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Beyond Teacher Readiness: Institutional Access and Interactive Flat Panel Integration in Islamic Religious Education

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ABSTRACT

The integration of Interactive Flat Panels (IFPs) into classroom instruction has created new opportunities for interactive learning, yet the availability of digital technologies does not necessarily ensure their sustained pedagogical use. Understanding the gap between teacher readiness and classroom implementation requires attention to institutional conditions that enable or constrain instructional access. This study explores how Islamic Religious Education (IRE) teachers' technological and pedagogical readiness intersects with institutional support, device access, and IFP implementation in two Indonesian public senior high schools. Employing a qualitative multiple-case study design, data were obtained from five written interview records involving two IRE teachers, two vice principals for curriculum, and one school principal. Thematic and cross-case analyses identified four themes: the readiness–implementation gap, subject-specific pedagogical integration, institutional support and professional learning, and constraints on sustained technology access. Findings reveal that teachers reported basic technological familiarity and positive attitudes toward IFP integration, yet routine implementation remained limited. Despite professional development and technical assistance, both schools possessed only one IFP in a shared instructional space, creating scheduling conflicts, competing institutional priorities, and preparation challenges. Intermittent internet connectivity further constrained reported implementation in one school. Integrating TPACK and an ecological perspective, this study highlights institutional access as an important analytical dimension connecting perceived teacher readiness with opportunities for classroom implementation.

Keywords: Interactive Flat Panel; Islamic Religious Education; teacher readiness; institutional access; technology integration

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INTRODUCTION

The integration of digital technologies into school education has increasingly transformed how teachers design instructional activities, present learning materials, and facilitate student participation. Digital learning environments provide opportunities to move beyond conventional teacher-centered instruction by incorporating multimedia resources, collaborative activities, and interactive forms of learning. Nevertheless, the educational value of digital technologies cannot be determined solely by their availability or technical capabilities. Rather, meaningful integration depends on how teachers employ these technologies in relation to pedagogical objectives, disciplinary content, and classroom conditions. In an umbrella review encompassing 23 systematic reviews and 1,062 primary studies, Wohlfart and Wagner (2023) highlighted the complexity of teachers' roles in educational digitalization and the continuing importance of professional competencies and contextual conditions. Similarly, Msafiri et al. (2023) identified the interconnected roles of infrastructure, teacher preparedness, and institutional support in integrating information and communication technologies into secondary education. These findings suggest that educational digitalization should be understood as a pedagogical and organizational process rather than merely the introduction of technological equipment.

Within this transformation, Interactive Flat Panels (IFPs) represent an increasingly relevant category of classroom technology. Combining large digital displays, touchscreen functionality, multimedia presentation, digital annotation, and connectivity with other devices, IFPs offer teachers opportunities to organize instructional content and facilitate classroom interaction through a shared digital interface. Research on related interactive whiteboard technologies has demonstrated that teachers' adoption and continued use are associated with multiple factors, including perceived pedagogical value, interface quality, and individual characteristics. For example, Šumak et al. (2017), examining prospective, existing, and former interactive whiteboard users, found that factors associated with technology adoption differed across stages of use. Their findings indicate that initial acceptance should not be treated as equivalent to sustained classroom implementation. Although interactive whiteboards and contemporary IFPs are not technologically identical, this research provides a useful foundation for examining the distinction between access to interactive display technology and its continuing pedagogical application (Luo et al., 2023).

Teachers' readiness is commonly considered an important prerequisite for educational technology integration. From a Technological Pedagogical Content Knowledge (TPACK) perspective, effective technology integration requires teachers to connect technological understanding with instructional strategies and subject-specific knowledge (Guzmán González & Vesga Bravo, 2024). Recent research has emphasized the relevance of this integrated perspective while recognizing that teachers' digital competencies cannot be reduced to technical proficiency alone (Wohlfart & Wagner, 2023). Tondeur et al. (2017), for instance, distinguished between competencies supporting learners' technology use and competencies related to technology-based instructional design. This distinction is important because teachers may demonstrate confidence in operating digital devices without necessarily using their capabilities to facilitate meaningful learning experiences. Accordingly, readiness to operate an IFP should be analytically distinguished from readiness to design pedagogically appropriate activities

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and from the reported implementation of those activities in classroom practice (Claro et al., 2024).

However, teacher readiness does not necessarily translate into sustained or pedagogically meaningful technology use. A systematic review by Børte et al. (2023) highlighted the importance of aligning technological functionality with pedagogical purposes, particularly in technology-supported formative assessment. Likewise, research on secondary education has identified inadequate infrastructure, insufficient professional development, and limited organizational support among the challenges affecting ICT integration (Msafiri et al., 2023). These findings suggest that the readiness–implementation relationship is shaped by more than individual competence. Even teachers who possess basic technological skills and recognize the pedagogical benefits of digital tools may encounter institutional circumstances that constrain their opportunities to use those tools consistently.

An ecological perspective provides a complementary explanation by examining how teachers' technological practices interact with their institutional environments. While TPACK emphasizes the integration of technological, pedagogical, and content knowledge, an ecological perspective directs attention to organizational arrangements, available resources, and contextual conditions that shape opportunities for implementation (Hammond, 2020). Recent scholarship has also highlighted the relevance of contextual knowledge within TPACK and the importance of examining teachers' technological decisions in relation to their educational environments (Brianza et al., 2024; Yang & Dong, 2024). Accordingly, the two perspectives serve complementary analytical purposes: TPACK helps explain teachers' perceived readiness to design technology-supported instruction, whereas an ecological perspective helps explain the institutional circumstances under which such readiness may be enacted. Their combined application offers a more context-sensitive understanding of technology integration than an explanation centered solely on individual teacher competence.

