

# Toward a Specialization-Centered Educational Information System: A Qualitative Case Study

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**Abstract.** Digital transformation in education requires information systems to accommodate the distinctive characteristics of specialization-based education. However, general-purpose systems may not adequately support diverse learning activities, evidence, and student development pathways. This study aimed to identify functional gaps and requirements and develop a conceptual framework for a specialization-centered educational information system. The study used a qualitative case study at SMA Thursina IIBS, Malang, Indonesia, with semi-structured interviews with eight informants, focus group discussions, observations, and document analysis. Thematic analysis identified four themes: existing functional gaps; system structure requirements; student development and evidence management; and flexible, integrated functionality. Findings were consolidated into six preliminary components: Specialization Student Database, Subject Learning, Seminar and Workshop, Apprenticeship, Project Portfolio, and Certificate of Completion. These informed a framework with four functions: specialization management; student development and evidence management; flexible learning and collaboration; and integrated information and reporting. The framework provides a basis for subsequent design, implementation, and empirical evaluation.

**Keywords:** Digital Transformation; Educational Information System; Educational Technology; Specialization-Based Education; Student Development Monitoring.

## 1. Introduction

Digital transformation has become a key component of educational development, as digital technologies increasingly support learning, information management, communication, student progress monitoring, and educational decision-making. However, digital transformation in education extends beyond the adoption of technological platforms. It also involves changes in educational processes, resources, organizational capacity, data management, and the alignment between digital systems and user needs (Castro Benavides et al., 2020; Fernández et al., 2023). Technology should therefore function as a means of supporting educational goals and student development rather than as an end in itself (UNESCO, 2023). The availability of a digital platform does not necessarily indicate effective digital transformation when its functions, workflows, and information structures are not sufficiently aligned with the educational processes that users actually perform.

Stakeholders with different roles, activities, and information needs use educational information systems. Previous studies have identified information quality, usability, timeliness, feature suitability, organizational readiness, and system integration as important considerations in developing and evaluating the effectiveness of educational information systems (Rahma et al., 2022; Latifah et al., 2022; Ariska & Sanjaya, 2023). Studies of school information systems have also

highlighted organizational complexity, the transition from manual processes, service improvement, human resource readiness, infrastructure, and implementation processes as factors that influence system development and optimization (Sidik et al., 2023; Burham et al., 2023). More recent studies on digital transformation and smart school implementation further suggest that integrated digital functions can support more centralized learning and school management (Utami et al., 2025; Hidayanti & Safuan, 2025). These studies indicate that the central challenge is not simply whether a school has a digital platform, but whether the system can adequately represent and support the educational processes, information flows, and decision-making needs of its users.

This challenge becomes more complex when digital systems are applied to specialization-based education. Unlike educational programs organized primarily around relatively standardized academic processes, specialization-based education may involve different learning pathways, activities, assessment practices, mentoring arrangements, and forms of evidence across specializations. Consequently, a single standardized digital workflow may not adequately represent the diversity of learning experiences and student development processes. A specialization-centered educational information system therefore needs to maintain integration of student information while providing sufficient flexibility to accommodate differences in learning activities, evidence, assessment, and progress monitoring.

The alignment between digital systems and student development is also important because student learning cannot always be represented adequately through conventional academic records. The increasing use of learning analytics demonstrates the value of integrating learner, learning process, and learning environment data to support feedback and educational decision-making (Ifenthaler & Yau, 2020; Ifenthaler et al., 2021). At the same time, learning analytics approaches must remain sensitive to the contexts and information needs of different educational stakeholders. In specialization-based education, student development may generate diverse forms of evidence beyond conventional grades. Competency-based e-learning systems, for example, have shown the potential of integrate competency portfolios with tracking of competency development and learning pathways (Margiené et al., 2022). This suggests that educational information systems should be capable of connecting learning activities, assessment, evidence, and student development rather than treating them as isolated information categories.

