral Intention (BI)—influence Perceived Effectiveness (EA). AINS is a digital platform aligned with the government-endorsed NILAM reading program under Malaysia's Digital Education Policy (2021–2030). A quantitative correlational design was employed, involving 65 students from a rural primary school. Correlational analyses revealed that all five constructs were significantly and positively associated with EA. However, regression results indicated that only IF ($\beta = 0.451$, $p < 0.001$) had a unique predictive effect. This study addresses a gap in previous research, which has largely overlooked rural students' perspectives in evaluating educational technology. The findings emphasize the critical role of students' motivation, confidence, and attitudes in shaping the perceived effectiveness of digital tools, rather than system features alone. Practical implications highlight the need to foster internal readiness to support meaningful and equitable technology integration in rural schools.**

***Keywords*—Advanced Integrated NILAM System (AINS), rural education, extended Technology Acceptance Model (TAM), digital literacy, perceived ease of use, behavioral intention**

I. Introduction

The digital transformation of education has emerged as a global imperative, driven by the growing demand for equitable access to learning and the integration of technology in classrooms worldwide [1]. In Malaysia, this priority is reflected in national initiatives such as the Digital Education Policy (2021–2030), which promotes digital literacy among students and teachers alike. A key effort under this agenda is the modernization of NILAM (*Nadi Ilmu Amalan Membaca*), a nationwide reading program, through the introduction of the Advanced Integrated NILAM System (AINS) [2]. AINS is an online platform designed to digitize reading record practices by enabling students to log their reading activities, receive personalized feedback, and earn digital badges to enhance engagement and motivation [3].

This shift from traditional paper-based systems to a centralized digital platform aligns with the broader goal of fostering digital competence among schoolchildren and creating a technology-enriched learning environment across Malaysian schools [4, 5]. AINS also serves as a tool to promote students' early engagement with digital platforms, thereby enhancing their digital fluency while simultaneously cultivating a culture of reading [6, 7]. Moreover, as part of the Digital Education Policy, the Ministry of Education endorses AINS as a national mechanism for integrating digital tools into daily classroom activities, thereby supporting educational modernization efforts in line with national aspirations [2].

However, implementing such systems in rural school contexts presents distinct challenges. Schools in remote or underserved areas often face limited technological infrastructure, unreliable internet connectivity, and a shortage of digital devices [8, 9]. Students in these communities typically have less exposure to technology at home, and parental support for digital learning is often limited due to low digital literacy levels among caregivers [10, 11]. These barriers hinder students' ability to engage meaningfully with platforms like AINS, potentially exacerbating existing disparities in digital access and educational achievement [12].

Despite the strategic aims of AINS, current research in the field of educational technology primarily focuses on teacher acceptance, with limited attention given to how primary school students themselves perceive these systems [13, 14]. This presents a significant gap in the literature, especially considering that students are the end users whose interaction with the platform ultimately determines its success. If the system is perceived as too difficult to use or not beneficial, students may disengage, undermining the initiative's intended outcomes [15]. The Technology Acceptance Model (TAM) suggests that perceived usefulness and perceived ease of use are key predictors of a user's intention to adopt technology [16]. These constructs are particularly relevant for evaluating the suitability of digital tools like AINS in rural settings, where user experiences are shaped by contextual limitations.

Although AINS was envisioned as a scalable, policy-aligned innovation for enhancing reading engagement, few studies have evaluated its effectiveness from the perspective of rural students. Without direct insights from this user group, efforts to scale and sustain its use may be misaligned with students' actual needs and capabilities. Therefore, this study aims to explore rural primary students' perceptions of AINS and examine how five key constructs—Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Internal Factors (IF), External Factors (EF), and Behavioral Intention (BI)— influence their perceived effectiveness of the system.

In doing so, the study contributes to the literature by giving voice to rural students in technology acceptance research, a population that has largely been overlooked. It also considers contextual barriers such as device access, internet availability, and family support [17, 18]. Ultimately, the findings will inform stakeholders with valuable insights on how to tailor

digital interventions to support more equitable technology adoption, ensuring that platforms like AINS fulfill their intended potential in rural educational settings.

II. Problem Statement

Despite strategic national efforts such as NILAM and the Digital Education Policy (2021–2030) [19–21], the actual usage of the Advanced Integrated NILAM System (AINS) among rural students remains alarmingly low. In the rural school examined for this study, students recorded an average of only 2.8 readings each, even after official briefings and guidance. NILAM records serve as a key indicator of the reading culture within a school; therefore, a lower number of recorded readings suggests that a strong reading culture has yet to be established. This usage pattern suggests more than just technical underperformance. It reflects a deeper disconnect between the system's intended design and the realities of students' digital readiness, home support, and reading motivation [18].

