



## Diffusion of Technological Innovation in Non-Formal Education: The Mediating Role of Digital Social Interaction

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Technological Innovation; Diffusion of Innovation; Non-Formal Education; Digital Social Interaction; Community-Based Learning

### Abstract:

This study examines the strategic diffusion of technological innovation in a non-formal language course institution through the lens of Diffusion of Innovation theory. While digital transformation has significantly influenced educational practices, empirical research on how technological innovation is diffused and sustained within community-based non-formal institutions remains limited. Using a qualitative case study design, data were collected through semi-structured interviews, observations, and document analysis involving 18 participants, consisting of 8 tutors and 10 learners actively engaged in technology-supported learning in Kampung Inggris, Pare. The findings reveal that innovation adoption was primarily influenced by perceived instructional relevance, ease of use, and compatibility with learning needs. Diffusion occurred through hybrid communication networks that combined interpersonal interaction with digitally mediated platforms, where early adopters served as internal change agents who modeled and legitimized technology use. Institutional support, including digital training and infrastructure, facilitated sustainability, though disparities in digital literacy hindered uniform integration. The study highlights the mediating role of digital social interaction in structuring innovation diffusion within non-formal education. By situating diffusion processes within relational and networked learning ecosystems, this research refines the contextual application of Diffusion of Innovation theory. It provides practical insights for sustaining inclusive technological transformation beyond formal educational systems.

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### Introduction

Digital transformation has fundamentally reshaped educational landscapes over the past decade. The integration of technologies such as mobile learning applications, learning management systems, artificial intelligence, and synchronous communication platforms is no longer perceived merely as instructional support tools but as structural components redefining educational ecosystems (Badawi & Adiyono, 2026; Nurjanah et al., 2025; Sari et

al., 2025; Wang et al., 2024). Systematic reviews indicate that digital transformation significantly influences instructional design, access flexibility, learner engagement, and institutional development strategies across educational contexts (Bond et al., 2024; Mabothe & Ngcamu, 2025; Zawacki-Richter et al., 2019). In this regard, technological innovation has become central to educational sustainability and institutional competitiveness in the digital era.

However, technology integration does not occur linearly or uniformly. Empirical studies emphasize that successful educational innovation depends not only on technological availability but also on organizational readiness, professional competence, and social dynamics within institutions (Al-Emran & Teo, 2020; Selwyn, 2022). Technology adoption, therefore, represents a socially constructed process shaped by interaction patterns, institutional culture, and collective sense-making. Understanding technological innovation in education requires moving beyond instrumental perspectives toward examining diffusion processes embedded within specific social systems.

Existing research on educational technology adoption has predominantly focused on formal education institutions such as schools and universities. These studies typically examine policy frameworks, leadership roles, infrastructure readiness, and teacher competencies within hierarchical organizational structures (OECD, 2021). In contrast, non-formal educational institutions, often characterized by community-based learning environments and flexible organizational structures, remain underexplored within innovation research despite their growing relevance in contemporary education systems.

Non-formal institutions, particularly community-based language course centers, operate within socially intensive ecosystems where peer interaction, informal mentoring, and collaborative communication constitute the core of learning processes. Such environments enable innovation to diffuse through horizontal networks rather than formal bureaucratic channels. Research on collaborative learning networks suggests that horizontal interaction structures can accelerate knowledge exchange and practice adoption more effectively than centralized systems (Greenhow & Askari, 2017; Prenger et al., 2021).

The Diffusion of Innovation theory provides a foundational framework for analyzing how innovations are adopted and disseminated within social systems (Rogers, 1962, 2003). The theory identifies innovation characteristics, communication channels, time dimensions, and social structures as determinants of adoption decisions. Nevertheless, contemporary digitally mediated learning environments characterized by hybrid online and offline communication networks suggest the need to revisit diffusion mechanisms beyond traditional linear models (Blyth & Thoms, 2021; Veletsianos, 2020).

In language learning contexts, technological innovation manifests through artificial intelligence-based speaking tools, mobile learning applications, learning management systems, and video conferencing platforms that facilitate authentic communicative practice. Empirical evidence demonstrates that artificial intelligence-driven feedback systems and mobile-assisted language learning enhance personalization, learner autonomy, and motivation (Burudi et al., 2024; Heinimäki et al., 2021; Lai & Bower, 2019). However, the long-term sustainability of such innovations depends on how effectively they are diffused and institutionalized within learning communities.