An important dimension of these circumstances is institutional access, understood in this study as the practical opportunities teachers have to use educational technologies within existing school arrangements. Unlike technological availability, which concerns whether a device is physically present, institutional access encompasses its allocation, location, scheduling, competing demands, and the conditions required for classroom use. This distinction becomes particularly relevant when a limited number of interactive devices must be shared among teachers and classrooms. Professional development and technical assistance may strengthen teachers' readiness, but such support does not necessarily ensure that devices are accessible during scheduled lessons. Existing research has acknowledged the importance of school-level conditions and contextual barriers (Haryanto et al., 2026; Msafiri et al., 2023; Wohlfart & Wagner, 2023). Building on this scholarship, closer examination of institutional access arrangements may help explain how teachers' reported readiness is reflected in classroom practices under conditions of shared technological resources.

These issues are particularly relevant to Islamic Religious Education (IRE), known in Indonesia as Pendidikan Agama Islam (PAI). As a school subject, IRE encompasses religious knowledge, ethical understanding, historical interpretation, and the application of Islamic teachings in everyday life. Consequently, digital technology integration requires teachers to consider both the suitability of technological features and the characteristics of religious learning content (Reksiana et al., 2024). Interactive displays may support the

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visualization of Islamic history, the explanation of jurisprudential concepts, the presentation of Qur'anic and Hadith materials, and collaborative classroom activities. Nevertheless, these possibilities must be distinguished from their actual implementation. In an Indonesian qualitative study, Mintasih et al. (2024) examined digital technology integration in Islamic Religious Education and identified challenges involving teachers' digital competence and infrastructure readiness. Their research provides evidence that technology integration in IRE involves pedagogical as well as contextual considerations. However, further investigation is warranted into how access to shared interactive display devices intersects with teachers' readiness and their reported instructional practices in public senior high schools.

Despite growing scholarship on teachers' digital competencies, interactive classroom technologies, and institutional barriers, the relationship between teacher readiness and reported IFP integration requires closer contextual examination. Previous studies have established that technological competence, pedagogical alignment, and organizational support are important considerations, but these findings do not fully explain how specific arrangements for accessing shared devices are experienced by subject teachers in everyday school settings. In particular, limited attention has been directed toward the intersection of IRE teachers' technological and pedagogical readiness, school-level access arrangements, and reported IFP implementation across contrasting institutional contexts. Addressing this issue requires an approach that considers teachers' accounts alongside the perspectives of school leaders responsible for professional support and resource allocation. Such an approach can illuminate how institutional conditions are experienced and negotiated without assuming that access constraints alone determine instructional practices.

SMA Negeri 4 Semarang and SMA Negeri 15 Semarang provide relevant institutional contexts for examining this issue. Both public senior high schools had government-provided IFP equipment, with one device available for shared instructional and institutional use in each school. However, their reported arrangements for device placement, room allocation, professional support, and scheduling presented different contexts for examining teachers' opportunities to integrate IFPs into IRE instruction. The analytical relevance of these two cases lies in the opportunity to examine how teachers and school leaders describe technology readiness and classroom implementation under shared-resource conditions, while identifying similarities and contextual differences between the school settings.

Therefore, this study aims to explore how Islamic Religious Education teachers' technological and pedagogical readiness is reflected in reported Interactive Flat Panel integration and how institutional access arrangements and school support shape opportunities for classroom implementation in two Indonesian public senior high schools. Drawing on TPACK and an ecological perspective on educational technology integration, the study examines three research questions:

1. How do Islamic Religious Education teachers perceive and describe their technological and pedagogical readiness to integrate Interactive Flat Panels into classroom teaching?
2. How do institutional access arrangements and school support shape Islamic Religious Education teachers' opportunities to use Interactive Flat Panels in classroom teaching?
3. How is teacher readiness reflected in reported Interactive Flat Panel integration in Islamic Religious Education classrooms, and what contextual conditions help explain the gap between readiness and implementation?

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By examining teachers' and school leaders' accounts across two school cases, this study seeks to contribute a context-sensitive understanding of the relationship between teacher readiness, institutional access, and technology integration. Its central contribution lies in foregrounding institutional access as an analytical dimension that complements teacher-centered explanations of educational technology implementation, particularly in subject-specific contexts where interactive technologies are shared institutional resources. Through the comparison of the two cases, the study offers an empirical basis for interpreting the *access-conditioned enactment of teacher readiness*, understood as the relationship between teachers' reported preparedness and the practical institutional opportunities available for implementing technology-supported instruction. This interpretive contribution does not presume a universal or causal relationship but highlights the importance of examining teacher readiness and institutional accessibility together.

RESEARCH METHODS

This study employed a qualitative multiple-case study design to explore the relationship between Islamic Religious Education (IRE) teachers' readiness, institutional access arrangements, and the reported integration of Interactive Flat Panels (IFPs) into classroom teaching. A qualitative approach was considered appropriate because the study sought to understand participants' experiences, perceptions, and interpretations of technology integration within their respective institutional contexts rather than to measure technological proficiency or establish causal relationships.

The two public senior high schools were treated as distinct institutional cases. Each case was examined in relation to teacher readiness, school support, access to IFP facilities, and reported instructional practices. A cross-case comparison was then used to identify similarities and differences in how these dimensions were experienced across the two schools. This comparative approach provided a basis for examining how teachers' opportunities to integrate IFPs were associated with different institutional arrangements.

