

# School Readiness for Coding and AI Education: A Case Study of Policy Implementation and Pedagogical Adaptation in Indonesia

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## ABSTRACT

The educational transformation driven by the Industrial Revolution 4.0 necessitates digital literacy and computational thinking, reflected in Indonesia's 2025 policy mandating Coding and AI as compulsory electives. This study examines policy implementation, student competency outcomes, barriers, and adaptive strategies within an early-adopting school context. A single instrumental case study was conducted at HelloMotion High School, selected for its pioneering role in digital curriculum integration prior to the national mandate. Data were collected from September to November 2025 through in-depth interviews with six key informants (one principal, one vice-principal, one teacher, and three students) and a survey of 99 students. Analysis employed Miles and Huberman's interactive model alongside descriptive statistics. Findings reveal a "Literacy-Aspiration Gap," where students demonstrated improved logical thinking ( $M = 3.35$ ,  $SD = 0.91$ ) but low interest in technology-related careers ( $M = 2.21$ ,  $SD = 1.11$ ). The primary challenges were identified as second-order barriers, including teacher beliefs and students' "instant generation" mindset, rather than infrastructural limitations. In response, the school implemented an Integrative Strategy Model combining project-based learning with specialized, diverse grouping to enhance engagement and learning outcomes. The study highlights that successful implementation of Coding and AI education extends beyond infrastructure provision to addressing pedagogical and attitudinal barriers. It contributes to policy discourse by emphasizing the need for interventions targeting internal resistance and aligning skill development with student motivation, ensuring more effective and sustainable digital education reform.

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## 1. INTRODUCTION

The Industrial Revolution 4.0 has brought fundamental changes, demanding that education systems prepare a generation capable not only of using technology but also of understanding and innovating through it. In response, the Indonesian government issued Permendikdasmen No. 13 of 2025, establishing Coding and Artificial Intelligence (AI) as compulsory elective subjects (Kemendikdasmen, 2025). This policy is a national strategy to strengthen 21st-century competencies in digital literacy, computational

thinking, and technology ethics and is expected to prepare students to participate actively in the digital economy and data-driven innovation. However, the transition to education based on coding and AI does not always proceed smoothly. A significant problem lies in the gap between this progressive national policy and schools' varying readiness to implement it effectively. While structural issues such as limited infrastructure and internet access are prevalent (Bappenas, 2025), the more complex, human-centered barriers at the school level remain less understood, creating a tangible risk of a policy-to-practice gap.

To analyze this implementation challenge, it is essential to define core constructs. School readiness in this context extends beyond technological infrastructure to encompass leadership vision, teacher pedagogical capacity, and an organizational culture conducive to innovation (Fullan, 2016). The targeted student outcomes include computational thinking, the cognitive skill of solving problems through algorithmic logic, pattern recognition, and abstraction (Wing, 2006), and AI literacy, which involves understanding its mechanisms, societal impacts, and ethical dimensions (Long & Magerko, 2020). Furthermore, following Ertmer's (1999) framework, barriers are categorized as first-order (external, e.g., resources, infrastructure) and second-order (internal, e.g., pedagogical beliefs, student attitudes) (Ertmer, 1999).

Globally, integrating coding and AI into curricula is recognized as vital for fostering systematic, creative, and collaborative thinking (Chernenko et al., 2021; Williamson et al., 2019). In Indonesia, policy directions such as Merdeka Belajar aim to balance curricular flexibility with the development of digital competencies (Haetami, 2025). However, prior research has primarily focused on macro-level challenges such as national infrastructure gaps and general perceptions of digitalization policies (Raharjo & Rohmadi, 2025; Saman & Wahyudi, 2025). A significant research gap persists; there is a scarcity of in-depth, micro-level studies that examine how national policy is interpreted, adapted, and enacted within the unique sociocultural context of individual schools, particularly those that are creatively oriented and have overcome first-order barriers. This gap limits our understanding of the second-order barriers and contextual adaptive strategies that ultimately determine successful implementation.

HelloMotion High School provides a critical and instrumental case to address this gap. As an Apple Distinguished School that has proactively integrated coding into its curriculum since 2022, it represents a unique context in which implementation is driven by internal vision and capacity rather than mere policy compliance. Studying this school enables a focused examination of second-order barriers and innovative strategies in high relief, offering insights often obscured in contexts facing first-order constraints (Stake, 1995).