Recent scholarship highlights the growing role of digital communication platforms and social networking spaces in shaping professional norms, fostering collaborative reflection, and accelerating the adoption of innovation among educators (Carpenter & Krutka, 2014; Trust et al., 2022). Digital interaction spaces function not merely as information channels but as arenas for social validation and collective negotiation of innovation practices. This dimension remains insufficiently theorized within diffusion

studies conducted in non-formal educational settings.

Despite the growing body of literature on educational technology integration, most studies emphasize pedagogical outcomes rather than strategic diffusion mechanisms within institutional ecosystems. Empirical research examining how innovation diffusion strategies operate within community-based non-formal institutions remains limited. Given their distinctive social dynamics and flexible structures, non-formal institutions provide a critical context for re-examining diffusion processes in digitally networked learning environments.

Addressing this gap, the present study introduces the concept of digital social interaction as a mediating dimension within the Diffusion of Innovation framework in non-formal education. Unlike prior studies that treat communication as a supportive variable, this research conceptualizes digital interaction networks as strategic accelerators that structure and legitimize innovation diffusion processes. By doing so, this study extends the theoretical applicability of diffusion models to community-based educational ecosystems characterized by interconnected communication networks.

This study aims to analyze the strategic diffusion of technological innovation in a non-formal language course institution through the lens of Diffusion of Innovation theory. By examining adopter categories, communication networks, and institutional capacity-building mechanisms, this research contributes theoretically to the development of a community-based diffusion model and practically to strategic innovation management in non-formal educational institutions operating in digitally connected environments.

## **Method**

This study employed a qualitative case study design to examine the strategic diffusion of technological innovation within a non-formal language course institution. The study used a qualitative approach to capture the social processes, interaction patterns, and contextual dynamics that shape innovation diffusion within a community-based educational ecosystem. The case study design enabled the researchers to examine in depth how the institution adopted, communicated, and institutionalized technological innovation within a bounded setting characterized by intensive social interaction and hybrid digital communication networks (Tisdell et al., 2025; Yin, 2018).

The research took place in a community-based language course institution located in an intensive learning environment widely recognized for its immersive language practices. The researchers selected this institutional context because it represents a non-formal educational ecosystem where peer interaction, informal mentoring, and digital communication networks play central roles in daily learning activities. These characteristics provided a relevant context for examining innovation diffusion processes beyond hierarchical formal structures.

The researchers selected participants through purposive sampling to ensure alignment with the research objectives. The study involved 18 participants, consisting of eight tutors and ten learners who actively engaged in technology-supported learning practices in Kampung Inggris Pare. The researchers recruited tutors based on their involvement in integrating mobile learning applications, learning management systems, artificial intelligence tools, and video conferencing platforms into instructional practices. The researchers subsequently applied snowball sampling to identify additional participants who played significant roles in the institution's technology adoption processes.

The researchers collected data through in-depth semi-structured interviews, non-participant observations, and document analysis. The interviews explored participants' experiences, perceptions, and decision-making processes related to technology adoption. Observations examined real-time instructional practices and digital interaction patterns in

classroom and online learning environments. The researchers also analyzed institutional documents, digital learning materials, and communication records to triangulate the findings and enhance data credibility (Yin, 2018).

The researchers analyzed the data using an interactive thematic analysis model consisting of data condensation, data display, and conclusion drawing (Miles et al., 2014). The analysis began with open coding to identify initial concepts emerging from interview transcripts and observation notes. The researchers then organized these codes through axial coding to establish relationships among categories related to innovation characteristics, communication channels, adopter categories, and institutional support mechanisms. Subsequently, selective coding integrated these categories into broader themes representing strategic diffusion mechanisms within the institution. The researchers conducted the analysis iteratively to maintain theoretical coherence and ensure alignment with the Diffusion of Innovation framework.

To enhance trustworthiness, the researchers implemented several validation strategies. They conducted triangulation across multiple data sources and methods to ensure the consistency of findings. The researchers also performed member checking by sharing preliminary interpretations with selected participants to confirm the accuracy of the representations. In addition, peer debriefing with academic colleagues helped refine thematic interpretation and minimize researcher bias. The study provided detailed contextual descriptions to support the transferability of findings to similar non-formal educational contexts.

The researchers carefully observed ethical considerations throughout the study. They informed participants of the research's purpose and obtained voluntary consent prior to data collection. The researchers maintained anonymity and confidentiality by assigning pseudonyms and removing identifying information from interview transcripts and institutional records. They stored all research data securely and used it exclusively for academic research purposes.

Through this methodological design, the study generated a comprehensive understanding of how a community-based non-formal educational institution strategically diffuses technological innovation and how digital social interaction functions as a mediating dimension within the diffusion process.