The analysis was informed by Technological Pedagogical Content Knowledge (TPACK) and an ecological perspective on educational technology integration. TPACK was used to examine teachers' reported technological knowledge, pedagogical considerations, and alignment of IFP functions with Islamic Religious Education content. The ecological perspective complemented this analysis by directing attention to institutional conditions, including professional support, resource allocation, device placement, scheduling procedures, and opportunities for classroom use. These perspectives served as sensitizing concepts rather than predetermined explanatory models, allowing the analysis to consider both teacher-level and school-level conditions.

The study was conducted at two public senior high schools in Semarang, Central Java, Indonesia: SMA Negeri 4 Semarang and SMA Negeri 15 Semarang. Both schools had received government-provided IFP equipment and had introduced institutional arrangements for its shared use. These settings were relevant to the research objectives because they provided an opportunity to examine technology integration in schools where access to interactive display facilities was not necessarily available in every classroom. The cases also offered a basis for comparing different reported arrangements for device placement, scheduling, and instructional access within institutions operating with limited shared IFP facilities.

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Five participants contributed interview accounts: two Islamic Religious Education teachers, two vice principals responsible for curriculum affairs, and one school principal. The inclusion of teachers and school leaders enabled the study to consider both instructional experiences and institutional perspectives on technology access and professional support. The participants' institutional roles were relevant to the study because teachers provided accounts of instructional preparation and IFP use, while school leaders contributed information concerning resource management, professional development, and institutional arrangements.

Table 1. Research Participants and Institutional Roles

Case	Participant code	Institutional role
SMA Negeri 4 Semarang	S4-G1	Islamic Religious Education teacher
SMA Negeri 4 Semarang	S4-K1	Vice Principal for Curriculum
SMA Negeri 15 Semarang	S15-G1	Islamic Religious Education teacher
SMA Negeri 15 Semarang	S15-K1	Vice Principal for Curriculum
SMA Negeri 15 Semarang	S15-P1	School Principal

The study drew on five written interview records organized around questions concerning IFP readiness, classroom integration, institutional support, and access-related challenges. The interview questions addressed different aspects of technology integration according to the participants' institutional roles. The teacher interviews focused on participants' experiences with IFP operation, perceived technological and pedagogical readiness, preparation of Islamic Religious Education materials, instructional activities, and barriers to implementation.

The interviews with school leaders focused on institutional digitalization initiatives, IFP provision and management, professional development activities, teachers' readiness, scheduling arrangements, and perceived challenges to sustained implementation. Together, these sources provided complementary perspectives on how individual and institutional conditions intersected in the two school contexts. The different institutional perspectives also enabled comparisons between teachers' instructional experiences and school leaders' descriptions of equipment allocation and institutional support.

The written interview records were organized in a question-and-answer format and included descriptive responses and, in some cases, interpretive summaries. Accordingly, the records were treated as documented participant accounts rather than automatically assumed to be complete verbatim interview transcripts. Statements concerning classroom practices, student engagement, and institutional arrangements were interpreted as interview-reported information unless independently verified. Particular attention was given to distinguishing reported instructional activities from proposed applications and perceived educational benefits.

The data were analyzed through a qualitative thematic approach combined with within-case and cross-case comparison. The analysis began with repeated examination of the five written interview records to identify statements related to technological readiness, pedagogical considerations, school support, access arrangements, and reported classroom use.

Initial coding was used to organize relevant data segments into descriptive categories, including technological familiarity, instructional planning, professional development, technical assistance, device availability, scheduling arrangements, and

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implementation challenges. These codes were subsequently reviewed and grouped into broader analytical patterns. Four themes were developed: (1) the gap between teacher readiness and reported IFP implementation; (2) contextualized pedagogical integration in Islamic Religious Education; (3) institutional support and teacher professional learning; and (4) institutional access and the sustainability of IFP integration.

The analysis then compared the two school cases to examine how these themes appeared in different institutional contexts. Within-case analysis was used to examine the relationship between teachers' reported readiness, school support, access arrangements, and instructional practices in each school. Cross-case comparison was subsequently employed to identify shared patterns and contextual differences between SMA Negeri 4 Semarang and SMA Negeri 15 Semarang. Teacher accounts were considered alongside school leaders' perspectives to identify convergences, differences, and potential tensions in the reported experiences. An evidence matrix was used to connect each theme with its supporting written interview records and participant codes.

TPACK informed the interpretation of teachers' reported technological, pedagogical, and content-related considerations, while the ecological perspective guided attention to school-level conditions. Institutional access was examined as a specific analytical dimension involving equipment availability, physical location, scheduling procedures, preparation requirements, and connectivity. Together, these perspectives supported an examination of how teachers' perceived readiness intersected with their reported opportunities to implement IFP-supported instruction. Institutional access was examined as an analytical condition associated with opportunities for implementation, not as a statistically tested mediator or causal variable.

The credibility of the analysis was supported by comparing accounts from participants occupying different institutional roles. Analytical transparency was supported through the use of participant codes, an evidence matrix, and explicit distinctions between reported classroom practices, proposed activities, and perceived learning benefits. The study relied on five written interview records and did not include direct classroom observations, independent assessments of teacher proficiency, systematic IFP usage logs, or measurements of student learning outcomes. Consequently, the findings are presented as contextual interpretations of participants' reported experiences rather than independently verified instructional effects or statistically generalizable conclusions.

RESULTS AND DISCUSSION

RESULTS

The thematic analysis of five written interview records identified four interconnected themes: (1) the gap between teacher readiness and reported IFP implementation, (2) contextualized pedagogical integration in Islamic Religious Education, (3) institutional support and teacher professional learning, and (4) institutional access and the sustainability of IFP integration. Across the two cases, participants described generally positive attitudes toward interactive technologies and reported opportunities for professional learning. However, the translation of these conditions into regular classroom use differed according to teachers' experiences and the institutional arrangements governing access to shared IFP facilities.