The theoretical lens of this study explicitly combines Ertmer's (1999) first- and second-order barriers framework with perspectives from policy implementation theory, particularly the interplay between policy change and implementers' capacity (Fullan, 2016). This lens allows for a nuanced analysis that moves beyond resource availability to examine the beliefs, practices, and organizational dynamics that facilitate or hinder meaningful change.

A potential novel contribution emerging from this study is the exploration of a "literacy-aspiration gap." This concept suggests a possible disconnect between gains in students' digital/computational literacy and their interest in pursuing technology-related careers, a phenomenon hinted at by preliminary student survey data (item Learning Impact (DP4)). This gap may be influenced by identity, perceived fit, and career imagery (Archer et al., 2015), which this study will explore in the specific context of a creatively oriented school.

Consequently, this research aims to answer the following questions: (1) How is the national Coding and AI policy implemented at HelloMotion High School? (2) What is its impact on student competency development? (3) What barriers does the school face in implementation? (4) What adaptive strategies are employed to overcome these barriers? By answering these questions, this study seeks to provide empirical insights into the micro-dynamics of digital policy implementation and offer a transferable model for other schools navigating similar transitions.

## 2. METHODS

This study employed a qualitative approach with a single instrumental case study design (Creswell & Poth, 2018; Stake, 1995). The case of the implementation of Permendikdasmen No. 13 of 2025 concerning Coding and Artificial Intelligence (AI) learning at HelloMotion High School was instrumental in providing insight into the broader phenomenon of digital education policy adaptation at the school level. The case study design was chosen for its ability to facilitate an in-depth, holistic exploration of a complex real-world phenomenon within its natural context, where the boundaries between policy, implementers, and the school environment are intertwined (Yin, 2018). This approach allowed for a comprehensive assessment of the interaction between macro-policy and micro-practice.

The research was conducted at HelloMotion High School in South Tangerang, Indonesia, over a three-month period from September to November 2025, capturing the initial implementation phase of the national policy. The school was purposively selected due to its status as an Apple Distinguished School and its early adoption of a design-thinking-based curriculum integrating coding and AI since 2022, making it a critical case for studying proactive policy adaptation in a resource-ready environment.

Participants were selected through purposive sampling to include key stakeholders directly involved in policy implementation. The sample included the school principal and the vice-principal for curriculum, who provided strategic perspectives. Two teachers, the Coding and AI subject teacher and a Mathematics teacher who also served as the vice-principal for curriculum, were selected to offer views from both a direct policy implementer and a related discipline. Three students from grades X, XI, and XII, representing diverse grade levels and engagement levels, were also included. Additionally, a focus group discussion (FGD) was conducted with three other teachers and academic staff involved in curriculum delivery. To capture broader student perceptions, a questionnaire was administered to 99 students from grades X, XI, and XII. Informed consent was secured from all adult participants, and informed assent, along with parental consent, was obtained for student participants. Anonymity and confidentiality were ensured by using pseudonyms, and all data were stored securely.

Data were collected using multiple techniques to ensure triangulation. In-depth, semi-structured interviews were conducted with six participants (a principal, two teachers, and three students), each lasting 45–60 minutes and audio-recorded and transcribed verbatim. One classroom observation of Coding and AI lessons was conducted, with field notes focusing on pedagogy, interactions, and technology use. One 90-minute FGD with three teachers was held to discuss preliminary findings and collective strategies.

A structured questionnaire using a 5-point Likert scale was distributed to assess four constructs: Perception and Motivation (PM), Learning Process (PP), Obstacle and Challenge (HT), and Learning Impact (DP). The instrument's reliability was assessed using Cronbach's Alpha, which yielded a score of 0.774, indicating acceptable internal consistency. Validity was confirmed using Pearson Correlation, with all items showing significance ( $p < 0.05$ ). The questionnaire also included open-ended questions for qualitative feedback. Document analysis of the school curriculum, lesson plans, and policy adaptation documents was conducted using a checklist.