This limited use is concerning because AINS was introduced to modernize reading practices, increase student engagement, and help reduce digital learning disparities [19–21]. However, the gap between its intended goals and actual usage could unintentionally deepen existing inequalities in education if left unaddressed [22].

The challenges are complex. Students face infrastructure barriers, limited access to personal devices and reliable internet, low parental support for technology use, and weak reading motivation [23, 24]. In rural areas where financial and social constraints are more severe, these difficulties are even more pronounced. Furthermore, the national reading culture presents an additional challenge. Malaysians reportedly read fewer books per year compared to several other countries, which further complicates efforts to promote sustained engagement with reading-focused platforms like AINS [25]. If students are unable to access or use AINS meaningfully, the system's educational potential cannot be realized.

The primary purpose of this study is to examine students' perceptions of the effectiveness of AINS use in rural schools, which may be influenced by several key factors. Specifically, the objectives of this study are:

1) To explore students' perceptions of the effectiveness of using the Advanced Integrated NILAM System (AINS) in rural schools.
2) To analyze the factors that influence students' NILAM record entries in the AINS system.
3) To determine the relationship between Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Internal Factors (IF), External Factors (EF), and Behavioral Intention (BI) with the Effectiveness of AINS Use (EA).
4) To examine the impact of Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Internal Factors (IF), External Factors (EF), and Behavioral Intention (BI) on the Effectiveness of AINS Use (EA).

To address these objectives, the study sought to answer the following research questions:

1) What are students' perceptions of the effectiveness of AINS use in rural schools?
2) What factors influence students' NILAM record entries in the AINS system?
3) Is there a significant relationship between Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Internal Factors (IF), External Factors (EF), and Behavioral Intention (BI) and the Effectiveness of AINS Use (EA)?
4) To what extent do Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Internal Factors (IF), External Factors (EF), and Behavioral Intention (BI) influence the Effectiveness of AINS Use (EA)?

III. Literature Review

The effective integration of digital technologies into educational practices is a global imperative, particularly for fostering foundational skills such as reading literacy. This review examines existing literature relevant to the critical importance of reading literacy, the multifaceted role and inherent challenges of technology in educational settings, the evolution of national reading programs like NILAM into digital systems such as the Advanced Integrated NILAM System (AINS), and the established theoretical models that explain technology acceptance among users. Particularly emphasis is placed on the unique context of rural primary school students, who are the focus of the present study.

A. The Importance and Challenges of Reading Literacy

Reading literacy is universally recognized as a cornerstone of individual development, academic success, and socioeconomic progress [26]. It involves not only the ability to decode text, but also to comprehend, critically evaluate, and engage with written information to support lifelong learning [27]. International assessments such as PISA consistently link national reading literacy levels to both educational and economic outcomes [28]. In Malaysia, despite ongoing efforts to promote reading, challenges persist. PISA 2022 results indicate that Malaysian students' reading comprehension scores remain below the international average compared to some regional peers [29]. Contributing factors to these literacy challenges include low intrinsic student motivation, limited access to diverse reading materials, and inconsistent parental support, particularly in disadvantaged areas [25, 30].

B. Technology in Literacy Education: Potentials and Barriers

Information and Communication Technology (ICT) offers transformative potential for literacy education by providing engaging, interactive, and personalized learning experiences that can enhance student motivation and interest in reading [8, 31]. Features such as multimedia content, digital rewards, and gamification have been shown to positively influence student engagement and reading habits [32, 33]. Studies confirm that well-designed digital applications can strengthen reading skills and enjoyment [34, 35], broaden access to reading materials, and develop essential digital literacy skills [36, 37]. However, successful technology integration faces challenges, especially in rural communities. The "digital divide", characterized by disparities in access to devices, reliable internet, and adequate infrastructure, remains a significant barrier [38–40], potentially exacerbating educational inequalities [1, 41–43]. Furthermore, effective use depends on the digital literacy

levels of both students and teachers [44, 45].

C. The NILAM Program and the Advanced Integrated NILAM System (AINS)

Malaysia's NILAM (*Nadi Ilmu Amalan Membaca*) program, launched in 1999, has been a key school-based initiative to cultivate reading habits through systematic recording and recognition [46]. However, traditional manual methods faced challenges related to efficiency, monitoring, and sustaining student engagement [27]. To address these issues and align with national digitalization goals, the Advanced Integrated NILAM System (AINS) was developed. AINS is a digital platform designed to modernize NILAM by enabling online logging of reading activities, offering digital rewards, and allowing real-time progress monitoring by educators [19, 20]. It aims to make NILAM more interactive and manageable [4, 28]. Nonetheless, successful implementation in rural schools depends on overcoming challenges such as limited device and internet access [29, 30] and fostering adequate digital literacy among users [31, 32].

