Jurnal As-Salam, Vol. 10 No. 2 Juli - Desember 2026
(Print ISSN 2528-1402, Online ISSN 2549-5593)
https://jurnal-assalam.org/index.php/JAS

SYSTEM QUALITY IN ISLAMIC BOARDING SCHOOL DIGITAL TRANSFORMATION: EXTENDING THE DELONE–MCLEAN MODEL TO A MULTIPORTAL ECOSYSTEM

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Abstract: This study examines perceived success in the *Thursina Smart Education System* (TSES), a multiportal platform used at an Islamic boarding school, by extending the DeLone–McLean model to include continuance use, user satisfaction, data governance maturity, decision quality, holistic learning performance, and holistic student development. A cross-sectional survey of 146 female students in grades 7–8 was conducted in April 2026. Reflective multi-item scales were analyzed using PLS-SEM with 5,000 bootstrap replications. High first-order HTMT ratios (SVQ–IPIQ = 0.998; LD–RCR = 0.984) led to unified reflective constructs for integrated service quality (ISQ) and holistic student development (HSD). Several HTMT values remained above 0.90 after respecification. Perceived system quality and ISQ were positively associated with continuance use and satisfaction, whereas information quality added no significant predictive contribution. Satisfaction and continuance use were associated with data governance maturity and decision quality. Decision quality was positively associated with holistic learning performance and HSD; data governance maturity was associated with HSD but not holistic learning performance. Harman's first factor explained 54.037% of the variance, indicating potential common-method concerns. Positive Q^2 values (0.414–0.463) were reported, but their calculation procedure requires verification. The results describe student-reported associations in one mandatory-use institution; they do not establish causal effects and should not be generalized beyond the female middle-school cohort.

Keywords: DeLone–McLean model; Islamic boarding school; PLS-SEM; multiportal information system; system quality

Abstrak: Penelitian ini mengkaji persepsi keberhasilan *Thursina Smart Education System* (TSES), sebuah platform multiportal di pesantren, dengan memperluas model DeLone–McLean melalui keberlanjutan penggunaan, kepuasan pengguna, kematangan tata kelola data, kualitas keputusan, kinerja pembelajaran holistik, dan perkembangan holistik siswa. Survei potong lintang dilakukan pada April 2026 terhadap 146 siswi kelas 7–8. Skala reflektif multi-item dianalisis menggunakan PLS-SEM dengan 5.000 replikasi bootstrap. Rasio HTMT orde pertama yang sangat tinggi (SVQ–IPIQ = 0,998; LD–RCR = 0,984) mendasari penggabungan indikator ke dalam konstruk reflektif terpadu, yaitu kualitas layanan terintegrasi (ISQ) dan perkembangan holistik siswa (HSD). Sejumlah nilai HTMT tetap melebihi 0,90 setelah restrukturisasi. Kualitas sistem dan ISQ berhubungan positif dengan keberlanjutan penggunaan dan kepuasan, sedangkan kualitas informasi tidak memberikan kontribusi prediktif tambahan yang signifikan. Kepuasan dan keberlanjutan penggunaan berhubungan dengan kematangan tata kelola data dan kualitas keputusan. Kualitas keputusan berhubungan positif dengan kinerja pembelajaran holistik dan HSD; kematangan tata kelola data berhubungan dengan HSD, tetapi tidak dengan kinerja pembelajaran holistik. Faktor pertama uji Harman menjelaskan 54,037% varians, sehingga kemungkinan bias metode umum tetap perlu diperhatikan. Nilai Q^2 positif (0,414–0,463) dilaporkan, tetapi prosedur perhitungannya masih memerlukan verifikasi. Temuan ini menggambarkan hubungan berdasarkan laporan siswa dalam satu institusi dengan penggunaan sistem wajib, tanpa membuktikan hubungan sebab-akibat atau mendukung generalisasi di luar kohort siswi tersebut.

Kata Kunci: Model DeLone–McLean; pesantren; PLS-SEM; sistem informasi multiportal; kualitas sistem

DOI: https://doi.org/10.37249/as-salam.v10i2.1671
Received: 19 May 2026; **Revised**: 25 July 2026; **Accepted**: 9 November 2026
To cite this article: Mardiyatal Firdausi, K., Prabowo, S. L., & Rohman, M. T. (2026). SYSTEM QUALITY IN ISLAMIC BOARDING SCHOOL DIGITAL TRANSFORMATION: EXTENDING THE DELONE–MCLEAN MODEL TO A MULTIPORTAL ECOSYSTEM. *Jurnal As-Salam*, *10*(2), 119–137. https://doi.org/10.37249/as-salam.v10i2.1671
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INTRODUCTION

Digital transformation in elementary and secondary education and Islamic boarding schools has shifted institutional routines toward data-driven workflows that encompass learning, student affairs, and communication with parents (Bond et al., 2020; Williamson, 2017). As administrative and instructional processes converge on a shared platform, school leaders need evidence that the quality of information, service experience, and data consistency across units are associated with improved decision-making and student learning outcomes, not merely increase adoption rates (DeLone & McLean, 2003; Petter et al., 2008). The DeLone–McLean information system (IS) success model offers a widely used framework for organizing such evidence, particularly when success is interpreted as net benefits rather than mere technological availability (Ward & Peppard, 2011).

An integrated smart education ecosystem differs from a standalone learning management system (LMS) because students, educators, and parents interact with overlapping databases and interfaces. Therefore, evaluating success in such a context requires a model that accommodates multiportal integration rather than a single-user–single-interface logic. This study focuses on the Thursina Smart Education System (TSES) at Thursina International Islamic Boarding School (Thursina IIBS) in Malang, Indonesia. TSES is a multiportal student information ecosystem with a Parent–Educator–Student architecture rather than a single LMS portal. Student functions include monitoring academic progress, viewing assignments and schedules, and coordinating dormitory routines; educator functions support administrative and instructional reporting; parent functions provide achievement summaries and institutional communication (Rosyid, 2025; Wiyono, 2021). Qualitative accounts of TSES describe support for holistic learning design and digital coordination (Rosyid, 2025), but this evidence is illustrative, not inferential. This study analyzes students' reported perceptions as the unit of analysis, consistent with research on IS success at the individual level, because middle-school users actively utilize TSES in daily learning and monitoring activities (Al Naqbi, 2024; DeLone & McLean, 2003; Petter et al., 2008).