## **Result and Discussion**

### **1. Result**

#### **a. Characteristics of Technological Innovation in Learning Practices**

The findings indicate that perceived instructional relevance primarily drove technological innovation within the institution. Participants adopted digital tools not merely because they were available, but because the tools directly supported communicative language practice. As a result, participants closely aligned the selection of technological tools with practical classroom needs and learner engagement objectives.

Interview data show that participants most frequently used mobile learning applications and artificial intelligence–based speaking tools. Participants valued these technologies because they enabled independent practice, provided immediate feedback, and offered flexible access beyond scheduled classroom sessions. Participants mainly used video conferencing platforms to simulate interactive discussions, while they used learning management systems to organize learning materials and monitor assignments. As summarized in Table 1, the number of participants adopting each technology varied with the perceived pedagogical benefits of that technology.

**Table 1. Interview Findings on Innovation Characteristics**

Innovation Type	Instructional Function	Number of Participants (n=18)	Representative Interview Excerpt
Mobile Learning Applications	Independent vocabulary and speaking practice	16	<i>“Mobile applications are very helpful because students can practice vocabulary and speaking outside classroom hours. They feel more flexible and are not limited by time or place. Many learners use the apps daily to strengthen their pronunciation and expand vocabulary.”</i>
Video Conferencing Platforms	Speaking simulation and interactive discussion	14	<i>“Video conferencing allows us to simulate real communication even when we cannot meet physically. Students feel that online discussions still create interaction, especially for speaking practice, and tutors can monitor participation directly.”</i>
AI Based Learning Tools	Automatic pronunciation and grammar feedback	11	<i>“AI tools give instant correction for pronunciation and grammar mistakes. Students feel more confident because they can practice privately without fear of being judged. The automatic feedback helps them identify specific weaknesses.”</i>
Learning Management System	Material assignment and management	12	<i>“The LMS helps organize learning materials and assignments in one place. Tutors can track student progress and ensure that tasks are submitted on time. It makes administrative aspects of learning more structured.”</i>

Overall, the findings suggest that the direct instructional applicability of innovations strongly influenced innovation adoption. Participants more rapidly integrated technologies that offered visible and immediate learning benefits into instructional practice. In contrast, they adopted tools perceived as administrative or complex more slowly and required longer adaptation periods to incorporate them effectively.

### b. Communication Channels Supporting Innovation Diffusion

The findings show that communication practices among tutors and learners closely shaped the diffusion of technological innovation within the institution. Participants usually became aware of innovations through informal interactions rather than formal institutional announcements. Every day, professional conversations therefore functioned as important spaces where participants introduced, discussed, and evaluated new digital tools.

Interview responses further highlight the role of hybrid communication networks that combine face-to-face interaction with digitally mediated platforms. Tutors frequently shared their experiences with learning applications during informal meetings, while digital messaging groups enabled them to disseminate tutorials, links, and practical guidance quickly. Peer observation also encouraged experimentation, as tutors felt more confident adopting tools that had already demonstrated effectiveness in their colleagues' instructional practices.

**Table 2. Summarizes These Interaction Patterns**

Communication Channel	Diffusion Mechanism	Number of Participants	Representative Interview Excerpt
Informal Tutor Discussions	Sharing applications	new 13	<i>“Most of the time I learn about new applications from casual discussions with other tutors. When someone successfully uses a tool in class, they usually explain how it works and share their experience.”</i>
Peer Observation	Observing successful implementation	12	<i>“After observing a colleague using a digital tool effectively in class, I felt encouraged to try it myself. Seeing practical results reduces hesitation.”</i>

Digital Messaging Groups	Sharing tutorials and experiences	14	<i>"In our messaging groups, tutors frequently share links, tutorials, and tips about new learning technologies. We also discuss challenges and solutions, which helps everyone understand the tools better."</i>
Peer Learning Among Students	Recommending applications	15	<i>"Students often recommend applications to each other. If one student finds a useful app, they share it with friends, and others try it based on that recommendation."</i>

These findings demonstrate that socially embedded communication processes largely shaped the diffusion process. Innovation spread horizontally across professional networks, supported by interpersonal trust and digital interaction spaces that facilitated rapid knowledge exchange.

### c. Variation in Adopter Categories

Differences in adoption behavior among tutors shaped the pace of technological integration within the institution. Not all participants responded similarly to emerging technologies. Some tutors displayed proactive attitudes toward experimentation, while others adopted tools only after observing demonstrated effectiveness.