D. Theoretical Framework: The Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), proposed by Davis [16], provides a robust framework for understanding user acceptance of new technologies. TAM posits that Perceived Usefulness (PU)—"the degree to which a person believes that using a particular system would enhance his or her job performance", and Perceived Ease of Use (PEOU)—"the degree to which a person believes that using a particular system would be free of effort" [16, p. 320]—are the primary determinants of an individual's Behavioral Intention (BI) to use a system, which in turn predicts actual usage. PEOU is also believed to directly influence PU. TAM has been widely applied and has served as the foundation for extended models such as TAM 2 [47], TAM 3 [48], and the Unified Theory of Acceptance and Use of Technology (UTAUT) [14], which incorporate additional factors. This study employed an expanded TAM framework that integrates other factors relevant to young learners in rural educational settings. Recent empirical research supports the predictive validity of TAM constructs across various educational and technology adoption contexts. For example, Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) have been shown to significantly influence Behavioral Intention (BI) in settings ranging from Small and Medium Enterprises (SMEs) to Internet of Things (IoT) adoption [49, 50]. Internal Factors (IF), such as user trust and collaboration, significantly influence PU and PEOU [51, 52], while External Factors (EF), including service quality and infrastructure access, have been found to moderate their effects [53]. Importantly, these studies collectively indicate that BI, as shaped by PU, PEOU, IF, and EF, serves as a key determinant of system success or perceived effectiveness (EA). These findings thus support the theoretical expansion of TAM to include contextual and motivational variables relevant to AINS adoption.

E. Key Factors Influencing Student Technology Acceptance and Use

Beyond the core TAM constructs, the literature suggests that additional internal and external factors significantly influence students' acceptance and use of educational technologies like AINS. Internal Factors (IF) include individual characteristics such as technological self-efficacy (belief in one's ability to use technology effectively) [54, 55], intrinsic motivation (e.g., interest in reading or technology) [56], prior digital experiences, and general attitudes toward technology [57–59]. External Factors (EF) relate to environmental and social influences. These include critical elements such as teacher guidance and support in using the system [60, 61], parental involvement and encouragement for digital learning activities [62–64], and the availability and quality of technological infrastructure and resources both at school and at home [65]. Understanding the interplay of these factors is essential for a comprehensive view of AINS adoption.

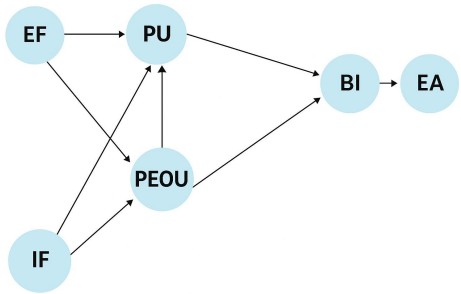

Fig. 1. Conceptual framework.

As illustrated in Fig. 1, the proposed framework hypothesizes that Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Internal Factors (IF), and External Factors (EF) influence students' Behavioral Intention (BI) to use AINS, which in turn predicts their Perceived Effectiveness of AINS use (EA). PEOU is also proposed to have a direct effect on PU. The model builds upon the original Technology Acceptance Model (TAM) and incorporates contextual and motivational variables particularly relevant to rural primary students. This conceptual linkage offers a structured yet holistic perspective on how personal beliefs and environmental supports interact to determine the perceived success of educational technology implementations like AINS.

F. The Present Study and Identified Research Gap

While TAM and related models have been applied in various Malaysian educational contexts [66, 67], there remains a specific gap in research focusing on the perceptions and acceptance of dedicated reading management systems like AINS among rural primary school students. Much of the existing literature addresses NILAM in its traditional form or general digital literacy, without specific analysis of AINS within this key demographic. This study aimed to fill this gap by investigating how Perceived Usefulness, Perceived Ease of Use, Behavioral Intention, and selected internal and external factors influence the perceived effectiveness of AINS among these students. The findings are expected to provide valuable insights for optimizing AINS and similar digital educational tools in rural school settings.

Based on the Technology Acceptance Model and the reviewed literature on factors influencing technology adoption and use in educational settings, the following hypotheses were developed for empirical testing in this study:

- **H1:** There is a significant relationship between Perceived Usefulness (PU) and the effectiveness of AINS use (EA).
- **H2:** There is a significant relationship between Perceived Ease of Use (PEOU) and the effectiveness of AINS use (EA).
- **H3**: There is a significant relationship between Internal Factors (IF) and the effectiveness of AINS use (EA).
- **H4**: There is a significant relationship between External Factors (EF) and the effectiveness of AINS use (EA).
- **H5**: There is a significant relationship between Behavioral Intention (BI) and the effectiveness of AINS use (EA).
- **H6**: Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Internal Factors (IF), External Factors (EF), and Behavioral Intention (BI) have a significant effect on the effectiveness of AINS use (EA).

IV. Methodology

This study employed a quantitative research approach using a cross-sectional survey design to examine rural primary school students' perceptions of the effectiveness of the Advanced Integrated NILAM System (AINS) and to identify the factors that influence its use. This design was selected for its suitability in collecting data from a sample at a single point in time, allowing for the examination of relationships between variables and the description of attitudes and perceptions within the target population [68].