Related quantitative research at the same institution has examined moral dynamics and identity among older students (Firdausi et al., 2025; Khabibah et al., 2025), but has not yet tested the chain of IS success from multiportal integration to continued use, satisfaction, decision quality, and learning outcomes among middle-school TSES users. More broadly, much educational technology research still emphasizes acceptance and ease of use (Dwivedi et al., 2019; Teo, 2011; Venkatesh et al., 2003) and rarely links the quality of integrated platforms with data governance maturity, decision quality, and

character-related outcomes within a single model. DeLone–McLean validation in online learning and student information systems indicates that the quality-to-benefit pathway is context-dependent (Çelik & Ayaz, 2022; Efiloğlu Kurt, 2019). Studies in Islamic education journals also confirm that supervision and institutional environmental factors mediate educational outcomes (Hakim, 2021), so IS success models need to be aligned with the pesantren context.

Five gaps motivated this study. First, implementation research often stops at usability and acceptance. In contrast, comprehensive models linking multiportal quality to continued use (CU), user satisfaction (US), data governance maturity (DGM), decision quality (DQ), and learning outcomes remain rare in a single specification (DeLone & McLean, 2003; Petter et al., 2008). Second, balanced holistic learning performance (LPH) across religious and general domains is rarely treated as a measurable net benefit of integrated school systems, even though it is relevant to *pesantren* accountability (Petter et al., 2008; Rosyid, 2025). Third, learning discipline and religious character reinforcement are often modeled as separate outcomes, yet in boarding-school *tarbiyah* they may be experientially coupled and empirically overlapping, requiring careful measurement specification (Petter et al., 2008). Fourth, perceptions of data governance and decision quality are often absent from educational IS models (Ward & Peppard, 2011). Fifth, inter-portal integration quality (IPIQ) remains limited in joint causal testing alongside classic DeLone–McLean dimensions within an integrated K–12 ecosystem (DeLone & McLean, 2003; Petter et al., 2008).

This study addresses four research questions: (RQ1) How do multiportal system-quality dimensions relate to continued use and user satisfaction after accounting for construct overlap? (RQ2) How do continued use and user satisfaction relate to data governance maturity and decision quality? (RQ3) How do decision quality and data governance maturity relate to holistic learning performance and holistic student development? (RQ4) To what extent do select indirect chains help explain overall success patterns?

The study contributes by extending IS success theory to a multiportal boarding-school context, testing whether system quality dominates incremental prediction when classic quality dimensions are modeled jointly, and respecifying overlapping service–integration and discipline–character domains into theoretically motivated unified constructs (ISQ and HSD). Methodologically, it reports a transparent PLS-SEM workflow and discusses discriminant-validity tensions when heterotrait–monotrait (HTMT) ratios are very high (Hair et al., 2022; Henseler et al., 2015). Practically, the findings inform priorities regarding system reliability, portal integration, and decision-support design in similar ecosystems.

LITERATURE REVIEW

DeLone and McLean (2003) propose that system quality (SQ), information quality (IQ), and service quality (SVQ) influence user adoption and satisfaction, which in turn are related to net benefits. In integrated school platforms, cross-portal data consistency, coherent workflows, and service continuity may contribute to continued use and satisfaction (Ward & Peppard, 2011). Continued use following initial adoption is

generally modeled as intention or continued behavior (Bhattacherjee, 2001). Efiloğlu Kurt (2019) reported that SQ predicts usage and satisfaction, while IQ predicts satisfaction in an e-learning system (N = 144). Çelik and Ayaz (2022) found in a student information system (N = 882) that SQ, IQ, and SVQ predicted usage but not satisfaction; usage and satisfaction also did not predict net benefits. Neither study modeled IPIQ, DGM, DQ, or character outcomes in a multiportal pesantren ecosystem.

DGM in digital schools encompasses perceptions of data consistency and trustworthy standards, while DQ reflects the belief that system-based decisions are timely, accurate, and accountable (Petter et al., 2008; Ward & Peppard, 2011). Conceptually, quality perceptions may flow toward usage and satisfaction, then toward governance and decision-making judgments, and finally toward learning-related outcomes. For estimation, DGM and DQ are treated as parallel consequences of CU and US in the final model. DQ is expected to enhance LPH across religious and general domains as well as LD supported by monitoring routines (DeLone & McLean, 2003; Petter et al., 2008). Religious character reinforcement (RCR) is initially conceptualized as a perception of religious behavior and responsibility potentially linked to learning discipline (LD), aligning with the roles of tarbiyah and mentoring beyond mere software *affordance* (Firdausi et al., 2025; Rosyid, 2025).

Higher-Order Respecification Rationale

In integrated multi-portal school ecosystems, students often experience service responsiveness and cross-portal coherence as a single performance layer rather than as separable survey dimensions (Ward & Peppard, 2011). Empirical HTMT diagnostics in the first-order specification (SVQ–IPIQ = 0.998) confirmed this overlap. Integrated Service Quality (ISQ) was therefore represented as a unified reflective construct incorporating SVQ and IPIQ indicators. Religious character reinforcement and learning discipline are institutionally distinct yet experientially coupled in boarding-school *tarbiyah*. The first-order HTMT of 0.984 indicated that middle-school respondents did not consistently distinguish the two scales. Holistic Student Development (HSD) was likewise represented as a unified reflective construct incorporating LD and RCR indicators, while acknowledging in the Discussion that temporal ordering cannot be established from cross-sectional data.

Contextual Qualification of Omitted Paths (H7, H9, H10)

Three propositions require contextual qualification at Thursina IIBS. First, because TSES access is institutionally required, continued use is not fully voluntary; satisfaction may therefore not be a necessary antecedent of continued use (H9; Bhattacherjee, 2001). Second, students experience inter-portal integration primarily as service coherence rather than as governance maturity per se (H7). Third, perceived data governance and decision quality share substantial overlap in student self-reports (HTMT = 0.946), making a direct DGM → DQ path difficult to identify separately from satisfaction-mediated channels (H10). These propositions remain theoretically plausible but were not estimated as direct paths in the final student-level model; alternative specifications are reported in the Methodology.