Despite growing research on digital transformation, educational information systems, learning analytics, and competency-oriented digital learning, limited attention has been given to how an existing school digital system can be conceptually restructured to represent heterogeneous specialization-based learning pathways within an integrated architecture. Existing studies have examined individual aspects such as usability, information quality, implementation readiness, learning analytics, and competency portfolios. However, they have not sufficiently articulated how of integrate specialization structures, diverse learning activities, competency-related evidence, mentoring, progress monitoring, and reporting within a specialization-centered school information system. The specific research gap, therefore, is not merely the addition of digital features, but the development of a system architecture that connects these heterogeneous educational processes while maintaining integration and flexibility.

This issue is particularly relevant in the context of the Specialization Program at SMA Thursina International Islamic Boarding School. The program involves several specializations with different learning characteristics, including specialization-based subjects, seminars and workshops, apprenticeships, projects, portfolios, and other competency-development activities. Such diversity creates different requirements for student data, learning activities, assessment, documentation, evidence of achievement, mentoring, and progress monitoring. The existing Thursina Smart Education System (TSES) provides an appropriate empirical context for examining the extent to which an existing educational information system can accommodate these requirements and where functional gaps remain. Perspectives from program managers, IT personnel, teachers or mentors, students, and alumni are therefore important for identifying the differences between existing system functionality and the requirements of specialization-based education.

This study contributes to the literature in three ways. First, it extends the discussion of educational information systems by highlighting the specific requirements of specialization-based education, where learning pathways, activities, and evidence vary across programs. Second, it conceptualizes flexibility and information integration as complementary requirements for representing heterogeneous specialization activities within an integrated system. Third, it proposes an empirically grounded conceptual framework that connects specialization management, student development and evidence management, flexible learning and collaboration, and integrated information and reporting.

## 2. Method

This study employed a qualitative case study design to examine the current condition, functional gaps, and requirements of an educational information system in supporting specialization-based education. The study was conducted at SMA Thursina IIBS, which implements five specialization pathways: Moslem Scholar, Sciencepreneur, Entrepreneur, Professional CEO, and Technopreneur. These pathways involve diverse learning activities, competency requirements, mentoring processes, projects, and forms of student evidence. Data were collected from June to August 2026. A qualitative case study approach was considered appropriate because the study sought to understand the experiences, practices, requirements, and perspectives of stakeholders within their actual educational and technological context.

Purposive sampling was used to select eight informants with direct knowledge of, or experience with, the Specialization Program and the Thursina Smart Education System (TSES). The informants comprised one Head of the Specialization Program (H1), two IT team members (I1 and I2), two teachers or mentors (T1 and T2), two students (S1 and S2), and one alumnus (A1). Each interview lasted approximately 15-30 minutes, depending on the participant's role and the depth of discussion. All interviews were conducted and analyzed in Indonesian, with the transcripts prepared verbatim in the original language. Relevant participant quotations are presented in their original Indonesian wording, followed by English translations in parentheses for reporting purposes, with the translations cross-checked against the original transcripts to preserve the meaning and context of participants' statements. In addition, we conducted a separate focus group discussion (FGD) with five Heads of Specialization Programs and two IT team members. of included these stakeholder groups to capture perspectives on program management, system management and technical support, instructional and mentoring practices, student experience, and alumni experience. The FGD was used to refine and validate the emerging findings and to identify preliminary system requirements across the different specialization programs.

Data were collected through semi-structured interviews, FGDs, observations, and document analysis. The interviews explored existing TSES functionality, limitations in supporting specialization-based learning, requirements for monitoring student development, management of learning evidence, and expectations regarding future system functionality and integration. The FGD examined the relevance and consistency of the interview findings across specialization programs and the IT team, particularly in relation to specialization-related data, learning activities, student evidence, monitoring, reporting, and system functions. Observations examined how TSES of currently used for attendance, learning materials, assessment, documentation, and information access. Document analysis reviewed relevant program materials, student activity evidence, assessment documentation, and available TSES records. The use of multiple data collection techniques enabled comparison across different sources and provided a more comprehensive understanding of TSES within its actual educational context.