The data reveal identifiable patterns consistent with adopter variation. A small group of tutors actively experimented with new applications and introduced them to colleagues. Others preferred to observe classroom outcomes before integrating digital tools into their routines. A minority expressed cautious attitudes and required additional reassurance before adoption. Learners generally demonstrated greater technological familiarity and often experimented independently. Table 3 summarizes these adoption patterns.

**Table 3. Interview Findings on Adopter Categories**

Adopter Category	Characteristics Observed	Number of Tutors	Representative Interview Excerpt
Innovators	Actively experiment with new tools	3	<i>"I usually explore new applications before others try them. I test their features and see whether they can improve student engagement. If they work well, I introduce them to colleagues."</i>
Early Adopters	Model and introduce tools to peers	5	<i>"After using a new tool successfully, I demonstrate it during tutor discussions. Other tutors often ask how it works and how to apply it in their own classes."</i>
Early Majority	Adopt after observing effectiveness	6	<i>"I prefer to observe first. When I see that a technology really helps students and does not complicate teaching, then I start using it gradually."</i>
Late Majority	Require strong evidence before adoption	2	<i>"I am careful with new technology. I need clear evidence and sometimes additional guidance before integrating it into my teaching routine."</i>

Variation in adopter readiness influenced the pace of diffusion. Early adopters played a bridging role in reducing uncertainty, while more cautious participants required observational validation before fully integrating technology into instructional practice.

### d. Institutional Support and Challenges in Sustaining Innovation

Institutional conditions shaped the sustainability of innovation beyond individual adoption decisions. Participants consistently emphasized the importance of infrastructure, training, and organizational support in facilitating technology integration. They therefore

viewed innovation not as a purely individual initiative but as part of a broader institutional environment that enabled or constrained technological adoption.

Interview data show that digital training programs and reliable internet access strengthened tutors' confidence in using technology for instructional purposes. Institutional encouragement to experiment with new tools also fostered a supportive climate for innovation. However, participants identified disparities in tutors' digital literacy as a continuing challenge. Senior tutors, in particular, sometimes had difficulty adapting to certain applications, leading to variation in the level of technology integration across classes. Table 4 summarizes these findings.

**Table 4. Interview Findings on Institutional Support and Constraints**

<b>Institutional Factor</b>	<b>Observed Impact</b>	<b>Number of Participants</b>	<b>Representative Interview Excerpt</b>
Digital Training Programs	Increased tutor confidence	12	<i>“The institution organizes digital training sessions to help tutors understand how to use certain applications. After attending these sessions, I feel more confident integrating technology into my teaching.”</i>
Internet Infrastructure	Facilitated technology integration	15	<i>“Stable internet access is essential. Without reliable connectivity, it would be difficult to conduct online discussions or use digital platforms effectively.”</i>
Institutional Encouragement	Motivated experimentation	10	<i>“The institution encourages tutors to try new approaches and technologies. This support makes us feel safe experimenting with innovative tools.”</i>
Digital Literacy Gap	Slowed uniform adoption	4	<i>“Some tutors, especially senior ones, find it challenging to adapt to new digital tools. This sometimes creates differences in how technology is used across classes.”</i>

In summary, institutional support created a favorable environment for technological innovation, but uneven digital competence influenced the consistency of implementation. Sustainable diffusion, therefore, depended on both supportive infrastructure and continuous capacity building among tutors.

## 2. Discussion

The findings of this study reaffirm the continuing relevance of Diffusion of Innovation theory in explaining technological adoption within educational contexts. Innovation characteristics such as relative advantage, compatibility with instructional needs, and perceived ease of use significantly influenced adoption decisions. Technologies that provided immediate pedagogical value, particularly those supporting communicative language practice, were more rapidly integrated. This confirms earlier research emphasizing perceived usefulness as a decisive determinant of educational technology adoption (Al Emran & Teo, 2020; Lai & Bower, 2019). In this context, the visibility of instructional impact outweighs administrative convenience in shaping early diffusion patterns.

At the same time, the study demonstrates that innovation diffusion in non-formal institutions is not merely a function of technological features. Rather, diffusion unfolds through socially embedded processes shaped by daily interaction and shared professional experience. Unlike hierarchical formal institutions, where technology adoption may follow strategic planning directives, the observed diffusion pattern was relational and community-driven. This finding underscores the need to situate diffusion processes within the specific social ecology of non-formal education.

One of the most significant findings concerns the role of hybrid communication networks. Diffusion did not occur exclusively through face-to-face interaction or formal

institutional announcements, but through an integration of interpersonal communication and digitally mediated exchanges. Messaging platforms, informal tutor discussions, and peer observation created a dynamic network through which innovation circulated rapidly. This supports emerging scholarship suggesting that digitally networked professional communities play a transformative role in shaping innovation uptake (Greenhow & Askari, 2022; Trust et al., 2022).