The research hypotheses are formulated as follows. H1: SQ is positively associated with CU. H2: IQ is positively associated with CU and US when controlling for SQ, ISQ,

and other quality dimensions (*incremental prediction*). H3–H4: SVQ incremental paths are subsumed under ISQ in the respecified model. H5: ISQ is positively associated with CU. H6: ISQ is positively associated with US. H7: IPIQ is positively associated with DGM (not estimated as a direct path in the final model). H8: CU is positively associated with DGM. H9: US is positively associated with CU (not estimated as a direct path). H10: DGM is positively associated with DQ (not estimated as a direct path). H11: DQ is positively associated with LPH. H12: DQ is positively associated with HSD. H13: LD is positively associated with RCR (subsumed under HSD in the respecified structural model). H14: CU and US mediate relationships between system quality perceptions and DQ, LPH, and HSD (tested via selected indirect chains).

The final estimated structural model includes direct paths from SQ, IQ, and ISQ to CU and US; from US and CU to DGM and DQ; from DGM and DQ to LPH and HSD. The paths US → CU, IPIQ → DGM, DGM → DQ, and LD → RCR were not included. Figure 1 summarizes the respecified structural model in the Findings section.

RESEARCH METHODOLOGY

Research Design and Location

The study employed a quantitative explanatory cross-sectional survey design to estimate a model at a single point in time (Hair et al., 2022; Wang & Cheng, 2020). The study was conducted at Thursina IIBS, where TSES integrates services for parents, educators, and students (Burhani & Rofiaty, 2024; Rosyid, 2025).

Participants and Sampling

The target population consisted of N = 221 active TSES users in grades 7 and 8 (grade 7: 115; grade 8: 106). Grade 9 was excluded to minimize confounding from exam preparation and shifting usage patterns (Hair et al., 2022). Thursina IIBS organizes middle-school instruction in gender-segregated divisions. At the time of data collection, all grade 7 and grade 8 students registered as active TSES users belonged to the female division (N = 221). The analytical sample is therefore exclusively female, not because of researcher selection on gender per se, but because the eligible population in these grades was female. This boundary condition limits generalization to male students and to coeducational settings.

Stratified random sampling was reported within each grade.

Inclusion criteria required a minimum TSES experience: more than one semester for grade 7; more than three semesters for grade 8. The minimum sample size $n_0 = 143$ was calculated using the Slovin formula at e = 0.05 (Cochran, 1977; Lohr, 2021), supplemented by PLS-SEM practical rules for model complexity (Hair et al., 2022). Following feasibility checks, straight-lining screening, multivariate outlier review, and listwise deletion of incomplete cases, the analytical sample comprised N = 146 complete cases (grade 7: 76; grade 8: 70), exceeding n_0. The proportion of 146/221 ≈ 66.0% reflects the authors' cleaning rules regarding the definition of the active-user population, not an independently audited survey response rate, as the number of questionnaires issued versus returned was not recorded separately in the field (April 6–11, 2026).

Instruments

A structured questionnaire measured eleven first-order reflective constructs on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree): SQ, IQ, SVQ, IPIQ, CU, US, DGM, DQ, LPH, LD, and RCR. Items were adapted from the literature on IS success and continued use, contextualized for TSES (Bhattacherjee, 2001; Petter et al., 2008; Ward & Peppard, 2011). Three reflective indicators per first-order construct were used to reduce respondent burden for middle-school participants completing an eleven-construct battery (Hair et al., 2022). Pilot testing in March 2026 reportedly yielded acceptable preliminary loadings and reliability, but short scales sample narrower item domains and can inflate HTMT overlap when constructs are conceptually adjacent (Henseler et al., 2015). We therefore interpret discriminant validity conservatively and apply unified-construct respecification where overlap was extreme. Content validity was assessed by experts in Islamic education management and management information systems at UIN Maulana Malik Ibrahim Malang; item wording was revised without altering construct definitions.

Structural Model Specifications

Diagnostic first-order estimation initially included direct paths SQ, IQ, SVQ, and IPIQ → CU and US; US and CU → DGM and DQ; DGM and DQ → LPH and LD; and LD → RCR. The paths US → CU, IPIQ → DGM, and DGM → DQ were not retained in the final model because of multicollinearity and identification concerns, not because the theoretical relationships were deemed impossible (Hair et al., 2022; Nitzl et al., 2016). Consequently, H7, H9, and H10 cannot be supported or rejected by direct-path evidence in the reported model.

Unified-Construct Respecification

Based on HTMT diagnostics (SVQ–IPIQ = 0.998; LD–RCR = 0.984), two unified reflective constructs were specified as a response to the observed overlap among adjacent measurement dimensions (Hair et al., 2022; Henseler et al., 2015): ISQ (six items: SVQ1–SVQ3 and IPIQ1–IPIQ3) and HSD (six items: LD1–LD3 and RCR1–RCR3). The final structural model estimated paths from SQ, IQ, and ISQ to CU and US; from US and CU to DGM and DQ; and from DGM and DQ to LPH and HSD. Convergent reliability, AVE, HTMT among remaining constructs, outer loadings, and inner VIF were re-evaluated after respecification.

Alternative Specifications Evaluated

Three alternatives were compared: (a) full first-order model including US → CU, IPIQ → DGM, and DGM → DQ; (b) partial model retaining only US → CU; (c) final parsimonious respecified model (Table 7). Model (a) exhibited collinearity (maximum inner VIF = 3.386 for SVQ → CU/US paths; threshold 3.3 per Kock, 2015) and nonsignificant direct paths for IPIQ → DGM and DGM → DQ. Model (b) yielded a nonsignificant US → CU path ($\beta = 0.118$, $p = 0.214$), consistent with mandatory-use logic. Model (c) provided the most stable estimates and is reported as final.

Procedures, Timeline, and Ethics

Data collection took place in four stages: (1) February 2026, model and item refinement; (2) March 2026, expert validation and pilot testing; (3) April 6–11, 2026, main survey at Thursina IIBS with standard instructions; (4) April 2026, data cleaning and SmartPLS 4 estimation.