Data analysis was conducted using Miles and Huberman's interactive model, which consists of four stages: data collection, data reduction, data display, and conclusion drawing (Miles et al., 2014). All interview, observation, and FGD results were transcribed verbatim to maintain data authenticity. At the data reduction stage, the researcher selected data relevant to the research focus and grouped the information into central themes, including policy implementation strategies, teacher readiness, student experiences, implementation barriers, and school adaptive strategies. The data display stage involved compiling thematic matrices and narrative descriptions that show relationships among variables and patterns in the findings. Quantitative data from the questionnaire were analyzed descriptively using SPSS version 25. Means and standard deviations were calculated for each item. The percentage of agreement (for scores of 4 and 5) was computed for the key items. These descriptive statistics are reported in the Findings section to support the qualitative insights.

Trustworthiness was ensured through several strategies. Credibility was achieved via triangulation of data sources (interviews, observations, documents, and questionnaires) and member checking with teacher participants. Transferability was supported by a thick description of the context and participants. Dependability was maintained through an audit trail documenting research procedures. Confirmability was addressed through researcher reflexivity and maintaining an audit trail of raw data and analytical decisions.

### 3. FINDINGS AND DISCUSSION

To ensure the credibility of the student perception data, the survey instrument underwent rigorous validity and reliability testing. Item validity was tested using Pearson correlation between each item and the total score, with a significance level of  $p < 0.05$ . Initial testing with 16 items revealed that one item (PM2) was invalid ( $p = 0.737$ ) and was subsequently removed from the instrument. After removal, all remaining 15 items were found to be valid ( $p < 0.05$ ), as shown in Table 1.

**Table 1.** Item-Total Validity Test Results (n=99)

Item	Construct	Pearson Correlation (r)	p-value	Status
PM1	Perception and Motivation	0.384	<0.001	Valid
PM3	Perception and Motivation	0.482	<0.001	Valid
PM4	Perception and Motivation	0.347	<0.001	Valid
PP1	Learning Process	0.218	0.03	Valid
PP2	Learning Process	0.342	<0.001	Valid
PP3	Learning Process	0.61	<0.001	Valid
PP4	Learning Process	0.426	<0.001	Valid
HT1	Obstacle & Challenge	0.452	<0.001	Valid
HT2	Obstacle & Challenge	0.26	0.009	Valid
HT3	Obstacle & Challenge	0.409	<0.001	Valid
HT4	Obstacle & Challenge	0.5	<0.001	Valid
DP1	Learning Impact	0.553	<0.001	Valid
DP2	Learning Impact	0.582	<0.001	Valid
DP3	Learning Impact	0.581	<0.001	Valid
DP4	Learning Impact	0.54	<0.001	Valid

Furthermore, reliability analysis using Cronbach's alpha on the collected data yielded an overall internal consistency of 0.774 for the 15 items (Table 2), which is considered acceptable and indicates good instrument reliability.

**Table 2.** Reliability Test Result

Cronbach's Alpha	Number of Items	Interpretation
0.774	15	Reliable

Table 3 presents the descriptive statistics for each construct, including the percentage of agreement (scores of 4 and 5), means, and standard deviations for Perception and Motivation (PM), Learning Process (PP), Obstacle and Challenge (HT), and Learning Impact (DP).

**Table 3.** Student Questionnaire Response Percentage

Item	Construct	Score (%)					Mean	SD
		1	2	3	4	5		
PM1	Perception and Motivation	8.08	29.29	35.35	22.22	5.05	2.87	1.017
PM3	Perception and Motivation	4.04	22.22	32.32	31.31	10.1	3.21	1.033
PM4	Perception and Motivation	10.1	30.3	43.43	12.12	4.04	2.70	0.952
PP1	Learning Process	3.03	12.12	38.38	37.37	9.09	3.37	0.921
PP2	Learning Process	2.02	24.24	37.37	26.26	10.1	3.18	0.983
PP3	Learning Process	2.02	21.21	38.38	31.31	7.07	3.20	0.926
PP4	Learning Process	5.05	20.2	27.27	37.37	10.1	3.27	1.058
HT1	Obstacle & Challenge	3.03	26.26	23.23	35.35	12.12	3.27	1.077
HT2	Obstacle & Challenge	9.09	34.34	35.35	16.16	5.05	2.74	1.006
HT3	Obstacle & Challenge	8.08	33.33	35.35	15.15	8.08	2.82	1.053
HT4	Obstacle & Challenge	13.13	36.36	25.25	20.2	5.05	2.68	1.096
DP1	Learning Impact	2.02	14.14	39.39	35.35	9.09	3.35	0.907
DP2	Learning Impact	7.07	18.18	43.43	22.22	9.09	3.08	1.027
DP3	Learning Impact	2.02	22.22	32.32	29.29	14.14	3.31	1.037
DP4	Learning Impact	31.31	33.33	22.22	9.09	4.04	2.21	1.109