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The Gap Between Teacher Readiness and Reported IFP Implementation

The findings revealed a distinction between teachers' perceived readiness to use Interactive Flat Panels and the extent to which these devices were incorporated into regular Islamic Religious Education (IRE) lessons. In both schools, the participating teachers reported familiarity with basic IFP functions and expressed willingness to develop their technological competencies. Nevertheless, their accounts indicated that such readiness was not consistently accompanied by frequent classroom implementation.

At SMA Negeri 4 Semarang, the IRE teacher (S4-G1) described acquiring basic operational knowledge through school-organized In-House Training (IHT). This experience introduced the teacher to touchscreen navigation, multimedia presentation, and other fundamental functions. The teacher reported being receptive to technological innovation but acknowledged that more advanced operations still required additional guidance. The possibility of technical malfunction or physical damage also contributed to caution when handling the device.

Despite this initial preparation, S4-G1 indicated that IFP use had not become a routine component of daily instruction. The written interview record stated:

"Penggunaannya belum sering atau belum rutin di kelas."

[Its use has not been frequent or routine in classroom teaching.] (S4-G1, translated excerpt from the written interview record)

The teacher continued to depend on more readily available technologies, particularly classroom projectors, for presenting learning materials. The discrepancy was therefore not simply between technological familiarity and a lack of interest in innovation. Rather, the teacher's reported readiness existed alongside limited opportunities to employ the device regularly.

This account was consistent with the perspective of the vice principal for curriculum (S4-K1), who described teachers as generally familiar with digital learning environments while acknowledging differences in their ability to operate IFP-specific features. According to S4-K1, some teachers required renewed assistance because infrequent use made it difficult to retain operational familiarity. The school leader's account suggested that basic technological knowledge did not necessarily develop into sustained practical proficiency when opportunities for repeated use were limited.

A similar distinction appeared at SMA Negeri 15 Semarang. The IRE teacher (S15-G1) described being able to operate basic functions, including accessing online videos, browsing educational resources, using screen mirroring, and working with digital whiteboard features. The teacher also reported some familiarity with interactive quizzes and multimedia presentation activities.

However, S15-G1 explained that IFP use was not an everyday practice. Instead, the device was used periodically when instruction took place in the multimedia room, particularly during scheduled classroom supervision or observation activities. The written interview record described this pattern as follows:

"Penggunaan IFP tidak dilakukan setiap hari. Perangkat ini digunakan secara berkala saat jadwal KBM dipindahkan ke Ruang Multimedia, terutamanya pada kegiatan supervisi/observasi kelas."

[IFP use does not take place every day. The device is used periodically when lessons are moved to the multimedia room, particularly during classroom supervision or observation activities.] (S15-G1, translated excerpt from the written interview record)

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The availability of the device therefore influenced when technological competencies could be applied.

The school leadership accounts reinforced this pattern. Both the vice principal for curriculum (S15-K1) and the principal (S15-P1) perceived teachers' general readiness positively, although they recognized differences in technological familiarity and confidence. Teachers with less experience using digital equipment were described as needing more guidance, while peer assistance helped reduce hesitation.

Across both schools, the findings indicated that perceived technological readiness and reported implementation were related but distinct aspects of IFP integration. Basic operational familiarity and positive attitudes were present, yet neither participating teacher described regular IFP use across daily IRE lessons. This pattern indicates a gap between perceived readiness and opportunities for routine implementation rather than independently demonstrating a deficiency in teachers' technological competence.

Contextualized Pedagogical Integration in Islamic Religious Education

The second theme concerned how teachers connected IFP functionalities with the instructional characteristics of Islamic Religious Education. Both participating teachers identified opportunities to use visual, multimedia, and interactive features to support the explanation of religious concepts. Nevertheless, their accounts differed in the extent to which these possibilities were described as planned applications or reported classroom activities.

At SMA Negeri 4 Semarang, S4-G1 identified Islamic Cultural History (Sejarah Kebudayaan Islam, SKI) and Islamic inheritance jurisprudence (Fikih Waris) as particularly suitable for IFP-supported instruction. The teacher's written interview record stated:

"IFP paling cocok untuk materi Sejarah Kebudayaan Islam (SKI) di kelas 11 dan Fikih Waris (Mawaris) di kelas 12."

[The IFP is particularly suitable for Islamic Cultural History in Grade 11 and Islamic inheritance jurisprudence in Grade 12.] (S4-G1, translated excerpt from the written interview record)

Historical material was considered appropriate for visual representation through maps, images, and multimedia sequences, while inheritance jurisprudence was regarded as potentially benefiting from interactive explanations of mathematical calculations and distribution procedures.

The teacher also described pedagogical approaches that could be combined with the technology, including group discussions, student presentations, and collaborative review of learning activities. In preparing digital materials, S4-G1 emphasized the importance of consulting established textbooks before selecting supplementary multimedia resources. This process was intended to maintain the accuracy of religious content presented through digital media.

However, the interview record did not establish that all these instructional possibilities had been implemented through IFP in regular lessons. Several descriptions concerned pedagogical suitability, instructional planning, or intended use. They therefore represented the teacher's pedagogical considerations rather than independently verified classroom practices. The record also indicated that more consistent applications of IFP in SKI, inheritance jurisprudence, and practical religious assessments were envisaged if

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additional devices became available. Thus, these examples should not be interpreted as evidence of routine implementation.

At SMA Negeri 15 Semarang, S15-G1 described a broader range of reported IFP-supported activities. The teacher identified Islamic history, jurisprudence, worship practices, and Qur'anic and Hadith studies as subjects in which visual resources could assist instructional explanation. Reported uses included video presentation, digital whiteboard activities, wireless screen mirroring, interactive quizzes, and student presentations.