Ethical safeguards for school-aged participants were as follows. (1) Institutional authorization was obtained from Thursina IIBS leadership before data collection. (2) Parental informed consent was collected through the school's standard communication channel after parents received an information sheet describing the study purpose, voluntary participation, anonymity, and data use. (3) Student assent was obtained immediately before survey administration; students were informed that participation was voluntary and would not affect grades or standing. (4) Anonymity was protected by removing direct identifiers; questionnaires used study codes only. (5) Confidentiality was maintained through encrypted storage and restricted access to the research team. (6) Surveys were administered by trained personnel following standardized instructions. (7) Procedures were aligned with UN CRC General Comment No. 25 (2021). Under UIN Maulana Malik Ibrahim Malang policy for low-risk anonymous educational surveys in partner schools, formal ethics committee review was not required; school authorization and parental consent procedures were followed as described above.

Researcher-Position Safeguards

One author holds a teaching role at Thursina IIBS and coordinated field logistics but did not administer surveys to their own students. Completed questionnaires were collected in sealed boxes and opened only by a designated research assistant for coding. Subject teachers did not have access to individual student responses. Students were reminded that responses were anonymous and unrelated to academic evaluation. These procedures reduce but do not eliminate insider-researcher and social desirability risks.

Data Analysis

The sample summary was verified using Microsoft Excel before exporting to SmartPLS. PLS-SEM was estimated using SmartPLS 4 (5,000 bootstrap subsamples, percentile interval, two-tailed $\alpha = 0.05$; Efron & Tibshirani, 1998).

Path coefficients, bootstrap tests, R^2, f^2, Q^2, and HTMT were extracted from the SmartPLS output archived by the authors. The measurement model was evaluated using indicator loadings, Cronbach's α, composite reliability (ρc), AVE, HTMT, and cross-loadings (Fornell & Larcker, 1981; Hair et al., 2022; Henseler et al., 2015). Multicollinearity was assessed using outer and inner VIF.

Potential common method bias was screened using Harman's single-factor test (Podsakoff et al., 2003). Inner VIF values were reported separately to assess collinearity among predictors in the structural model (Kock, 2015); these values do not constitute a standalone full-collinearity test for common method bias. Harman's test applied an unrotated principal component solution to all 33 survey items in SPSS 29 (Table 4). Inner VIF was computed for each endogenous latent variable; values below 3.3 were interpreted as evidence against severe structural collinearity (Kock, 2015). Because Harman's test is a screening procedure with limitations, shared-method bias cannot be ruled out by these diagnostics; procedural safeguards are therefore discussed separately. Q^2 values were reported as calculated using blindfolding with an omission distance of $D = 7$ (Stone, 1974); the software and original calculation output still require verification. Effect sizes (f^2) were interpreted using Cohen's (1988) conventions: ≥ 0.02 small, ≥ 0.15 medium, ≥ 0.35 large. Mediation was reported selectively for H14 (Nitzl et al., 2016).

Research Integrity

The authors conducted the empirical analysis in SmartPLS 4 without using generative AI to analyze data or fabricate results. ChatGPT and Claude were used only during the pre-research phase to generate topics; the theoretical framework, hypotheses, and final drafting were determined by the authors. All references were verified against the original publications.

FINDINGS AND DISCUSSION

Findings

Sample Profile

Table 1 summarizes the population, inclusion criteria, Slovin's n_0, and the analytical sample. Table 2 confirms that the grade distribution in the analytical sample (N = 146) aligns with the population.

Table 1. Population, inclusion criteria, Slovin's minimum sample size, and PLS-SEM analytical sample

Descriptive	Value
Population: active female TSES users, grades 7–8	N_pop = 221
Grade 7	115 (52.04% of population)
Grade 8	106 (47.96% of population)
Inclusion Criteria:	
Inclusion: minimum TSES experience	Grade 7: >1 semester; Grade 8: >3 semesters
Minimum sample (Slovin, e = 5%)	n0 ≈ 142.35 → 143
Formula	n = N / (1 + N e^2)
Analytical complete-case sample (PLS-SEM; listwise)	N = 146
Grade 7 in the analytical sample	76 (52.05% of N)
Grade 8 in the analytical sample	70 (47.95% of N)

Source: Research data, 2026

Note: N_pop = active user population; n_0 = minimum sample size; N = full analytical sample for PLS-SEM. The 146/221 ratio reflects data cleaning rules, not the response rate of a separately audited survey.

The proportion of Grade 7 and Grade 8 students in the analytical sample (N = 146) closely resembles the eligible population (Table 2). This similarity alone does not eliminate potential selection bias.

Table 2. Profile of the analytical sample by class (N = 146)

Grade Level	N	% of N
Grade 7	76	52.05
Grade 8	70	47.95
Total	146	100.00

Source: Research data, 2026
Note: Percentages are calculated based on N = 146.

Measurement Model

Table 3 reports convergent validity and reliability for first-order constructs used in the diagnostic stage (Panel A), high HTMT pairs that motivated respecification (Panel B), unified-construct measurement evidence (Panel C), and HTMT after respecification (Panel D).

Table 3. Summary of the measurement model: reliability, AVE, HTMT, and unified-construct respecification

Panel A. First-order construct reliability and validity

Construct	Loading Range	Cronbach's α	Pc	AVE	Decision
SQ	0.863–0.897	0.853	0.911	0.773	Met
IQ	0.801–0.889	0.794	0.879	0.708	Met
SVQ	0.806–0.886	0.819	0.892	0.734	Met
IPIQ	0.800–0.821	0.735	0.850	0.653	Met
CU	0.822–0.919	0.857	0.913	0.778	Met
US	0.898–0.901	0.882	0.927	0.809	Met
DGM	0.825–0.890	0.832	0.899	0.749	Met
DQ	0.850–0.895	0.843	0.905	0.761	Met
LPH	0.870–0.903	0.863	0.916	0.785	Met
LD	0.844–0.889	0.839	0.903	0.756	Met
RCR	0.847–0.901	0.833	0.900	0.750	Met

Source: SmartPLS 4 output, 2026.
Note: Thresholds: α and ρc > 0.70; AVE > 0.50 (Hair et al., 2022). Maximum outer VIF = 2.457 (DQ2).