### 3.1. Implementation of Coding and AI Policy at HelloMotion High School

The research results indicate that the implementation of Permendikdasmen No. 13 of 2025 on coding and AI learning at HelloMotion High School is more advanced than at most other schools in Indonesia. The school has integrated coding into its curriculum since 2022, even before the national policy was officially enacted. This initiative stemmed from the principal's vision to merge creativity, technology, and design as pillars of 21st-century learning. HelloMotion High School applies AI and coding not as separate subjects, but as a cross-disciplinary approach integrated into design, animation, and creative technology projects. As the principal explained, *"We saw the national policy as a framework to scale our creative vision, not a checklist to follow."* This vision translated into a cross-disciplinary, project-based model observed in classrooms, where students applied Swift programming to create interactive elements for visual design projects or to develop simple chatbots for Sociology campaigns on social issues, thereby learning coding logic in authentic, creative contexts.

This approach aligns with previous findings that the success of technology-based learning implementation heavily depends on the school's transformational leadership and long-term vision (Maxwell, 2024). The HelloMotion principal serves as an instructional leader, actively facilitating collaboration between teachers and students and developing internal support systems, such as technology training and digital laboratories. This finding reinforces the view that digital education innovation is determined not only by the availability of infrastructure but also by the leadership's ability to create an innovative learning culture (Dai et al., 2025; Handayani et al., 2025)

However, this finding also stands in sharp contrast to many case studies in Indonesia that frequently report a significant policy-practice gap. Research by Beladinna et al. (2025) highlights how schools, particularly in rural areas, struggle to translate macro-policies (such as the Kurikulum Merdeka) into effective classroom practices. (Niaty Beladinna et al., 2025). HelloMotion High School avoided this gap. Because the implementation was driven by an internal vision since 2022, before the national policy was enacted in 2025, the school had the autonomy to build a contextually relevant learning ecosystem, making it a successful and rarely documented bottom-up implementation model

Besides school policy support, the successful implementation is also bolstered by the readiness of the learning ecosystem. Based on interviews, teachers and students show a high level of adaptation to digital learning, primarily through the design thinking approach, which emphasizes empathy, ideation, and prototyping in the learning process. This model allows students to learn coding and AI in real-world contexts and through collaborative projects, such as creating simple AI-based applications for social

campaigns. This is consistent with previous research stating that integrating coding into context-based projects can enhance students' systematic and collaborative thinking skills (Elnaffar et al., 2025). Furthermore, teachers play a strategic role as the main drivers in the successful implementation of the Coding and AI policy. Based on in-depth interviews, HelloMotion teachers position themselves not just as technical instructors, but also as facilitators of student creativity and exploration. Teachers develop a student-centered learning approach that combines theory, practice, and reflection through project-based activities.

### 3.2. Impact of Policy Implementation on Student Competency Development

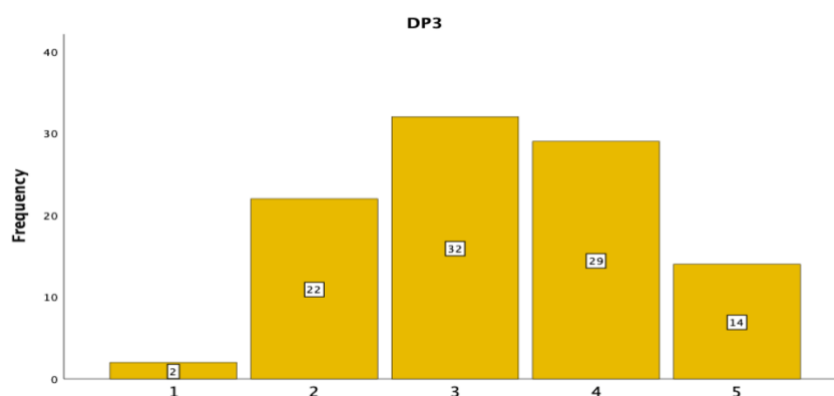
The program demonstrably enhanced key 21st-century competencies. The Principal, Teachers, and several students reported improvements in analytical, logical, and systematic thinking, as well as in problem-solving abilities. Questionnaire data confirm that Items DP1 and DP3 have positive mean scores. This confirms the impact on cognitive skills and ethical awareness. The improvement in computational thinking and digital literacy skills found in this study aligns with the pedagogical goals of coding education. Many studies, such as the study on robotic coding, confirm the positive impact of such interventions on students' cognitive and decision-making skills (Meral et al., 2024).