A. Population and Sampling

The target population for this research comprised 96 Level 2 students, including those in Years 4, 5, and 6, at a specific rural primary school in Malaysia where the AINS program was actively implemented. The school was purposively selected due to its rural classification, its existing use of AINS, and the presence of contextual factors relevant to the study, such as limited technological infrastructure—including only 11 shared laptops for student use—and reported unstable internet connectivity, as well as the diverse socioeconomic backgrounds of its students. Only one school was included in the study, as it had already integrated AINS into its reading program and exhibited the contextual challenges central to the research focus. This purposive, single-site approach aligns with prior studies that selected rural schools actively implementing specific educational technologies to gain context-rich insights [69]. These conditions provided an authentic setting to explore the challenges and perceptions related to AINS adoption in resource-constrained environments [70].

From the target population, a final sample of 65 students who provided complete and usable questionnaire responses was obtained, resulting in a response rate of 67.7%. While the school was selected purposively, participant sampling followed a convenience sampling approach based on student availability and willingness to participate during the data collection period [68].

B. Instrument

The primary instrument for data collection was a structured questionnaire developed by adapting items from established scales grounded in the Technology Acceptance Model (TAM) [16] and related studies on technology acceptance in educational settings [14, 54, 55, 71, 72]. The questionnaire consisted of several parts. The first part gathered demographic information, including students' age, gender, and year level. Subsequent sections assessed the core constructs of the study: Perceived Usefulness (PU) was measured with five items evaluating students' beliefs about how AINS could enhance their participation in the NILAM program and their reading activities; Perceived Ease of Use (PEOU) was assessed with five items gauging students' perceptions of the effort required to learn and use AINS; Behavioral Intention (BI) was measured with five items examining students' intentions to continue using AINS; External Factors (EF) were assessed using six items that explored environmental influences such as teacher support, parental involvement, and access to school and home resources. Some items in this section were self-constructed by the researcher to better reflect the specific context; Internal Factors (IF), including student-specific attributes like technological self-efficacy and intrinsic motivation related to AINS, were measured with four items; finally, the Perceived Effectiveness of AINS Use (EA) was evaluated with three items focusing on the system's impact on students' reading records, motivation, and literacy skills. All perceptual items were rated using a 5-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) [53]. To ensure the quality of the instrument, content and face validity were established through expert review, followed by a pilot test involving 30 students. Detailed psychometric results, including reliability coefficients, are presented in the Results section.

V. Result

The data collected in this study were analyzed using the Statistical Package for the Social Sciences (SPSS) Version 27. Descriptive statistics, Spearman's rank-order correlation, and multiple linear regression analysis were employed to evaluate the findings.

A. Demography

A total of 65 Level 2 primary school students from a rural school participated in this study. The demographic profile of the respondents showed that 52.3% (n = 34) were male and 36.9% (n = 24) were female, while 10.8% (n = 7) did not specify their gender. Regarding grade level, 43.1% (n = 28) were in Year 6, 33.8% (n = 22) were in Year 5, and 23.1% (n = 15) were in Year 4 (Fig. 2).

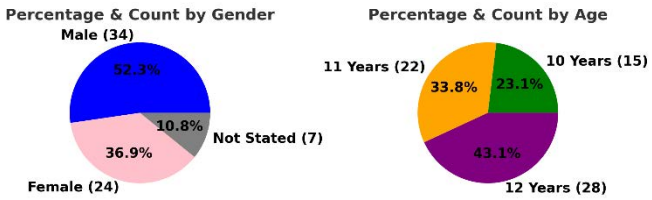

Fig. 2. Pie chart for age and gender.

B. Item Reliability and Validity

Before the main data collection, the validity and reliability of the questionnaire were established. Content and face validity were confirmed through reviews by two subject matter experts, who assessed the relevance, clarity, and appropriateness of the items for the intended constructs and

target student population. A pilot study involving 30 students produced an overall Cronbach's alpha coefficient of .908 for the entire instrument, indicating high internal consistency.

Table 1 presents the full psychometric results of the instrument. Individual constructs demonstrated the following reliability coefficients: Behavioral Intention (α = 0.760), External Factors (α = 0.769), and Effectiveness of AINS (α = 0.729), all of which indicated good reliability. Perceived Usefulness (α = 0.679), Perceived Ease of Use (α = 0.618), and Internal Factors (α = 0.679) showed moderate reliability. These values are considered acceptable for exploratory nature of this research, particularly in its initial stages of instrument application with a student population [73, 74]. These preliminary checks confirmed the instrument's suitability for use in the main study.