The team analyzed the data using thematic analysis, following the iterative stages described by Nowell et al. (2017) and Braun and Clarke (2021). The analysis involved familiarization with the data, generation of initial codes, searching for patterns and themes, reviewing themes, defining and naming themes, and producing the analytical account. The team coded and compared interview transcripts, FGD records, observation notes, and relevant documents across informants and data sources. Related codes were grouped into broader categories and refined into four themes: (1)

current state and functional gaps of TSES; (2) requirements for a specialization-centered educational information system; (3) student development monitoring and evidence management; and (4) flexible and integrated functionality for diverse specialization-based learning practices. The findings were subsequently compared with FGD, observation, and document evidence to identify requirements supported across multiple sources.

The team iteratively developed the proposed conceptual framework from empirical findings. The team translated requirements identified through thematic analysis and refined through the FGD into preliminary functional components based on their primary purposes. The team then grouped and integrated these components into four interconnected functions: specialization management; student development and evidence management; flexible learning and collaboration; and integrated information and reporting. This process established a clear analytical link between stakeholder findings, identified functional requirements, and the proposed conceptual framework. The framework therefore represents a conceptual and empirically grounded output of the qualitative study rather than a tested software architecture.

The trustworthiness of the findings was strengthened through data and source triangulation, member checking, and maintenance of an audit trail. Triangulation enabled comparison of information obtained from different stakeholder groups and data collection techniques. Member checking confirmed the interpretation of participants' views, while the audit trail documented coding decisions, thematic development, interpretation, and the transformation of findings into system requirements. The study did not include technical implementation, usability testing, or quantitative evaluation of the proposed framework. Such evaluation is therefore positioned as a direction for subsequent research and system development.

### 3. Result

The analysis of eight informants identified four themes concerning the optimization of the Thursina Smart Education System (TSES) in supporting the Specialization Program at SMA Thursina IIBS: (1) current state and functional gaps, (2) specialization-centered TSES requirements, (3) student development monitoring and evidence management, and (4) flexible and integrated functionality for diverse specialization practices. The findings came from interviews and were refined through FGDs, observations, and document analysis. Overall, TSES supported basic academic functions but did not yet fully accommodate the distinctive structures, activities, achievement evidence, and monitoring needs of the Specialization Program.

The four themes indicate that TSES optimization requires alignment between system structure and specialization characteristics, integration of student activities and achievement evidence, and flexibility to accommodate diverse learning practices. The FGD further confirmed these needs and translated them into preliminary functional requirements for a dedicated Specialization Module. Table 1 summarizes the thematic findings and their implications for TSES optimization is presented in Table 1.

**Table 1.** Summary of Thematic Analysis and TSES Optimization Needs

| Theme                                    | Key Findings from Informants                                                                                                                         | Identified TSES Requirement                                                | Implication for TSES           |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|--------------------------------|
| Current State & Gaps of TSES             | TSES supports attendance, learning materials, quizzes, assessment, and documentation, but lacks a dedicated structure for specialization management. | Dedicated management of specialization-related components                  | Specialization-specific module |
| Specialization-Centered System Structure | Users require representation of specialization pathways, students, activities, assessments, portfolios, and program monitoring.                      | Data structures and functions aligned with specialization characteristics. | Specialization management      |

|                                           |                                                                                                                            |                                                                                           |                                                                            |
|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Student Development & Evidence Management | Trace student development through activities, portfolios, assessments, feedback, and achievements.                         | Integration of achievement evidence and progress-monitoring mechanisms.                   | Student development and evidence management                                |
| Flexible & Integrated Functionality       | Activities and learning products differ across specializations and may involve collaboration and publication requirements. | Flexible activity formats, collaboration support, and controlled information integration. | Flexible learning and collaboration; integrated information and reporting. |

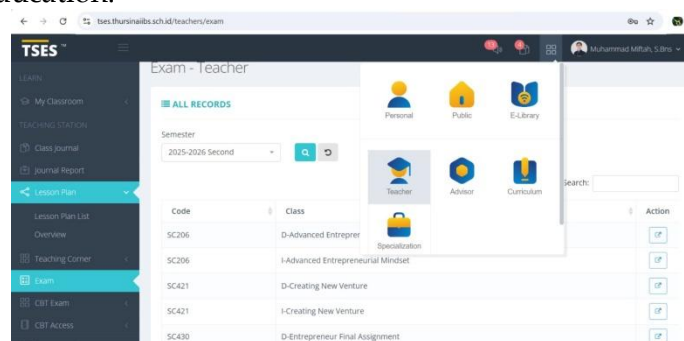
Source: Author's own synthesis based on thematic analysis, 2026

The findings provide the empirical basis for the subsequent analysis of each theme and the development of the proposed TSES Optimization Framework.