Survey results from 99 students show strong agreement that coding improved logical thinking (44.44%, DP1: Mean=3.35) and that AI ethics materials fostered wiser use of technology (43.43%, DP3: Mean=3.31) shown in Table 4.

**Table 4.** Selected Student Survey Results on Competency and Career Interest (n=99)

Item Code	Item Statement (Abridged)	Mean	Standard Deviation	% Agree (Score 4+5)
DP1	Coding improves my logical thinking.	3.35	0.907	44.44%
DP3	AI ethics material makes me wiser in using tech.	3.31	1.037	43.43%
DP4	I am considering a career in technology.	2.21	1.109	13.13%
PP3	PBL improves my computational thinking.	3.20	0.926	38.38%

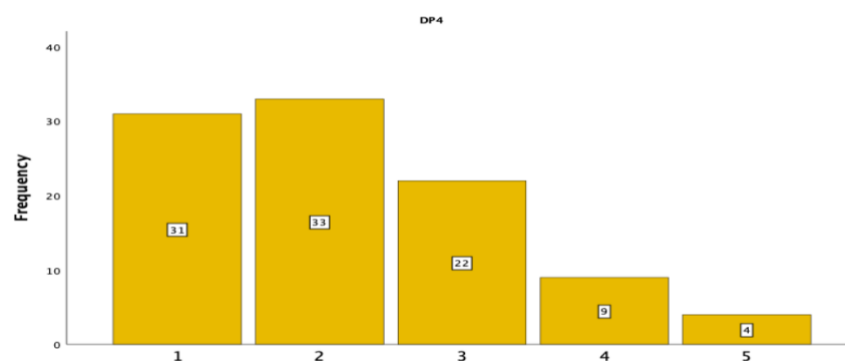
Figure 1 illustrates the distribution of student responses on a 5-point Likert scale. The data reveal a trend toward positive perception; with 43.43% of responses in the agreement range (scores 4–5)



**Figure 1.** Chart of Students Learning Impact (DP3: AI ethics material makes me wiser in using tech)

The data from observations and interviews corroborated this; students adeptly debugged projects and engaged in nuanced discussions about algorithmic bias. One student, K, reflected, "I used to just use apps. Now I think about the logic behind them and question if they're fair."

On the other hand, Figure 2 below illustrates the distribution of student responses, showing a strong tendency toward disagreement, with 64% of responses falling into categories 1 and 2. In contrast, only 13.13% of responses indicated agreement, while 22.22% remained neutral. This pattern suggests a generally critical or hesitant stance among students regarding the aspect under study.



**Figure 2.** Chart of Students Learning Impact (DP4: I am considering a career in technology)

However, a more nuanced and significant finding emerged alongside these gains: a clear disconnect between competency and career aspiration. Despite improved skills, only 13.13% of students agreed they were considering a technology career after the course. Student participants, who are mostly inclined towards creative arts, view coding as a supplementary skill, a cognitive tool, but do not see it as central to their professional identity. This indicates that the program's main impact is on literacy and mindset, rather than on vocational interests, for the majority of students. As one student aspiring to be an animator stated:

*"It's a useful skill for problem-solving, but my passion is in visual storytelling, not software engineering."  
"Personally, this [coding] is not my passion... I want to enter the entertainment world, music and film, which I feel has no direct connection to coding or AI."*

Student A, also stated:

*"I might just use it for simple things or just as a hobby. Something I can do in my spare time, [not a career]."*