Table 1. Cronbach's Alpha (α)

Variables	No. of Item	Cronbach's Alpha (α)
PU	5	0.679
PEOU	5	0.618
BI	5	0.760
EF	6	0.769
IF	4	0.679
EA	3	0.729
Total	28	0.908

C. Descriptive Statistics

Descriptive statistics were computed for the main constructs of the study: Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Behavioral Intention (BI), External Factors (EF), Internal Factors (IF), and the perceived Effectiveness of AINS Use (EA). Table 2 presents the mean scores, standard deviations, and interpretation levels for each construct, based on a 5-point Likert scale (1.00–2.33 = Low, 2.34–3.66 = Moderate, and 3.67–5.00 = High, adapted from Ref. [75]). The number of respondents (N) for each construct was 65.

Table 2. Descriptive statistics

Variables	Mean	Std. Deviation	Level
PU	3.7569	0.59318	High
PEOU	3.5354	0.61857	Moderate
BI	3.7385	0.67261	High
EF	3.8692	0.61414	High
IF	3.5038	0.85979	Moderate
EA	3.6974	0.81164	High

The students' overall perception of the Effectiveness of AINS Use (EA) was rated as High. This positive perception was further supported by item-level analysis, where students gave high ratings to AINS for increasing their motivation to read (Mean = 3.78) and improving literacy skills (Mean = 3.82). However, its impact on increasing the quantity of recorded readings was rated as Moderate (Mean = 3.49).

Perceived Usefulness (PU) and Behavioral Intention (BI) were also rated as High. The students generally found AINS helpful in making the recording process easier and making the NILAM program more interesting. They also expressed a strong intention to use the tool, recognizing it as an important resource.

External Factors (EF) received a high mean score, driven primarily by positive perceptions of teacher guidance and school facilities. However, aspects related to home resources and parental support within this construct were rated as Moderate.

In contrast, Perceived Ease of Use (PEOU) and Internal Factors (IF) received Moderate overall ratings. For PEOU, although the students felt they could learn to use AINS relatively quick, they reported less confidence in using it independently without assistance. As for IF, the students showed high general confidence in using technology for learning, but their confidence specifically in handling AINS—particularly in resolving technical issues—was more moderate. These descriptive findings offer an overview of student perceptions and highlight the varying levels of influence from different factors, setting the stage for further analysis of their interrelationships and predictive power.

D. Correlation Analysis

To address the third research objective, which explored the relationships between Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Behavioral Intention (BI), External Factors (EF), Internal Factors (IF), and the Effectiveness of AINS Use (EA), Spearman's rank-order correlation coefficient (Spearman's rho) was calculated. This non-parametric test was selected because the data for all key study variables were not normally distributed, as indicated by the Kolmogorov-Smirnov test ($p < 0.05$ for all variables).

As shown in Table 3, the analysis revealed statistically significant positive relationships between all independent variables and the dependent variable, EA. Specifically, Perceived Usefulness (PU) demonstrated a strong positive correlation with EA ($rs = 0.581$, $p < 0.01$), while Perceived Ease of Use (PEOU) also showed a significant positive correlation ($rs = 0.528$, $p < 0.01$). Behavioral Intention (BI) exhibited a strong positive relationship with EA ($rs = 0.573$, $p < 0.01$). External Factors (EF) correlated significantly and positively with EA ($rs = 0.444$, $p < 0.01$). Among all predictor variables, Internal Factors (IF) had the strongest positive correlation with EA ($rs = 0.644$, $p < 0.01$).

Table 3. Spearman correlation

Variable	Mean PU	Mean PEOU	Mean BI	Mean EF	Mean IF	Mean EA
Mean PU	1.000					
Mean PEOU	0.528**	1.000				
Mean BI	0.733**	0.540**	1.000			
Mean EF	0.503**	0.433**	0.605**	1.000		
Mean IF	0.521**	0.678**	0.526**	0.478**	1.000	
Mean EA	0.581**	0.528**	0.573**	0.444**	0.644**	1.00

Note: **$p < 0.01$ indicates a statistically significant correlation.

These findings support hypotheses H1 through H5, confirming significant positive relationships between PU, PEOU, BI, EF, and IF with the Perceived Effectiveness of AINS use.

E. Multiple Regression Analysis

To address the fourth research objective, which aimed to determine the predictive impact of Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Behavioral Intention (BI), External Factors (EF), and Internal Factors (IF) on the Perceived Effectiveness of AINS Use (EA), a multiple linear regression analysis was conducted. Prior to the analysis, diagnostic checks were performed to ensure that the assumptions of multiple regression were satisfactorily met.

Table 4 presents the model summary statistics for the

multiple regression analysis. The R value for the model was 0.723, indicating a strong positive correlation between the combined predictor variables and the dependent variable, Perceived Effectiveness of AINS Use (EA). The coefficient of determination (R^2) was 0.523, suggesting that approximately 52.3% of the variance in the students' perceptions of AINS effectiveness can be explained by the five independent variables: PU, PEOU, BI, EF, and IF. The adjusted R squared value was 0.483, providing a more conservative estimate of explained variance, which is particularly relevant when evaluating models with multiple predictors. The Standard Error of the Estimate was .58362, indicating the average distance between the observed and predicted EA scores.