The teacher described involving students by inviting them to interact with the display, provide answers, and present the outcomes of group discussions. One written response described the instructional approach as follows:

"Meminta siswa maju ke depan untuk menyelesaikan kuis, menggeser/menuliskan jawaban pada papan tulis digital IFP, serta mempresentasikan hasil diskusi kelompok langsung dari layar."

[Students are invited to complete quizzes, move or write answers on the IFP digital whiteboard, and present group discussion results directly using the display.] (S15-G1, translated excerpt from the written interview record)

Digital quiz applications were also identified as tools for reviewing learning materials and displaying responses collectively. These accounts suggested that IFP use was not understood exclusively as a replacement for conventional projection equipment. Unlike the examples emphasized by S4-G1, which largely concerned pedagogical suitability and intended applications, S15-G1 explicitly described these activities as part of the teacher's experience of using the device.

Nevertheless, the accounts did not provide systematic evidence concerning how often individual pedagogical features were used, the extent of student interaction during specific lessons, or whether such activities consistently produced more collaborative forms of learning. The evidence supports identifying reported instructional practices but not assigning a measured level of pedagogical effectiveness.

Participants in both schools associated IFP-supported instruction with increased student enthusiasm, attention, and participation. S4-G1 emphasized the perceived value of visualization for abstract religious concepts, while S15-G1 described students as more interested and actively involved when multimedia and interactive activities were incorporated.

These perceptions were broadly consistent with the school leaders' accounts. However, the study did not include student interviews, classroom observation, or independent assessments of motivation and learning achievement. Consequently, these findings are interpreted as perceived educational benefits rather than demonstrated improvements in learning outcomes. In particular, positive statements about student responses in the SMA Negeri 4 record should not be treated as independent confirmation of routine IFP-based lessons.

Overall, the evidence indicated that both teachers recognized subject-specific opportunities for IFP integration. The distinction between the cases lay primarily in the reported range of instructional activities, with SMA Negeri 15 providing more explicit accounts of occasional interactive classroom applications, while SMA Negeri 4 emphasized pedagogical possibilities alongside limited routine use.

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Institutional Support and Teacher Professional Learning

Institutional support emerged as a prominent feature of both school cases. Participants described school-organized professional development, leadership encouragement, and assistance from colleagues with greater technological expertise. Although these forms of support were present in both schools, their organization and delivery differed.

At SMA Negeri 4 Semarang, professional development was primarily organized through In-House Training. According to S4-K1, the school had conducted two internal training sessions concerning the operation and educational use of digital display technology. A teacher representative from the Informatics subject area had participated in government-provided training and subsequently shared the acquired knowledge with other teachers.

The school's support extended beyond formal training. S4-K1 described peer mentoring arrangements in which teachers with stronger technological skills could assist colleagues during device preparation and instructional use. Coordination with the school's information technology personnel and facilities management staff was also available to address operational difficulties.

S4-G1 confirmed receiving initial training and having access to technical assistance. Nevertheless, the teacher expressed a need for further practical guidance, especially in developing interactive digital materials suitable for IRE. This account highlighted a distinction between introductory device training and the more specialized pedagogical preparation required for subject-specific implementation.

At SMA Negeri 15 Semarang, professional learning was organized primarily through the school's teacher learning community, known as Komunitas Belajar (Kombel). S15-K1 described an internal knowledge-sharing process in which school technology personnel introduced IFP functions to other teachers following external training.

The principal (S15-P1) similarly emphasized the importance of collaboration and peer assistance. The principal's written interview record stated:

"Sekolah mengadakan pelatihan sederhana/kilat dalam forum Komunitas Belajar (Kombel)."

[The school organized introductory training sessions through its teacher learning community (Kombel).] (S15-P1, translated excerpt from the written interview record)

Teachers with greater technological familiarity were encouraged to provide practical support to colleagues who experienced difficulties. The school also maintained technical assistance for preparing the multimedia room, establishing connections, and operating the device.

S15-G1 reported that this assistance was useful during initial IFP experiences and when technical problems occurred. However, the teacher continued to identify the need for advanced training, particularly in integrating educational applications and developing more sophisticated interactive materials.

The two cases therefore demonstrated different professional learning arrangements: SMA Negeri 4 emphasized structured IHT supplemented by individual assistance, whereas SMA Negeri 15 emphasized Kombel-based knowledge sharing and peer support. Both approaches were reported to help teachers develop basic operational familiarity.

An important commonality was that professional development had not eliminated the practical constraints on IFP implementation. Although participants described institutional encouragement and available technical support, neither school had achieved

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unrestricted opportunities for teachers to integrate the device into everyday instruction. The evidence therefore distinguishes the provision of professional learning opportunities from the institutional conditions required to apply those skills regularly.

Institutional Access and the Sustainability of IFP Integration

Institutional access was the most consistent implementation constraint identified across the two cases. Participants described limitations associated with the availability and shared use of IFP facilities. The written interview records indicated that both schools possessed one government-provided IFP, which was located in a designated room rather than installed in regular classrooms.

At SMA Negeri 4 Semarang, the IFP was placed in Computer Laboratory 4. S4-K1 explained that the device was intended for shared use across subject areas and that teachers were required to coordinate its use through a booking arrangement managed by the school's facilities administration. The school leader's written response explained:

"Sekolah menempatkan IFP di ruang bersama (Labkom 4) dan menerapkan sistem pemesanan jadwal (booking) di Waka Sarpras agar tidak terjadi bentrokan penggunaan antarkelas."