Panel B. First-order HTMT pairs above 0.90 (*transparency*)

Pairs	HTMT
SVQ ↔ IPIQ	0.998
SVQ ↔ IQ	0.947
RCR ↔ LD	0.984
DGM ↔ DQ	0.946
RCR ↔ DGM	0.946
IQ ↔ IPIQ	0.942
RCR ↔ DQ	0.939
LPH ↔ LD	0.918

Source: SmartPLS 4 output, 2026.
Note: HTMT = heterotrait–monotrait ratio. Values close to 1.00 indicate substantial overlap among the constructs as measured by the questionnaire.

Panel C. Unified reflective constructs in the final model

Construct	Indicators	Loading range	Cronbach's α	ρc	AVE	Decision
ISQ	SVQ1–SVQ3, IPIQ1–IPIQ3	0.733–0.856	0.875	0.906	0.617	Met
HSD	LD1–LD3, RCR1–RCR3	0.800–0.861	0.908	0.929	0.686	Met
SQ	SQ1–SQ3	0.863–0.897	0.853	0.911	0.773	Met
IQ	IQ1–IQ3	0.801–0.889	0.794	0.879	0.708	Met
CU	CU1–CU3	0.822–0.919	0.857	0.913	0.778	Met
US	US1–US3	0.898–0.901	0.882	0.927	0.809	Met
DGM	DGM1, DGM4, DGM5	0.824–0.890	0.832	0.899	0.749	Met
DQ	DQ1, DQ2, DQ5	0.846–0.897	0.843	0.905	0.761	Met
LPH	LPH1–LPH3	0.870–0.903	0.863	0.916	0.785	Met

Source: SmartPLS 4 output (final respecified model), 2026.
Note: ISQ = Integrated Service Quality; HSD = Holistic Student Development. All loadings ≥ 0.70; α and ρc > 0.70; AVE > 0.50 (Hair et al., 2022).

Panel D. HTMT after higher-order respecification (selected pairs)

Pair	HTMT
DGM ↔ DQ	0.946
ISQ ↔ IQ	0.946
ISQ ↔ DGM	0.942
HSD ↔ DQ	0.923
IQ ↔ DGM	0.925
LPH ↔ HSD	0.912
US ↔ CU	0.895

Source: SmartPLS 4 output, 2026.
Note: The SVQ–IPIQ (0.998) and LD–RCR (0.984) pairs were no longer assessed separately after their indicators were combined under ISQ and HSD. Several remaining HTMT values exceeded 0.90, notably DGM–DQ, so discriminant validity was not fully established for those pairs. Additional construct merging would require theoretical justification.

Common Method Variance Diagnostics

Harman's single-factor test was applied to all 33 indicators using unrotated principal component analysis in SPSS 29. Three factors exceeded eigenvalue 1.0 (Table 4). The first factor explained 54.037% of total variance, marginally above the conventional 50% rule-of-thumb (Podsakoff et al., 2003). The result raises potential shared-method concerns without quantifying their impact on individual paths. Inner VIF values concern structural collinearity and cannot independently rule out common method

bias; Table 5 reports inner VIF for the final structural model. Maximum inner VIF was 3.183 (ISQ → CU/US), below the 3.3 threshold (Kock, 2015).

Table 4. Harman's single-factor test (unrotated PCA, N = 146, 33 items)

Factor	Eigenvalue	% Variance	Cumulative %
1	17.832	54.037	54.037
2	1.789	5.423	59.460
3	1.318	3.995	63.455

Source: SPSS 29, 2026.

Note: Three factors exceeded eigenvalue 1.0. The first unrotated factor explained 54.037% of total variance, marginally above the 50% rule-of-thumb (Podsakoff et al., 2003). Shared-method bias cannot be ruled out by Harman's test or structural inner VIF alone; procedural safeguards are also described.

Table 5. Inner collinearity VIF (*structural model*)

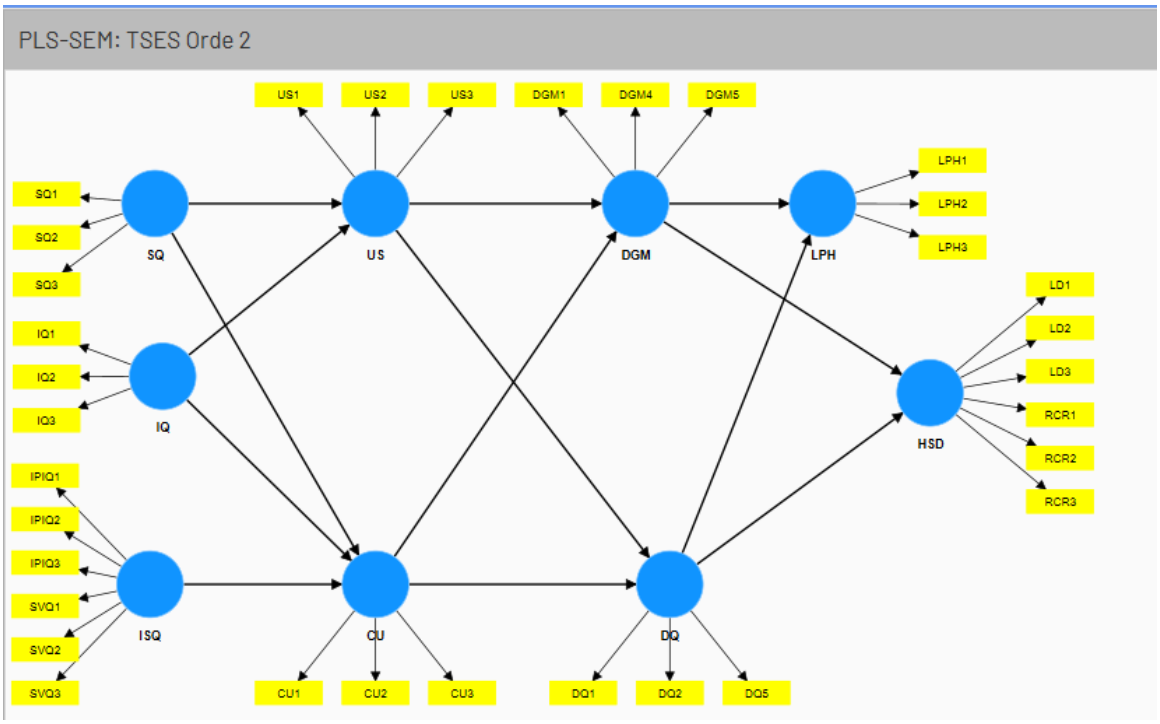
Path	Inner VIF
CU → DGM	2.602
CU → DQ	2.602
DGM → HSD	2.671
DGM → LPH	2.671
DQ → HSD	2.671
DQ → LPH	2.671
IQ → CU	2.807
IQ → US	2.807
ISQ → CU	3.183
ISQ → US	3.183
SQ → CU	2.159
SQ → US	2.159
US → DGM	2.602
US → DQ	2.602

Source: SmartPLS 4 output, 2026

Note: Threshold < 3.3 (Kock, 2015). The reported inner VIF values are below 3.3 and assess collinearity within the structural model, not common method bias directly.