### Existing TSES and Functional Gaps

The findings indicate that TSES has provided a functional foundation for routine learning and academic management through features for attendance, learning materials, quizzes, assessment, and achievement documentation. T1 described TSES as *"cukup mendukung"* (fairly supportive), particularly for attendance, material uploading, and quizzes, while T2 reported using it to record attendance, grades, learning achievements, and student progress. From the student perspective, S1 indicated that TSES facilitated access to specialization courses and learning modules, and the alumnus reported that learning materials were relatively easy to locate across different formats. Observations of the TSES platform corroborated these accounts, confirming that the system already supports essential learning and academic activities. However, these existing functions primarily address general learning and academic administration and do not yet fully accommodate the distinctive structure and requirements of the Specialization Program.

The main limitation concerns the absence of a dedicated system structure for managing specialization-specific activities, evidence, and progress. T2 stated that there was *"belum ada modul tersendiri untuk spesialisasi"* (no dedicated module for specialization), indicating that specialization-related information and activities were not yet managed through a distinct system structure. This finding was reinforced by H1, who explained that the Specialization Program was still *"included dalam kurikulum"* (included within the curriculum), resulting in limited differentiation between general curricular management and specialization-specific requirements. From the student perspective, S2 reported the absence of dedicated monitoring for portfolios and activity deadlines. Portfolio-related information and specialization achievements were therefore not yet integrated into a dedicated TSES structure, limiting the visibility of student development across activities and outcomes. These findings suggest that the fundamental gap lies not in the absence of basic digital learning functions, but in the limited capacity of the existing system's limited capacity to represent and manage the heterogeneous activities, evidence, and developmental processes associated with specialization-based education.



Source: Author's documentation of TSES, 2026

### Figure 1. Existing TSES Functions Supporting Learning Activities

The interview findings were subsequently confirmed and refined through the FGD involving the Specialization Program and IT teams. Participants agreed on the need for a dedicated

Specialization Module to organize specialization pathways, student data, activities, achievements, and supporting documents within a more structured system environment. This convergence across stakeholder perspectives and supporting observations indicates a functional gap between the existing TSES, which is predominantly oriented toward general learning and academic administration, and the more specific, structured, and integrated requirements of the Specialization Program. Accordingly, the first theme establishes the empirical basis for defining the preliminary functional requirements of a specialization-centered educational information system, particularly in relation to specialization management, activity documentation, evidence management, and student development monitoring.

### Requirements for a Specialization-Centered Educational Information System

The second theme indicates that a specialization-centered educational information system requires a system structure that explicitly represents the Specialization Program rather than merely adding individual features to the existing TSES. The interview findings identified a set of interrelated requirements of managing assessment matrices, student work, competition records, activity documentation, student databases, progress monitoring, digital portfolios, mentor evaluations, and dashboards for presenting student achievements and activities. T2 emphasized the need to manage assessment matrices, student work, competition participation, and activity documentation. At the same time, I1 and I2 highlighted the importance of structured student data management, progress monitoring, digital portfolios, mentor evaluations, and achievement dashboards. H1 further emphasized the need to document student development activities, including seminars, short courses, and competitions, together with relevant feedback. Taken together, these findings indicate that the requirements extend beyond the addition of isolated features; they concern the establishment of an integrated information structure capable of representing specialization pathways, learning activities, evidence, assessment, mentoring, and student development in a connected manner.

The interview-derived requirements were subsequently consolidated and refined through an FGD involving the Specialization Program and IT teams. Importantly, the resulting categories were treated as preliminary functional components, rather than final software modules, because the study did not proceed to technical system design or implementation. The FGD consolidated the requirements into six preliminary functional components of the proposed Specialization Module: Specialization Student Database, Subject Learning, Seminar and Workshop, Apprenticeship, Project Portfolio, and Certificate of Completion. These components represent the principal categories of specialization-related activities, learning processes, evidence, and completion records that participants considered necessary for more structured management within TSES. The consolidation process also demonstrates how diverse stakeholder requirements were translated into a more coherent functional structure while retaining the characteristics of the Specialization Program. Table 2 presents the FGD-validated requirements, and their expected outputs are presented in Table 2.