Importantly, communication channels in this context functioned not only as conduits for information but also as arenas for collective validation. Tutors did not adopt technologies simply because they received information about them; instead, they adopted them after observing successful implementation and receiving peer endorsement. This pattern indicates that tutors relied on shared experiences and professional trust when deciding whether to integrate new technologies into their instructional practices.

These findings further demonstrate that actors within non-formal institutions socially construct legitimacy through trust-based interaction. In digitally connected educational ecosystems, communication networks distribute validation processes across peer interactions rather than concentrating them within institutional leadership. As a result, innovation diffusion becomes a socially negotiated process shaped by collaborative evaluation and shared professional judgment.

The variation in adopter categories further illustrates the temporal dynamics of diffusion. Innovators and early adopters played critical roles in modeling technology integration and reducing uncertainty for their peers. Their practices created visible examples that encouraged gradual acceptance among early majority tutors. This dynamic reflects Rogers' categorization of adopter groups while also emphasizing the relational dimension of change agents in community-based institutions. Diffusion in this setting emerged through modeling and demonstration rather than policy enforcement.

Interestingly, learners demonstrated greater digital familiarity than some tutors, which indirectly influenced diffusion patterns. This reverse influence suggests that diffusion in non-formal institutions may be multi-directional rather than strictly teacher-driven. Learner experimentation and peer recommendations contributed to the normalization of technology, reinforcing the idea that innovation ecosystems in community-based institutions are interactive rather than hierarchical.

Institutional capacity building emerged as a crucial factor for sustaining diffusion beyond initial experimentation. While innovation often began informally through peer interaction, long-term integration required structured support mechanisms such as digital training and reliable infrastructure. This aligns with the digital transformation literature, which emphasizes that sustainable technological change depends on organizational readiness and professional development (Bond et al., 2020; OECD, 2021). Informal diffusion may trigger innovation, but institutional scaffolding ensures its continuity.

However, the persistence of digital literacy disparities reveals that diffusion processes remain uneven. Senior tutors who experienced difficulties adapting to digital platforms occasionally slowed uniform integration across instructional groups. This finding illustrates that innovation diffusion is neither automatic nor homogeneous. Even within supportive environments, variations in competence can create asymmetrical adoption patterns that require targeted intervention.

A central contribution of this study is identifying digital social interaction as a mediating dimension in the diffusion process. Traditional interpretations of Diffusion of Innovation theory conceptualize communication channels as mechanisms for transmitting information across a social system. The present findings suggest that in digitally connected

non-formal institutions, communication networks actively structure perception, legitimacy, and risk assessment. Digital interaction not only accelerates awareness but shapes collective evaluation and normalization of innovation practices.

From a broader perspective, the study contributes to global discussions on innovation and technology in education by foregrounding the underexplored context of non-formal institutions. As digital transformation increasingly permeates diverse educational sectors, understanding the mechanisms of diffusion in flexible, community-based environments becomes essential. The network-driven diffusion pattern observed in this study offers insights that may inform similar institutions operating in digitally connected contexts worldwide. By situating diffusion within relational, hybrid communication ecosystems, this research expands contemporary understanding of how technological innovation becomes socially sustained beyond formal educational systems.

## Conclusion

This study confirms that social dynamics, rather than the technological characteristics alone, shape technological innovation in non-formal education. Participants adopted technologies perceived as directly enhancing communicative learning more rapidly, yet their sustained integration depended on interaction patterns among tutors and learners. Innovation diffusion, therefore, emerged through relational processes embedded in everyday professional communication rather than through centralized institutional mandates.

A key contribution of this research is highlighting the mediating role of digital social interaction in the diffusion process. Hybrid communication networks that combined face-to-face engagement with digitally mediated platforms functioned as spaces for collective validation, peer modeling, and uncertainty reduction. Early adopters served as internal change agents, accelerating normalization, while institutional training programs and infrastructure supported long-term sustainability. These findings refine the application of the Diffusion of Innovation framework within digitally connected, community-based educational environments.

More broadly, this study contributes to global discussions on educational technology and innovation by foregrounding the underexplored context of non-formal institutions. The community-driven, network-mediated diffusion pattern identified in this study suggests that sustainable technological transformation requires strategic alignment among innovation characteristics, social interaction networks, and institutional capacity-building. Understanding this interplay is therefore essential for guiding inclusive and context-responsive digital innovation beyond formal educational systems.

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