Structural Model

Figure 1 shows the structure of the respecified model; path coefficients and R^2 estimates are reported in Table 6. Table 6 reports direct paths, R^2, selected local f^2, and Q^2.



Source: SmartPLS 4 output, 2026.

Figure 1. Structural model of the success of the Thursina Smart Education System (TSES) *based on student perceptions (N = 146)*

Notes. SQ = system quality; IQ = information quality; ISQ = integrated service quality (SVQ + IPIQ items); CU = continuance use; US = user satisfaction; DGM = data governance maturity; DQ = decision quality; LPH = holistic learning performance; HSD = holistic student development (LD + RCR items). The diagram shows the model connections; Table 6 reports standardized path coefficients and R² values. Paths US → CU, IPIQ → DGM, and DGM → DQ were not estimated

In the final model, SQ significantly predicted CU (β = 0.449, p < .001) and US (β = 0.420, p < .001). ISQ also significantly predicted CU (β = 0.369, p < .001) and US (β = 0.403, p < .001). IQ did not add incremental prediction to CU (β = −0.024, p = .804) or US (β = −0.009, p = .926). US and CU significantly predicted DGM and DQ, with larger coefficients for US. DQ strongly predicted LPH (β = 0.660, p < .001) and HSD (β = 0.553, p < .001). DGM predicted HSD (β = 0.325, p < .001) but did not significantly predict LPH (β = 0.125, p = .236). R^2 values ranged from moderate to substantial (CU 0.546; US 0.570; DGM 0.595; DQ 0.614; LPH 0.582; HSD 0.695). The reported Q^2 values were positive (0.414–0.463), but their calculation method must be confirmed before they are interpreted as evidence of predictive relevance.

Table 6. Structural model results (direct paths, bootstrap N = 146)

Panel A. Direct paths

Path	β	T	p	Decision (α = .05)
SQ → CU	0.449	5.314	< .001	Supported (H1)

SQ → US	0.420	4.374	< .001	Supported
IQ → CU	−0.024	0.248	.804	Not supported (H2)
IQ → US	−0.009	0.093	.926	Not supported (H2)
ISQ → CU	0.369	3.946	< .001	Supported (H5)
ISQ → US	0.403	3.807	< .001	Supported (H6)
CU → DGM	0.208	2.311	.021	Supported (H8)
CU → DQ	0.225	2.586	.010	Supported
US → DGM	0.597	7.498	< .001	Supported
US → DQ	0.594	7.933	< .001	Supported
DGM → LPH	0.125	1.185	.236	Not supported
DGM → HSD	0.325	3.909	< .001	Supported
DQ → LPH	0.660	7.005	< .001	Supported (H11)
DQ → HSD	0.553	6.688	< .001	Supported (H12)

Source: SmartPLS 4 bootstrapping results (final model), 2026.
Note: H7, H9, and H10 were not tested as direct paths. H3–H4 and H13 are subsumed under ISQ and HSD measurement respecification.

Panel B. R^2 and adjusted R^2

Construct	**R^2**	**R^2 adjusted**
CU	0.546	0.537
US	0.570	0.561
DGM	0.595	0.589
DQ	0.614	0.608
LPH	0.582	0.576
HSD	0.695	0.690

Source: SmartPLS 4 output (final model), 2026.

Panel C. Selected local f^2 (Cohen, 1988)

Path	**f^2**	**Magnitude**
SQ → CU	0.206	Medium
SQ → US	0.191	Medium
ISQ → CU	0.094	Small
ISQ → US	0.119	Small
IQ → CU	0.000	Negligible
IQ → US	0.000	Negligible
US → DGM	0.338	Medium
US → DQ	0.352	Large
CU → DGM	0.041	Small
CU → DQ	0.050	Small

DQ → LPH	0.390	Large
DQ → HSD	0.374	Large
DGM → HSD	0.129	Small–medium
DGM → LPH	0.014	Negligible

Source: SmartPLS 4 output (final model), 2026

Panel D. Reported Q^2 values (calculation method to be verified)

Construct	**Q^2**
CU	0.414
US	0.450
DGM	0.437
DQ	0.457
LPH	0.445
HSD	0.463

Source: Author-reported Q^2 values, 2026 (original calculation output pending verification)

Note: All six reported values were positive; the calculation procedure requires verification before conclusions about predictive relevance can be finalized.

Effect sizes for significant paths ranged from small to large by Cohen's (1988) guidelines. The largest local f^2 values were observed for DQ → LPH (0.390), DQ → HSD (0.374), and US → DQ (0.352). The reported positive Q^2 values require methodological confirmation before conclusions about predictive relevance are finalized.

Table 7. Selected specific indirect effects (bootstrap)

Mediation chain	**β**	**t**	**p**	**Note**
US → DQ → LPH	0.392	5.161	< .001	Significant
US → DQ → HSD	0.328	4.989	< .001	Significant
SQ → US → DQ → LPH	0.165	3.375	.001	Significant
SQ → US → DQ → HSD	0.138	3.258	.001	Significant
ISQ → US → DQ → LPH	0.158	3.117	.002	Significant
ISQ → US → DQ → HSD	0.132	3.016	.003	Significant
SQ → US → DGM → HSD	0.082	2.758	.006	Significant
ISQ → US → DGM → HSD	0.078	2.314	.021	Significant
CU → DQ → LPH	0.149	2.328	.020	Significant
CU → DQ → HSD	0.124	2.346	.019	Significant
US → DGM → LPH	0.074	1.160	.246	Not significant
SQ → US → DGM → LPH	0.031	1.114	.265	Not significant

Source: SmartPLS 4 bootstrapping results, 2026

Table 8. Alternative model specifications evaluated

Model	Specification	Key Result
A	Full first-order + US→CU, IPIQ→DGM, DGM→DQ	Inner VIF > 3.3 for SVQ; omitted paths nonsignificant
B	Partial: adds US → CU only	US → CU path nonsignificant (mandatory-use logic)
C	Final parsimonious model + HO measurement	Reported in Tables 4–6; theoretically aligned

Source: SmartPLS 4 sensitivity analyses, 2026.