**Table 2.** FGD-Validated Requirements for the Module of TSES Specialization Program

| Preliminary Functional Component | Main Function                                                       | Data/Evidence Managed                                                            | Primary Users                       |
|----------------------------------|---------------------------------------------------------------------|----------------------------------------------------------------------------------|-------------------------------------|
| Specialization Student Database  | Manage specialization student profiles and organizational structure | Student, class/department, subject, HoD, and teacher data                        | Management, HoD, teachers, students |
| Subject Learning                 | Support learning aligned with specialization curricula              | Learning materials, activities, and assessments                                  | Students, teachers                  |
| Seminar & Workshop               | Document developmental activities beyond routine learning           | Attendance, worksheets, responses, certificates                                  | Students, HoD, management           |
| Apprenticeship                   | Manage structured apprenticeship experiences.                       | Registration, placement profile, logbook, documentation, HoD review, certificate | Students, HoD, management           |

|                           |                                               |                                                                          |                           |
|---------------------------|-----------------------------------------------|--------------------------------------------------------------------------|---------------------------|
| Project Portfolio         | Document projects and student achievements    | Project type, project name, documentation, and certificates              | Students, HoD, management |
| Certificate of Completion | Consolidate final specialization achievements | Subject, seminar/workshop, apprenticeship, and project portfolio records | Students, HoD, management |

Source: FGD between Specialization Program and IT teams, Thursina IIBS, 2026

The FGD further clarified the functional relationships and responsibilities associated with the preliminary components. For example, the Apprenticeship component involves student input and review by the Head of Department, indicating that the system must accommodate different user roles and stages of information validation. Similarly, the Certificate of Completion component is intended to consolidate evidence generated from Subject Learning, Seminar and Workshop, Apprenticeship, and Project Portfolio activities, thereby connecting evidence from different specialization activities into a more comprehensive record of student development. The IT team additionally emphasized that system development should be preceded by clearly defined requirements, data flows, user authorities, and standard operating procedures. These findings demonstrate that a specialization-centered educational information system requires more than functionality tailored to different specialization activities. It also requires an integrated structure in which data, evidence, user responsibilities, validation processes, and reporting are connected through clearly defined workflows and governance. Thus, this theme provides the empirical basis for organizing specialization-related requirements into the proposed conceptual framework while maintaining flexibility for the diverse learning practices of different specialization pathways.

### **Student Development & Evidence Management**

The third theme indicates that the requirements of TSES extend beyond recording learning activities toward more systematic student development monitoring supported by traceable and verifiable evidence. Although TSES already records grades, assignments, and learning achievements, evidence associated with the Specialization Program is not yet fully integrated into the system. T2 reported that student work was still stored separately, while S2 noted the absence of specific monitoring for portfolios and activity deadlines. From the system management perspective, I1 emphasized the need to capture student progress, participation in activities, competency achievements, project scores, portfolios, and mentor records. The FGD further specified the types of evidence that should be associated with different specialization activities. For Seminar and Workshop, the required evidence includes attendance, worksheets, student responses, and certificates. For Apprenticeship, the evidence comprises placement profiles, registration records, logbooks, documentation, certificates, and review by the Head of Department. For Project Portfolio, the evidence includes project types, project documentation, and certificates. These findings indicate that evidence of participation, learning processes, and achievement should be connected to the relevant TSES structures rather than maintained solely as separate archives, thereby enabling a more traceable relationship between student activities, assessment results, and supporting evidence.

The findings also demonstrate the need for structured academic completion tracking and verification as a complementary mechanism within student development monitoring. S1 highlighted the use of a *kartu kendali*, or academic clearance card, to record subject requirements, including quiz scores, remedial activities, projects, and teacher verification. The card confirms completion of academic requirements before students become eligible to take the final examination, illustrating the practical importance of linking assessment records with completion status and teacher validation. Figure 2 presents the *kartu kendali* as an institutional example of this completion-tracking mechanism.