Table 4. Multiple regression model summary for predicting effectiveness of AINS use (EA)

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
1	0.723[a]	0.523	0.483	0.58362

Note: a. Predictors: (Constant), PU, PEOU, BI, EF, IF

The results of the Analysis of Variance (ANOVA), presented in Table 5, were used to evaluate the overall statistical significance of the regression model in predicting the Perceived Effectiveness of AINS Use (EA). The ANOVA revealed that the regression model was statistically significant, with an F-statistic of 12.956 and degrees of freedom (df) of 5 and 59 (F(5, 59) = 12.956). The significance value (*p*-value) was less than 0.001 (Sig. < 0.001), indicating that the set of five independent variables collectively provide a statistically significant prediction of the students' perceptions of AINS effectiveness. These results confirm that the model is a good fit for the data.

Table 5. ANOVA for multiple regression model predicting effectiveness of AINS Use (EA)

Model	Sum of Squares	df	Mean square	F	Sig
Regression	22.064	5	4.413	12.956	<0.001
Residual	20.096	59	0.341		
Total	42.161	64			

Table 6. Coefficients (Model 1)

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig
	B	Std. Error	β		
(Constant)	0.246	0.563		0.437	0.664
PU	0.239	0.179	0.175	1.335	0.187
PEOU	0.079	0.169	0.060	0.468	0.642
BI	0.208	0.170	0.173	1.225	0.226
EF	0.001	0.157	0.001	0.008	0.994
IF	0.426	0.120	0.451	3.534	<0.001

Table 6 shows the predictive factors influencing the Effectiveness of AINS Use (EA). Only one factor had a significant impact: Internal Factors (IF) (B = 0.426, t(59) = 3.534, $p < 0.001$). However, the other four factors, Perceived Usefulness (PU) (B = 0.239, t(59) = 1.335, $p = 0.187$), Perceived Ease of Use (PEOU) (B = 0.079, t(59) = 0.468, $p = 0.642$), Behavioral Intention (BI) (B = 0.208, t(59) = 1.225, $p = 0.226$), and External Factors (EF) (B = 0.001, t(59) = 0.008, $p = 0.994$), did not have a significant effect on EA. As a result, H6 was partially supported. While all five predictors were positively correlated with EA, only Internal Factors had a statistically significant unique contribution in the regression model.

VI. Discussion

This study aimed to address key research questions concerning rural primary school students' perceptions of the Advanced Integrated NILAM System (AINS) and the factors influencing its adoption and perceived effectiveness. Specifically, it sought to explore students' perceptions of AINS effectiveness, analyze factors influencing their AINS use, determine the relationships between Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Internal Factors (IF), External Factors (EF), Behavioral Intention (BI), and the Effectiveness of AINS Use (EA), and test the predictive impact of these factors on EA. The study's findings offer insights into how an expanded Technology Acceptance Model (TAM) applies to this specific user group and context.

A. Students' Perceptions of AINS Effectiveness

The overall perception of the Effectiveness of AINS Use (EA) among the student participants was found to be high. This positive reception is encouraging and suggests that students, even in rural settings with potential technological limitations, recognize the value of AINS as a tool to support their engagement with the NILAM program. This finding is consistent with existing research indicating positive student attitudes toward well-designed digital learning tools [76, 77]. Students specifically appreciated AINS for making it easier to record their reading compared to manual methods and for making the NILAM program more engaging. This sentiment reflects a broader preference among today's students for digital interfaces [78]. Furthermore, the perception that AINS helped improve literacy skills and motivation to read aligns with research highlighting technology's potential to support reading comprehension and engagement [79–81]. However, the more moderate perception of AINS's impact on increasing the quantity of recorded readings or helping students achieve personal literacy goals suggests that, while the tool is valued, its deeper impact may depend on factors beyond mere availability, such as enhanced system features or stronger pedagogical integration [80, 82, 83].

B. Analysis of Factors Influencing AINS Use

Regarding the factors influencing AINS use, Perceived Usefulness (PU) and Behavioral Intention (BI) were rated highly by the students. This is a positive indication, as according to TAM [16], these are critical drivers of technology adoption. The students clearly recognized the usefulness of AINS and expressed an intention to continue using it. External Factors (EF) also received a high overall rating, particularly in areas related to teacher guidance and school-provided facilities, underscoring the vital role of the immediate educational support system [84]. However, within EF, home-based factors such as device access and direct parental support for AINS were rated only moderately. This finding is particularly relevant in the rural context and highlights the ongoing presence of the digital divide, where limited out-of-school access and support continue to pose significant barriers [9, 85–87].