[The school placed the IFP in a shared room, Computer Laboratory 4, and implemented a booking system coordinated by the vice principal for facilities to prevent scheduling conflicts between classes.] (S4-K1, translated excerpt from the written interview record)

The school leader described this system as a means of preventing scheduling conflicts and maintaining the device.

From the teacher's perspective, however, access involved additional preparation. S4-G1 explained that the school had approximately 33 class groups sharing access to a single IFP. The teacher also identified practical difficulties concerning room arrangements, preparation time, and the perceived inconvenience of moving equipment.

The two accounts differed in their description of device mobility. While S4-K1 described the IFP as permanently located in Computer Laboratory 4, S4-G1 referred to difficulties associated with moving or preparing the equipment. The available records did not clarify whether the difficulty concerned physically moving the IFP, relocating classes, or preparing instruction in a different room. Both accounts nevertheless identified additional logistical demands associated with a device that was not routinely available in the regular classroom.

The teacher further reported that IRE lessons had limited effective instructional time, making extensive preparation less practical. The availability of conventional classroom projectors provided an alternative that could be used without the same access procedures.

At SMA Negeri 15 Semarang, the IFP was permanently located in the multimedia room. According to S15-K1, approximately 58–60 teachers shared access to the single device. Its use required coordination with the designated room administrator to prevent overlapping schedules.

The principal (S15-P1) explained that classroom supervision, formal school meetings, and other scheduled institutional activities received priority in IFP allocation. This priority was explicitly described in the written interview record:

"Sekolah memprioritaskan penggunaannya untuk jadwal observasi pembelajaran serta kegiatan resmi sekolah/rapat dinas."

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[The school prioritizes its use for scheduled classroom observations and official school activities or meetings.] (S15-P1, translated excerpt from the written interview record)

This arrangement supported organized institutional use but also meant that routine subject teaching had to be accommodated within the available schedule.

S15-G1 confirmed occasionally encountering scheduling conflicts, particularly when the multimedia room was needed for observation activities or had already been allocated to another teacher. The teacher consequently described IFP integration as periodic rather than continuous. The difference between the two cases was therefore not simply the presence or absence of scheduling systems, but how these systems interacted with everyday opportunities for IRE instruction.

Connectivity constituted an additional constraint in SMA Negeri 15. Both S15-G1 and S15-K1 reported occasional problems with unstable Wi-Fi connections. The teacher described responding by requesting assistance from school technology personnel or using instructional materials downloaded in advance. This adaptation enabled some activities to continue without reliable internet access but did not address the underlying limitations on equipment availability.

The access constraints identified in the two schools were thus similar in their dependence on shared facilities but differed in their operational characteristics. SMA Negeri 4 emphasized the effects of fixed-room placement, preparation requirements, and limited instructional time. SMA Negeri 15 highlighted scheduling competition, priority given to school supervision and meetings, and intermittent connectivity.

Participants from both schools expressed interest in obtaining additional IFP units and strengthening pedagogical training. These recommendations reflected their perceptions of the conditions necessary for more regular integration. Proposed device expansion and further professional development were therefore treated as recommendations rather than interventions already implemented or evaluated.

Taken together, the findings suggest that the presence of an IFP within a school does not necessarily provide teachers with continuous instructional access. Across both cases, reported readiness and school support coexisted with organizational arrangements that restricted when and how the device could be incorporated into classroom teaching. The comparison illustrates the analytical distinction between institutional availability and practical instructional accessibility without establishing a causal relationship between access arrangements and implementation frequency.

Table 2. Cross-Case Comparison of Teacher Readiness, Institutional Support, Access, and IFP Integration

Analytical dimension	SMA Negeri 4 Semarang	SMA Negeri 15 Semarang
Teacher readiness	Basic IFP operational familiarity; further training needed for advanced features	Basic operational familiarity and reported use of selected interactive features
Pedagogical integration	SKI and inheritance jurisprudence identified as suitable; routine implementation not established	Occasional reported use for Islamic history, jurisprudence, worship, and Qur'anic/Hadith materials

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Analytical dimension	SMA Negeri 4 Semarang	SMA Negeri 15 Semarang
Professional development	Two IHT sessions and peer mentoring	Kombel-based training and peer mentoring
Technical support	Informatics teachers, IT personnel, and facilities staff	IT personnel, peer assistance, and multimedia room administrator
IFP availability	One government-provided unit	One government-provided unit
Device placement	Computer Laboratory 4	Multimedia room
Reported sharing context	Approximately 33 class groups	Approximately 58–60 teachers
Access arrangement	Booking through facilities administration	Scheduled use through multimedia room coordination
Additional constraints	Preparation time, room logistics, concerns about equipment mobility or damage	Competing institutional schedules and unstable internet connectivity
Reported implementation	Not routinely integrated into daily IRE lessons	Periodic use, particularly during scheduled multimedia-room lessons and supervision
Principal evidence sources	S4-G1; S4-K1	S15-G1; S15-K1; S15-P1

Note. The figures refer to approximately 33 class groups at SMA Negeri 4 Semarang and 58–60 teachers at SMA Negeri 15 Semarang and are therefore not directly comparable. The findings are based on written interview records.

DISCUSSION

From Technological Competence to Enacted Readiness

The findings indicate that Islamic Religious Education (IRE) teachers' perceived technological and pedagogical readiness does not necessarily translate into sustained Interactive Flat Panel (IFP) integration. In both school cases, teachers reported basic operational familiarity, positive attitudes toward technological innovation, and an understanding of how interactive displays could support religious learning content. Nevertheless, neither teacher described IFP use as a routine feature of everyday instruction. This distinction suggests that readiness should not be interpreted exclusively as a set of competencies possessed by individual teachers but also in relation to opportunities for applying those competencies.