Source: Institutional document reviewed during the study, SMA Thursina IIBS, 2026

**Figure 2.** *Kartu Kendali* (quiz & project monitoring form) for tracking subject completion and teacher verification

Taken together, these findings indicate that TSES requires an integrated information mechanism connecting student activities, assessment, evidence, validation, feedback, and completion status. The FGD further confirmed the need to organize these elements through structured information flows across specialization activities. Thus, the requirement identified in this theme is not simply the addition of a portfolio or monitoring feature, but the establishment of an integrated approach to student development monitoring and evidence management in which learning activities and their supporting evidence can be traced, verified, and connected to student completion and development records. The academic clearance mechanism represented by the *kartu kendali* provides a complementary example of how assessment, requirements, and verification can be connected within such an information structure.

#### **Flexible & Integrated Functionality**

The fourth theme indicates that the diversity of learning activities, evidence, outputs, and processes across specializations requires an educational information system to provide both flexible functionality and integrated information structures. T2 explained that activities involving programming, Figma, and IoT were not yet fully supported because task submission was primarily limited to text or PDF formats. This finding demonstrates the need for format flexibility so that the system can accommodate different forms of learning evidence and outputs, including conventional documents, external links, digital designs, code, and project documentation. Flexibility is also required at the workflow level because different specialization pathways may involve different activity sequences, forms of evidence, responsible personnel, and validation processes. Rather than imposing a uniform workflow across all pathways, the system therefore needs to accommodate variations in activities, processes, responsibilities, and validation. In addition, A1 proposed a *collaboration* feature to facilitate cross-specialization collaboration when activities require competencies from different fields. These findings indicate that flexibility in a specialization-centered educational information system has at least two complementary dimensions: format flexibility, which concerns the types of evidence and outputs that can be submitted or managed, and workflow flexibility, which concerns variations in learning activities, processes, roles, validation, and cross-specialization collaboration.

Alongside flexibility, the findings indicate a need for integrated information that connects records and evidence generated across different specialization activities and enables their appropriate use for monitoring, reporting, and controlled publication. I1 proposed that achievement records, activities, and student work stored in TSES could be utilized for controlled publication through the school website. At the same time, the FGD further supported information integration through the Certificate of Completion, which consolidates records from Subject Learning, Seminar and Workshop, Apprenticeship, and Project Portfolio. These findings suggest that integration should not be understood merely as technical connectivity between systems, but as the ability to connect related information and evidence across different functional components into a coherent student development record. Such integration can support the continuity of information from learning activities and evidence collection to achievement records, completion verification,

monitoring, reporting, and controlled publication. Taken together, this theme establishes that a specialization-centered educational information system requires a balance between flexibility and integration; flexibility allows the system to accommodate the heterogeneous characteristics of specialization-based learning, while integration ensures that information generated through these diverse processes remains connected, traceable, and usable for student development monitoring and institutional information needs. These findings provide the empirical basis for incorporating flexibility and integration as interconnected dimensions of the proposed conceptual framework.

#### 4. Discussion

##### Repositioning TSES as a Specialization-Centered Digital System

The findings indicate that repositioning TSES toward a specialization-centered system requires more than adding isolated features. Although TSES already supports general academic functions, specialization-related activities, evidence, achievement records, roles, and monitoring requirements were not yet represented within a dedicated and connected structure. The findings therefore suggest that specialization-based education needs to be represented as an explicit structural layer within the existing educational information system. This interpretation is consistent with digital transformation perspectives that emphasize changes in organizational structures, processes, and information flows rather than merely digitizing existing activities (Castro Benavides et al., 2020; Fernández et al., 2023). It also aligns with human-centered system design, which emphasizes the alignment of system functions with contextual user requirements (Thazila et al., 2022). In this context, the diversity of specialization pathways and activities explains why conventional academic functions alone cannot represent specialization-based education. Table 3 summarizes the relationship between the empirical requirements and their architectural implications is summarized in Table 3.