Conversely, Perceived Ease of Use (PEOU) and Internal Factors (IF) were rated as moderate overall. The moderate

PEOU suggests that while the students generally found AINS relatively easy to learn, a notable portion felt less confident using it independently without assistance. This may indicate usability challenges for younger users or highlight the need for more robust initial training and ongoing support [83, 88]. The moderate rating for IF, particularly the students' lower confidence in solving technical problems with AINS despite their general confidence with technology, suggests that basic digital literacy does not automatically translate into proficiency with specific applications [89].

C. Correlation and Regression Analysis in Context

The correlation analysis confirmed the hypothesized positive relationships (H1–H5) between all predictor variables (PU, PEOU, BI, EF, IF) and the perceived Effectiveness of AINS Use (EA). All factors were significantly and positively correlated with EA, with Internal Factors (IF) showing the strongest correlation ($rs = 0.644$, $p < 0.01$). This finding is consistent with existing literature that emphasizes the critical role of user perceptions and intrinsic characteristics in technology acceptance [90].

The multiple regression analysis, conducted to test H6 (the combined effect of PU, PEOU, BI, EF, and IF on EA), revealed that while the overall model was significant and explained 52.3% of the variance in EA, only Internal Factors (IF) emerged as a statistically significant unique predictor of EA ($\beta = 0.451$, $p < 0.001$). Although all five predictors—PU, PEOU, BI, EF, and IF—showed significant positive correlations with EA, only IF remained a statistically significant predictor when all variables were entered simultaneously into the regression model. This finding provides partial support for H6. While PU, PEOU, BI, and EF were positively correlated with EA, only Internal Factors demonstrated a significant unique contribution in predicting perceived effectiveness. This strong, singular predictive power of IF is consistent with existing research emphasizing the critical role of individual learner characteristics, such as self-efficacy, intrinsic motivation, and attitudes toward technology, in the successful adoption of educational technologies [13, 91–95]. These findings suggest that for rural primary students using AINS, their internal confidence and motivation are central to shaping how effective they perceive the system to be.

D. Revisiting TAM: Explaining the Non-Significance of PU and PEOU

The non-significance of PU and PEOU as unique predictors of perceived effectiveness (EA) in the multivariate model, once IF was accounted for, is an intriguing outcome that warrants discuss in relation to the classic TAM. While TAM typically positions PU and PEOU as direct determinants of BI, with BI influencing actual use and, subsequently, outcomes like effectiveness, our findings suggest a different dynamic for young, rural primary students using AINS.

This deviation from the traditional TAM structure, particularly for this demographic, can be understood by considering the nature of the study population and the educational setting. For primary school students, especially in a context where AINS use may be encouraged or semi-mandatory as part of the NILAM program, the initial decision to adopt or use the system may not stem solely from a conscious evaluation of its usefulness or ease of use. Unlike voluntary technology adoption scenarios often examined in TAM research, where PU and PEOU directly influence user choice, the students in this context are likely engaging with AINS due to program requirements or teacher directives. These efforts aim to address existing educational disparities and promote essential skill acquisition for all the students. This is particularly relevant in rural areas, where communities have historically lagged behind in both educational and technological aspects.

Consequently, once the students are already using the system (regardless of their initial evaluation of its usefulness or ease of use), their perception of its effectiveness appears to be more strongly influenced by their internal psychological attributes. This includes their self-efficacy in navigating the digital tool, their intrinsic motivation to engage with it, and their resilience in overcoming minor technical challenges, all of which are captured under Internal Factors [96, 97]. Studies conducted in similar educational contexts, such as those involving students with unique learning needs or limited prior digital exposure, have shown that learners often feel demotivated or struggle to comprehend new knowledge when instructional approaches do not align with their learning styles [98]. These studies consistently emphasize that practical, hands-on engagement and the development of internal confidence and motivation are critical for students to perceive digital tools as effective, once basic access and instruction are in place. In this context, the typical 'hurdles' of PU and PEOU may be overcome or rendered less influential by the initial push for adoption, allowing IF to emerge as the most salient predictor of how effective the students perceive the system to be.

This finding does not invalidate TAM but rather enriches its applicability and interpretation, particularly within compulsory educational technology settings for young learners. It suggests that in specific contexts, the interplay between TAM's core constructs and other potent factors, such as IF, can produce more nuanced outcomes. In these situations, user-centered internal attributes may hold greater explanatory power for perceived effectiveness, especially beyond the initial adoption phase.

E. Implications for Educational Practice and Policy

The implications of this study are significant. For educational practice in rural schools, the findings strongly suggest that interventions must go beyond simply providing access to AINS and offering basic technical training. A concerted effort is needed to strengthen the students' Internal Factors, such as building their digital self-efficacy, fostering intrinsic motivation for reading and using digital learning tools, and creating a classroom atmosphere that encourages exploration and reduces technology-related anxiety. Teachers play a central role in facilitating these conditions.