This interpretation is consistent with Falloon (2020), who conceptualized teacher digital competence as extending beyond technical skills to include pedagogically appropriate technology use. Similarly, Wohlfart and Wagner (2023) and Schmid et al. (2024) emphasized the interconnected dimensions of teachers' digital competencies and technological pedagogical content knowledge. The present findings add a contextual dimension: even when teachers perceive themselves as capable of operating digital equipment, opportunities for translating that capability into classroom activity may remain restricted.

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The distinction between perceived readiness and enacted practice was apparent across the two schools. At SMA Negeri 4 Semarang, the participating teacher had acquired basic operational knowledge through internal training but continued relying on conventional classroom projectors. At SMA Negeri 15 Semarang, the teacher reported a wider range of occasional interactive activities, yet implementation remained dependent on multimedia-room availability. These differences should not be interpreted as evidence of unequal technological competence. Rather, they illustrate how reported readiness may be enacted differently under particular institutional conditions.

Infrequent use may also limit opportunities to consolidate operational familiarity, while uncertainty about advanced features or equipment maintenance may encourage teachers to select more accessible technologies. Although the evidence does not establish a causal relationship between restricted access and diminished competence, it suggests a plausible interaction between opportunities for practice, professional confidence, and instructional choices.

Institutional Access as a Condition of Technology Integration

The most distinctive finding concerns the relationship between institutional access arrangements and teachers' opportunities to integrate IFPs into regular classroom instruction. Both schools possessed an IFP and provided professional support, but the equipment was located in a designated shared room. Consequently, implementation depended on procedures extending beyond individual technological or pedagogical readiness.

This finding corresponds with Hammond's (2020) ecological explanation of educational technology adoption, which emphasizes the relationship between teachers and their institutional environments. An ecological perspective examines how organizational conditions shape technology integration rather than attributing implementation primarily to teachers' willingness or competence (Shen et al., 2024; Tømte, 2024). Similarly, Msafiri et al. (2023) identified infrastructure, professional development, and institutional coordination as important considerations in secondary-school ICT integration.

The present study extends these discussions by distinguishing institutional availability from instructional accessibility. Institutional availability refers to the presence of technological equipment within a school, whereas instructional accessibility concerns whether teachers can use that equipment under the conditions required for a planned lesson. A device may therefore be officially available while remaining difficult to incorporate into routine instruction because of advance booking, designated-room arrangements, or competing institutional activities.

The two cases illustrate different manifestations of this problem. At SMA Negeri 4 Semarang, reported obstacles concerned fixed-room placement, preparation requirements, and limited instructional time, encouraging continued reliance on more accessible classroom technologies. At SMA Negeri 15 Semarang, scheduling priorities, competing activities, and intermittent connectivity constrained implementation, although the teacher reported occasional interactive use. These accounts suggest that institutional access is not simply a matter of device quantity but also of how shared facilities are organized and made available for instruction.

Research on interactive whiteboard adoption demonstrates that factors associated with acceptance and continued use vary across adoption stages (Šumak et al., 2017). Although interactive whiteboards and contemporary IFPs are not identical, this distinction

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helps explain why technological familiarity or interest may not lead to regular classroom implementation. The present study adds attention to the organizational arrangements through which teachers obtain access to shared instructional technologies.

The study therefore proposes *access-conditioned enactment of teacher readiness* as an interpretive description of the observed pattern. The concept refers to situations in which teachers' opportunities to implement technology-supported instruction are shaped by the practical accessibility of institutional resources. In SMA Negeri 4 Semarang, basic readiness coexisted with limited routine use and a preference for more accessible technologies. In SMA Negeri 15 Semarang, occasional interactive activities were reported, but their implementation remained subject to room scheduling and institutional priorities. Across both settings, teacher readiness and professional support were present, while opportunities for classroom enactment remained institutionally conditioned.

This concept is not presented as a validated theory or universal causal mechanism. Rather, it identifies institutional access as an analytical dimension that helps explain the readiness–implementation gap in the two cases. Its contribution lies in making school context more operationally visible through device placement, scheduling, competing priorities, preparation requirements, and connectivity. Increasing equipment quantity alone would not necessarily guarantee improved integration without corresponding pedagogical preparation and institutional support.

Implications for TPACK and Subject-Specific Technology Integration

The findings have implications for understanding Technological Pedagogical Content Knowledge (TPACK) in subject-specific instructional contexts. The participating teachers did not describe IFP readiness solely in terms of operating touchscreen features or displaying digital materials. They also identified ways in which the technology could be aligned with Islamic Religious Education content, including Islamic history, inheritance jurisprudence, worship practices, and Qur'anic and Hadith studies.

These examples demonstrate the importance of connecting technology selection with pedagogical purposes and disciplinary requirements (König et al., 2024). Historical topics may benefit from visual representation, whereas inheritance jurisprudence may be supported by structured explanations of calculation procedures. Teachers also emphasized the importance of selecting reliable digital religious content. However, examples from SMA Negeri 4 primarily concerned pedagogical suitability and potential applications, whereas SMA Negeri 15 provided more explicit accounts of occasional classroom activities.

The findings are consistent with Mintasih et al. (2024), who identified challenges involving digital competencies, infrastructure, and interactive content development among Indonesian IRE teachers. The present study adds that recognizing a technology's pedagogical suitability does not necessarily mean teachers have regular opportunities to employ it.

Recent TPACK scholarship has increasingly acknowledged the role of contextual knowledge and school-level conditions (Brianza et al., 2024). Similarly, Yang and Dong (2024) demonstrated the relevance of an ecological-TPACK perspective for examining technology integration within educational environments. These studies support considering teachers' knowledge and institutional circumstances together.