Hypothesis decisions: H1 supported; H2 not supported; H3–H4 subsumed under ISQ; H5–H6 supported; H7, H9, and H10 not tested as direct paths; H8 supported; H11–H12 supported; H13 subsumed under HSD; H14 partially supported (significant chains primarily through US → DQ; chains through DGM → LPH generally nonsignificant).

Discussion

Taken together, the respecified model suggests that student perceptions of system reliability and integrated service quality are primary entry points to post-adoption success in a mandatory-use boarding-school ecosystem. This pattern extends DeLone–McLean theorizing by showing that, when use is institutionally required, satisfaction and decision quality were associated with students' perceptions of learning-related benefits (DeLone & McLean, 2003; Petter et al., 2008).

System Quality and Integrated Service Experience

Within this cross-sectional sample, SQ was the clearest exogenous driver of both CU and US, with medium effect sizes (f^2 = 0.206 and 0.191). ISQ also contributed significantly to CU and US (f^2 = 0.094 and 0.119), supporting the decision to treat service quality and inter-portal integration as a unified student-facing service layer (Ward & Peppard, 2011). IQ did not add statistically detectable incremental prediction when modeled jointly with SQ and ISQ. A conservative interpretation is that middle-school users may experience "*good information"* and smooth cross-portal performance as a fused platform judgment rather than as separable questionnaire dimensions (DeLone & McLean, 2003; Petter et al., 2008). The takeaway is bounded: the model supports a dominant role for perceived system quality in this sample, not a universal hierarchy of quality dimensions across all schools.

Post-Adoption Perceptions and Decision Quality

US and CU were strongly associated with both DGM and DQ, with medium-to-large effect sizes for satisfaction-related paths (f^2 = 0.338–0.352). Beyond statistical significance, these f^2 values clarify practical importance: higher satisfaction ratings were associated with higher decision-quality ratings within this sample. Continuance-use paths showed smaller f^2 values, consistent with mandatory institutional use that attenuates the practical leverage of quality perceptions on usage behavior.

Governance Perceptions and Student-Layer Distance

Data governance maturity did not significantly predict LPH, yet it significantly predicted HSD. A plausible interpretation is that middle-school students experience

governance arrangements, data standards, accountability routines, and role clarity as administrative infrastructure that is relatively distal from day-to-day academic performance judgments, but still connected to broader developmental routines of discipline and character formation supported by institutional monitoring (Petter et al., 2008; Ward & Peppard, 2011). Students interact with TSES outputs (grades, schedules, announcements) more directly than with governance processes organizing those outputs. Consequently, DQ remains the dominant bridge to LPH, whereas DGM shows a more selective association with HSD. This finding does not imply that governance is unimportant institutionally; rather, it suggests a stakeholder-boundary condition for extending IS success models to student self-report data in multiportal schools.

Holistic Student Development as a Coupled Perception Domain

DQ predicted LPH and HSD with large effect sizes ($f^2 = 0.390$ and 0.374). Given the first-order HTMT of 0.984 between LD and RCR, HSD captures a coupled developmental domain for predictive modeling. However, given the cross-sectional design, we refrain from causal claims that discipline temporally precedes religious character reinforcement, or vice versa. Discipline may precede character reinforcement, character commitments may motivate discipline, or both may co-develop through mentoring structures that the survey did not temporally resolve (Firdausi et al., 2025; Rosyid, 2025).

Comparisons and Practical Implications

Comparisons with DeLone–McLean validation studies in educational contexts reveal both convergence and divergence. SQ emerges as a relatively robust antecedent of usage in student samples (Çelik & Ayaz, 2022; Efiloğlu Kurt, 2019). The incremental role of IQ is inconsistent across contexts. For Islamic boarding schools and multiportal schools in similar mandatory-use ecosystems, four practical implications follow. First, prioritize student-facing system reliability (uptime, speed, stability) before expanding features. Second, strengthen decision-support routines that students perceive as timely and actionable, as DQ aligns strongly with LPH and HSD. Third, evaluate portal integration using operational metrics of data consistency, not only overlapping survey dimensions. Fourth, avoid claims that the platform directly "builds religious character"; technology contributions are more plausibly communicated through disciplined learning routines and institutional *tarbiyah* processes (Firdausi et al., 2025; Hakim, 2021; Rosyid, 2025).

Limitations

Limitations include the cross-sectional design; single-source self-reports; single-site female middle-school scope; reliance on short three-item first-order scales; remaining discriminant-validity concerns from HTMT values above 0.90 after respecification (especially DGM–DQ); omitted paths US → CU, IPIQ → DGM, and DGM → DQ; insider-researcher field coordination; absence of formal university ethics-board documentation for this low-risk school survey; and the first unrotated factor in Harman's test explaining 54.037% of item variance, so single-source self-report bias cannot be fully ruled out despite procedural and statistical mitigation. Future research should enrich measurement to reduce overlap, add temporal waves, incorporate educator and parent perceptions, and report transparent multi-model comparisons across sites.

CONCLUSION

This study contributes context-bound evidence from a mandatory-use multiportal smart education system in a female middle-school division of an Indonesian Islamic boarding school. Within these boundary conditions, perceived system quality and integrated service quality dominate incremental prediction of continuance use and user satisfaction; information quality does not. Decision quality strongly aligns with holistic learning performance and holistic student development. Data governance maturity predicts holistic student development but not holistic learning performance on direct paths. The most coherent indirect success chains run through user satisfaction and decision quality (SQ/ISQ → US → DQ → LPH/HSD). Findings inform investment priorities in reliable student-facing systems and actionable decision-support routines in similar pesantren ecosystems, while cautioning against overclaiming direct technology effects on character formation. Generalization beyond this setting requires multi-site, multi-informant, and longitudinal replication.