**Table 3.** From Specialization Requirements to Architectural Alignment

| Empirical Requirement                                   | Architectural Implication                                   | Contribution to TSES              |
|---------------------------------------------------------|-------------------------------------------------------------|-----------------------------------|
| Distinct specialization pathways and student structures | Explicit specialization layer within TSES                   | Specialization-centered structure |
| Diverse learning and developmental activities           | Activity-specific functional components                     | Program-aligned functionality     |
| Multiple forms of student evidence                      | Integrated evidence structures                              | Evidence-based monitoring         |
| Different roles and validation processes                | Role- and workflow-aware design                             | Workflow flexibility              |
| Records distributed across activities                   | Cross-component information integration                     | Integrated information            |
| Existing general academic functions                     | Integration with, rather than replacement of, existing TSES | Architectural continuity          |

Source: Author's own synthesis based on interview and FGD findings, 2026

Table 3 shows that the architectural implication of the findings is not the creation of independent features, but the alignment of specialization requirements with the existing information architecture. Existing academic functions can remain the foundation, while specialization-specific structures provide the flexibility and information organization required to represent diverse activities and student development. This shifts the design focus from isolated feature additions of integrating educational structures, information flows, user responsibilities, evidence, and monitoring requirements.

##### Evidence-Based Student Development

The findings further indicate that student development in specialization-based education requires a broader and more integrated evidence structure than conventional academic records. The key issue is therefore not the diversity of evidence itself, but the limited integration of evidence across specialization activities. This finding supports the view that academic grades alone cannot adequately represent student development and aligns with research emphasizing the use of learner,

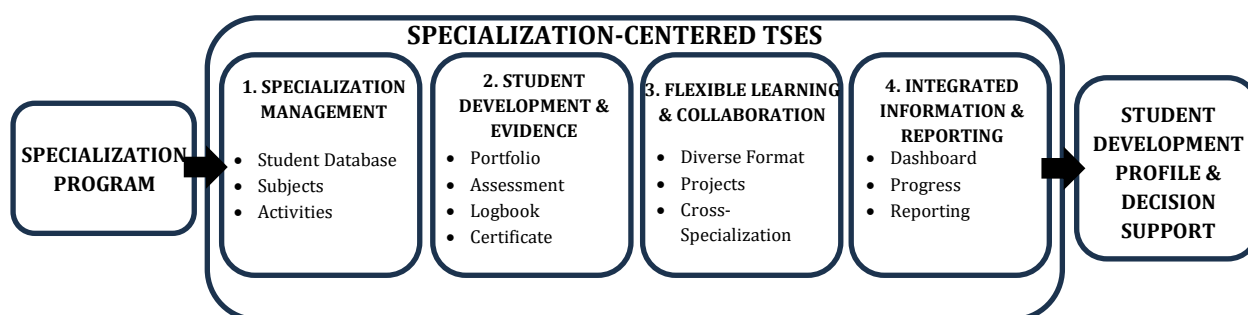
learning-process, and learning-environment data to support educational feedback and decision-making (Ifenthaler & Yau, 2020; Ifenthaler et al., 2021).

The implication for TSES is that evidence should connect to student development rather than remain as isolated activity records. Such integration can support future monitoring and analytics-oriented functions, although the effectiveness of dashboards or learning analytics remains subject to subsequent system development and empirical evaluation (Matcha et al., 2020). Thus, the main architectural implication is the need for Student Development and Evidence Management as an integrated function within a specialization-centered system.

### Flexibility and Integration as Architectural Requirements

The findings indicate that specialization-based education requires an educational information system that balances flexibility with integration rather than applying a uniform functional structure across all specialization pathways. The diversity of learning activities and outputs is illustrated by Technopreneur activities involving programming, Figma, and IoT, which do not always fit conventional assignment submission based on text or PDF files. A1 also proposed a collaboration feature across specializations to support projects requiring competencies from different fields. The FGD further demonstrated that specialization activities involve different input, process, validation, and output requirements, with Apprenticeship additionally involving multiple user roles and review responsibilities. These findings suggest that flexibility encompasses at least two dimensions: format flexibility, which enables the management of diverse forms of learning outputs and evidence, and workflow flexibility, which accommodates differences in activities, processes, responsibilities, and validation across specialization pathways. At the same time, flexibility needs to be supported by information integration so that data generated through these heterogeneous processes can remain connected. This interpretation aligns with UNESCO (2023) and OECD (2021), which emphasize that educational technology must adapt to educational contexts, objectives, processes, data, and governance. In this sense, an effective specialization-centered architecture should not seek to standardize all specialization activities but should provide a common information structure that accommodates different activities and workflows.