For AINS system developers and educational policymakers, while ensuring the system is useful (PU) and user friendly (PEOU) remains essential, the dominant influence of IF suggests that incorporating features designed to actively boost student confidence and engagement such as could significantly enhance its perceived effectiveness. Such features may include truly adaptive learning paths, more meaningful gamification, and personalized feedback that highlights progress and builds self-belief. Additionally,

addressing External Factors related to home access and parental digital literacy remains a vital challenge for ensuring equity in rural areas. Implementing strategies to involve and educate parents on how to support their children's use of AINS could be highly beneficial.

Theoretically, this study contributes to the literature by emphasizing the profound impact of Internal Factors on perceived system effectiveness within an expanded TAM framework for young, rural learners. The findings suggest that for this demographic and context, IF may serve as a more direct and powerful predictor of effectiveness outcomes than PU or PEOU alone, particularly once initial acceptance of the system is established or assumed.

VII. Conclusion

This study explored rural primary school students' perceptions of the Advanced Integrated NILAM System (AINS) and the factors influencing its adoption and perceived effectiveness, using an expanded Technology Acceptance Model (TAM) as the guiding framework. Data were collected from 65 students in a single rural primary school in Malaysia through a structured quantitative questionnaire. The findings revealed that while students generally expressed positive views toward AINS and rated Perceived Usefulness (PU) and Behavioral Intention (BI) highly, Internal Factors (IF), particularly self-efficacy and intrinsic motivation, emerged as the only significant predictors of the system's perceived effectiveness. These results highlight that a student's internal disposition plays a central role in shaping how meaningful and beneficial they perceive the system to be, especially within rural learning environments where digital exposure and confidence may vary considerably.

Although traditional TAM constructs such as PU and Perceived Ease of Use (PEOU) were positively correlated with effectiveness, they did not emerge as significant predictors in the regression analysis. This finding implies that, for primary students, the usability or perceived utility of a digital tool may be less influential than their own confidence and motivation when assessing its effectiveness. In structured school settings where technology use is integrated into learning routines, internal readiness and digital self-belief appear to have a greater impact than system attributes alone. These insights point to the need to adapt TAM frameworks to better reflect the experiences of younger learners, particularly in under-resourced educational contexts.

The study offers several important implications. For educational policymakers and school leaders, efforts to improve digital engagement in rural areas must extend beyond simply providing infrastructure and access. It is essential to implement targeted interventions that build students' internal capabilities. This includes fostering their confidence in using digital tools, nurturing their interest in reading through interactive digital platforms like AINS, and providing sustained emotional and academic support. Teachers also require professional development that not only strengthens their digital teaching competencies, but also equips them to foster motivation, resilience, and digital self-efficacy among their students. In addition, parental involvement must be strengthened. The moderate ratings for home-based support revealed a persistent digital divide that may hinder students' engagement with tools like AINS beyond school hours. Initiatives that educate and empower parents to support digital literacy at home are essential to ensuring equitable and sustainable technology integration. From a system design perspective, developers of AINS and similar platforms should incorporate features that not only enhance ease of use, but also actively promote learner autonomy, confidence, and motivation. Features such as personalized progress tracking, interactive feedback, and engaging user-friendly interfaces can improve the student's experience and help reinforce positive learning behaviors.

The findings of this study should be interpreted in light of several limitations. The sample was drawn from a single rural primary school in Malaysia, which may limit the generalizability of the results to urban settings or other educational contexts. Moreover, the data were collected through quantitative self-report questionnaires at a single point in time, which may not fully capture the depth of students' experiences or account for changes over time. Furthermore, the reliability for three constructs (Perceived Usefulness, Perceived Ease of Use, and Internal Factors) was moderate, indicating the need for further refinement of the measurement instrument.

Future research should aim to address these limitations by incorporating larger, more diverse samples from various geographic regions and school contexts. Employing mixed-methods approaches, including qualitative data collection, could provide deeper insights into students' perceptions and the specific challenges they face. Longitudinal studies would also be beneficial for tracking changes in AINS adoption and its impact over time. Further validation and refinement of the measurement instrument for the primary school context is recommended. In addition, exploring the perspectives of teachers and parents would offer a more holistic understanding to inform well-rounded support strategies.

In conclusion, this research demonstrates that the successful integration of educational technologies like AINS relies not only on system design and institutional support, but also on the psychological readiness and motivation of the learners themselves. To effectively expand digital learning in rural settings, it is essential to prioritize strategies that strengthen students' internal capacities, ensuring they become not merely passive users of technology but confident, motivated participants in their own learning journeys.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

E.S. Waimin conducted the research, wrote the paper, and analyzed the data while I. F. Kamsin reviewed and finalized the paper. Both authors had approved of the final version.

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