REFERENCES

Al Naqbi, S. H. (2024). A Mixed-Method Approach to Post-Implementation Success of Technology Performance in UAE Universities: Assessing DeLone and McLean IS Success Model. *Sage Open*, *14*(2), 21582440241240827. https://doi.org/10.1177/21582440241240827

Bhattacherjee, A. (2001). Understanding Information Systems Continuance: An Expectation-Confirmation Model. *MIS Quarterly*, *25*(3), 351–370. https://doi.org/10.2307/3250921

Bond, M., Buntins, K., Bedenlier, S., Zawacki-Richter, O., & Kerres, M. (2020). Mapping research in student engagement and educational technology in higher education: A systematic evidence map. *International Journal of Educational Technology in Higher Education*, *17*(1), 2. https://doi.org/10.1186/s41239-019-0176-8

Burhani, A. Z., & Rofiaty, R. (2024). Peran Knowledge Management Dalam Meningkatkan Kualitas Layanan Pendidikan. *Jurnal Kewirausahaan dan Inovasi*, *3*(1), 1–9. https://doi.org/10.21776/jki.2024.03.1.01

Çelik, K., & Ayaz, A. (2022). Validation of the DeLone and McLean information systems success model: A study on a student information system. *Education and Information Technologies*, *27*(4), 4709–4727. https://doi.org/10.1007/s10639-021-10798-4

Cochran, W. G. (1977). *Sampling techniques* (3rd ed.). Wiley.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean Model of Information Systems Success: A Ten-Year Update. *Journal of Management Information Systems, 19(4)*, 9–30. https://doi.org/10.1080/07421222.2003.11045748

Dwivedi, Y. K., Rana, N. P., Jeyaraj, A., Clement, M., & Williams, M. D. (2019). Re-examining the Unified Theory of Acceptance and Use of Technology (UTAUT): Towards a Revised Theoretical Model. *Information Systems Frontiers*, *21*(3), 719–734. https://doi.org/10.1007/s10796-017-9774-y

Efiloğlu Kurt, Ö. (2019). Examining an e-learning system through the lens of the information systems success model: Empirical evidence from Italy. *Education and Information Technologies*, *24*(2), 1173–1184. https://doi.org/10.1007/s10639-018-9821-4

Efron, B., & Tibshirani, R. (1998). *An introduction to the bootstrap* . Chapman & Hall.

Firdausi, K. M., Khabibah, K. F., Susilawati, S., & Esha, M. I. (2025). The Influence of Holistic Education Strategy on Santri's Morally Excellent Character: The Mediating Role of Spiritual Discipline. *Abjadia: International Journal of Education*, *10*(4), 853–861. https://doi.org/10.18860/abj.v10i4.35109

Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research, 18(1), 39–50.* https://doi.org/10.2307/3151312

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2022). *A primer on partial least squares structural equation modeling (PLS-SEM)* (3rd ed.). SAGE Publications.

Hakim, A. (2021). Contribution and effectiveness of academic supervision of madrasah supervisors on education. *Jurnal As-Salam*, *5*(1), 1–9. https://doi.org/10.37249/assalam.v5i1.252

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, *43*(1), 115–135. https://doi.org/10.1007/s11747-014-0403-8

Khabibah, K. F., Firdausi, K. M., & Yaqien, N. (2025). The Influence of Pop Culture on Students' Islamic Identity: Moderation of Educational Environment Management at Thursina IIBS. *Abjadia : International Journal of Education*, *10*(4), 952–962. https://doi.org/10.18860/abj.v10i4.35371

Kock, N. (2015). Common Method Bias in PLS-SEM: A Full Collinearity Assessment Approach. *International Journal of e-Collaboration*, *11*(4), 1–10. https://doi.org/10.4018/ijec.2015100101

Kock, N., & Hadaya, P. (2018). Minimum sample size estimation in PLS-SEM: The inverse square root and gamma-exponential methods. *Information Systems Journal*, *28*(1), 227–261. https://doi.org/10.1111/isj.12131

Lohr, S. L. (2021). *Sampling: Design and Analysis* (3rd ed.). Chapman and Hall/CRC. https://doi.org/10.1201/9780429298899

Nitzl, C., Roldan, J. L., & Cepeda, G. (2016). Mediation analysis in partial least squares path modeling: Helping researchers discuss more sophisticated models. *Industrial Management & Data Systems*, *116*(9), 1849–1864. https://doi.org/10.1108/IMDS-07-2015-0302

Petter, S., DeLone, W., & McLean, E. (2008). Measuring information systems success: Models, dimensions, measures, and interrelationships. *European Journal of Information Systems*, *17*(3), 236–263. https://doi.org/10.1057/ejis.2008.15

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Rosyid, M. A. (2025). Dinamika Pesantren Thursina International Islamic Boarding School dalam merespon revolusi industri 5.0. *Thesis*. Malang: UIN Maulana Malik Ibrahim. http://etheses.uin-malang.ac.id/id/eprint/72711

Stone, M. (1974). Cross-Validatory Choice and Assessment of Statistical Predictions. *Journal of the Royal Statistical Society Series B: Statistical Methodology*, *36*(2), 111–133. https://doi.org/10.1111/j.2517-6161.1974.tb00994.x

Teo, T. (2011). Factors influencing teachers' intention to use technology: Model development and test. *Computers & Education*, *57*(4), 2432–2440. https://doi.org/10.1016/j.compedu.2011.06.008

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward A Unified View. *MIS Quarterly*, *27*(3), 425–478. https://doi.org/10.2307/30036540

Wang, X., & Cheng, Z. (2020). Cross-Sectional Studies. *Chest*, *158*(1), S65–S71. https://doi.org/10.1016/j.chest.2020.03.012

Ward, J., & Peppard, J. (2011). *Strategic planning for information systems* (3rd ed.). Wiley.

Williamson, B. (2017). *Big data in education: The digital future of learning, policy and practice*. SAGE Publications Ltd.

Wiyono, D. F. (2021). Curriculum development strategic management model Islamic International Boarding School (IIBS) in Thursina IIBS Malang. *Ta Dib: Jurnal Pendidikan Islam*, *10*(1), 121–142. https://doi.org/10.29313/tjpi.v10i1.8232