Integration also enables specialization-related information to support broader institutional needs, including monitoring, reporting, and controlled information dissemination. In this configuration, TSES can function as a structured and verified internal source of educational information, while external platforms can provide appropriate interfaces for dissemination. This reflects a broader understanding of digital transformation in which data, processes, and governance are connected rather than managed as isolated functions (Castro Benavides et al., 2020; Fernández et al., 2023).



Source: Author's own elaboration, 2026

**Figure 3.** Proposed TSES Optimization Framework for Specialization-Based Education

Based on the overall findings, the proposed conceptual framework brings together four interconnected functions: Specialization Management; Student Development and Evidence Management; Flexible Learning and Collaboration; and Integrated Information and Reporting. These functions synthesize the empirical requirements identified across the study findings and provide a conceptual structure for connecting specialization pathways and activities, student

evidence and development records, diverse learning practices and collaboration, and information use for monitoring, reporting, and controlled publication. Figure in presents the resulting framework. Importantly, the framework should be interpreted as a conceptual and empirically grounded model rather than a validated technical architecture; its usability, technical feasibility, information quality, and effectiveness require subsequent design, implementation, and empirical evaluation.

## 5. Conclusions

This study shows that the Thursina Smart Education System (TSES) provides basic functions to support learning and academic management but does not yet fully accommodate the characteristics and requirements of the Specialization Program at SMA Thursina IIBS. The main functional gaps concern the absence of a dedicated specialization structure, limited integration of portfolios and achievement evidence, insufficient progress monitoring, and limited flexibility in accommodating diverse learning activities, outputs, and workflows across specializations. The findings therefore indicate that a specialization-based educational information system requires more than general academic and administrative functions. It needs an information structure capable of connecting specialization activities, assessment, evidence, validation, feedback, and student development records within an integrated yet flexible environment.

Based on the integration of interviews, observations, document analysis, and the FGD involving the Specialization Program and IT teams, this study developed a conceptual framework for a specialization-centered educational information system comprising four interconnected functions: Specialization Management; Student Development and Evidence Management; Flexible Learning and Collaboration; and Integrated Information and Reporting. The FGD further consolidated the identified requirements into six preliminary functional components: Specialization Student Database, Subject Learning, Seminar and Workshop, Apprenticeship, Project Portfolio, and Certificate of Completion. Conceptually, the framework positions specialization-based education as an explicit structure within the broader educational information system while maintaining integration with existing academic functions. The study therefore contributes a specialization-centered perspective for conceptualizing educational information systems that can accommodate heterogeneous learning activities and evidence while supporting more systematic student development monitoring, information integration, and educational decision-making. From a policy perspective, the findings suggest that schools implementing specialization-based or enrichment programs should incorporate program-specific requirements into educational information-system policies, particularly for documenting, integrating, monitoring, and reporting of diverse student development evidence. Such policies should establish consistent documentation and reporting mechanisms while retaining sufficient flexibility to accommodate different specialization activities, outputs, and workflows.

This study is a qualitative case study at a single institution with a limited number of informants, and the proposed framework has not yet undergone technical implementation, usability testing, or empirical evaluation. Accordingly, the policy implications should be understood as context-sensitive considerations for institutional planning rather than general policy prescriptions. Future research should therefore translate the conceptual framework into a system design and development process, potentially through a design and development or user-centered design approach. Subsequent evaluation should examine usability, information quality, user acceptance, workflow suitability, data integration, dashboard effectiveness, and the system's ability to generate coherent student development profiles based on portfolios and achievement evidence. Such research is necessary to determine the technical feasibility, practical usability, and effectiveness of the proposed specialization-centered educational information system in supporting specialization-based education in secondary school contexts.

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