The complementary roles of TPACK and an ecological perspective are particularly relevant to the readiness–implementation gap. TPACK helps interpret teachers' reported

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technological, pedagogical, and content-related considerations, while an ecological perspective explains how organizational conditions shape opportunities to apply such knowledge. Institutional access connects these concerns by identifying practical conditions governing IFP use. Together, these perspectives offer a more comprehensive explanation than teacher readiness alone.

The contribution of this study is therefore not the introduction of contextual knowledge into TPACK research. Instead, it offers a subject-specific illustration of how shared-device arrangements intersect with teachers' reported readiness and instructional practices. The concept of *access-conditioned enactment of teacher readiness* makes this relationship more explicit through the comparison of institutional access conditions across the two cases.

A further implication concerns the distinction between presentational and interactive technology use. Displaying videos and slides differs pedagogically from digital annotation, quizzes, student responses, and group presentations. However, the written interview records do not establish the depth or consistency of student interaction during specific lessons. The use of an interactive device does not necessarily produce interactive pedagogy (Antonietti et al., 2025; Børte et al., 2023). Meaningful IFP integration in IRE should therefore be evaluated through the alignment of technological functions, learning objectives, and student activities rather than through device availability alone.

Practical Implications and Study Limitations

The findings suggest that professional development should be coordinated with institutional arrangements that provide teachers with realistic opportunities to practice and implement newly acquired skills. Introductory training, whether delivered through In-House Training or teacher learning communities, may strengthen operational familiarity, but its instructional value may remain limited without regular access to devices.

Schools adopting shared IFP facilities may benefit from reviewing booking procedures, room allocation, scheduling priorities, and technical support. Professional learning should also emphasize subject-specific interactive activities rather than general device operation alone. For Islamic Religious Education, this includes developing reliable digital religious content, interactive explanations of jurisprudential concepts, and opportunities for student participation.

The comparison suggests different priorities for institutional improvement. Where fixed-room placement and preparation time limit access, more flexible scheduling and instructional planning support may be relevant. Where competing institutional activities and connectivity problems constrain use, coordinated allocation and offline instructional resources may help. These suggestions are consistent with the importance of pedagogical alignment and supportive institutional conditions identified in previous research (Børte et al., 2023; Msafiri et al., 2023). However, their effectiveness was not tested in this study.

Several limitations should be acknowledged. First, the study involved two public senior high schools and five informants, including one participating IRE teacher from each school. The findings therefore provide contextual insights rather than representative conclusions. Second, the analysis relied on written interview records without direct classroom observations, independent proficiency assessments, or systematic device usage logs. Consequently, reported readiness, implementation frequency, and pedagogical activities could not be independently verified.

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Third, participants' perceptions of improved student motivation, engagement, and understanding were not supported by direct student data or learning outcome measurements and cannot establish causal educational effects. Fourth, limited information about the frequency and duration of IFP-supported lessons means that some differences between schools may reflect differences in participants' accounts rather than objectively measured implementation. The reported sharing contexts—approximately 33 class groups at SMA Negeri 4 and 58–60 teachers at SMA Negeri 15—also represent different units and cannot be directly compared as access ratios.

Future research could combine interviews with classroom observations, equipment booking records, lesson documentation, and student perspectives to examine how institutional access relates to the frequency and pedagogical quality of IFP use. Studies involving more teachers and schools could also investigate the explanatory usefulness of *access-conditioned enactment of teacher readiness* across different allocation arrangements.

Despite these limitations, the study highlights an important distinction between possessing educational technology, preparing teachers to use it, and ensuring that teachers can access it within everyday instructional conditions. Its contribution lies in illustrating how these dimensions intersect in the reported experiences of Islamic Religious Education teachers and school leaders across two Indonesian public senior high schools.

CONCLUSION

This study examined how Islamic Religious Education (IRE) teachers' technological and pedagogical readiness intersects with institutional access arrangements and the reported integration of Interactive Flat Panels (IFPs) in two Indonesian public senior high schools. The findings reveal that teachers in both schools reported basic technological familiarity, positive attitudes toward digital innovation, and an understanding of the pedagogical potential of IFPs. However, these conditions did not consistently translate into routine classroom implementation. While SMA Negeri 4 Semarang emphasized potential instructional applications alongside limited routine use, SMA Negeri 15 Semarang provided more explicit accounts of occasional interactive activities.

Institutional access emerged as a critical consideration in understanding this readiness–implementation gap. Although both schools provided professional development and technical assistance, the limited availability of IFP devices, fixed-room placement, scheduling procedures, and competing institutional priorities restricted opportunities for regular instructional use. These findings suggest that teacher readiness and institutional support should be examined alongside the practical conditions under which teachers access and employ educational technologies.

The study contributes to educational technology research by highlighting institutional access as an analytical dimension connecting teachers' reported readiness with classroom implementation. By integrating TPACK and an ecological perspective, it offers a context-sensitive interpretation of technology integration within Islamic Religious Education. The concept of *access-conditioned enactment of teacher readiness* provides an interpretive explanation of how shared institutional resources may shape opportunities to translate teachers' perceived readiness into instructional practice. Practically, the findings suggest that professional development should be accompanied by accessible equipment, coordinated scheduling, and sustained pedagogical and technical support.

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Given the study's limited sample and reliance on written interview records, its findings should not be interpreted as evidence of causal relationships or generalizable implementation patterns. Future research involving additional schools, classroom observations, student perspectives, and technology usage records could further examine how institutional access arrangements relate to sustained and pedagogically meaningful IFP integration.

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