Another wrote in the survey,

*"This should be an elective, not a mandatory subject for everyone."*

Figures 1 and 2 reveal a telling contrast that underscores the literacy-aspiration gap observed among students in coding and AI education. This "literacy-aspiration gap" challenges a common linear assumption in STEM education policy that exposure and skill mastery naturally catalyze corresponding career interest (Jin & Zha, 2020). Instead, it aligns with theories of identity and "science capital" (Archer et al., 2015), where career choices are influenced by a sense of belonging and perceived fit. For students in a creative arts school, proficiency in coding may not translate into a "technologist" identity. This finding, specific to this case, suggests that the success of compulsory digital literacy curricula should also be evaluated on their ability to broaden students' conceptions of how technology intersects with diverse fields and lives, not just on skill acquisition. Informatics education programs need to explicitly design learning experiences that not only build skills (what I can do) but also shape identity and belonging (who I can be) in the technology field, for example, through projects that integrate the arts, humanities, and technology. It implies a need for pedagogical designs that explicitly connect computational thinking to a wider array of future pathways and identities.

### 3.3. Barriers and Challenges in Policy Implementation

Many studies in the Indonesian context and other developing nations continue to identify "First-Order Barriers", such as a lack of infrastructure, device availability, internet connectivity, and teacher technical training, as the main obstacles (Abedi & Ackah-Jnr, 2023). Contrary to the prevalent narrative in developing contexts, the primary barriers at HelloMotion were not a lack of devices or connectivity, because the school had a robust 1:1 iPad program. The most formidable challenges were psychological and pedagogical, fitting Ertmer's framework of second-order barriers (Ertmer, 1999). Teachers consistently highlighted the diversity of student mindsets and readiness. In an FGD, a teacher described the challenge of engaging the "instant generation" who expected quick results and often questioned the

relevance of coding to their creative goals. The Coding-AI teacher noted, “The hardest part isn’t teaching Swift syntax; it’s making logical problem-solving compelling for a student who dreams of being a painter.”

Observations in class revealed this diversity: while some students persevered through debugging, others disengaged quickly after encountering errors. Survey data quantified this challenge: 58% of students reported difficulty understanding algorithm concepts (HT1: Mean = 3.45). This constellation of findings, such as teacher reports of motivational issues, observed engagement dips, and student-reported conceptual difficulty, converges to illustrate that student mindset and pedagogical adaptation were the central bottlenecks.

To systematically analyze these barriers, this study employed an integrated framework combining Ertmer’s (1999) typology of first- and second-order barriers and the Consolidated Framework for Implementation Research (CFIR) (Damschroder et al., 2022). Ertmer distinguishes between first-order barriers, which are external and resource-related (e.g., lack of technology, time, training), and second-order barriers, which are internal and relate to pedagogical beliefs, attitudes, and practices. The CFIR framework provides five domains for examining implementation contexts: (1) Intervention Characteristics, (2) Outer Setting, (3) Inner Setting, (4) Characteristics of Individuals, and (5) Process of Implementation. By integrating these two frameworks, we can better understand the multi-level challenges the school faces and how it navigates them. Table 1 presents a structured overview of the barriers and adaptation strategies across the five CFIR domains.

**Table 5.** Analysis of Implementation Barriers and Adaptation Strategies Based on Ertmer’s Typology and CFIR Domains.

CFIR Domain	First-Order Barriers (External, Technical)	Second-Order Barriers (Internal, Pedagogical-Cultural)	Key Findings from Study	Observed Adaptation Strategies
1. Intervention Characteristics	- Lack of detailed technical guidelines and resources from the ministry - Limited access to specialized AI tools and platforms	- Teachers' perception that the curriculum was too complex and abstract - Misalignment between policy expectations and local student readiness levels	The national policy provided a broad mandate but lacked detailed operational guidance. The school had to develop its own curriculum and materials.	The school developed a design-thinking-based curriculum and created modular content that could be adapted to different student levels.
2. Outer Setting	- Insufficient government funding for ongoing teacher training - Weak partnerships with industry or universities for support	- High parental expectations for immediate digital literacy outcomes - Pressure from the district for measurable results and accountability	While the policy was strongly supported from the top, there was little bottom-up scaffolding or external partnerships.	The school leveraged its Apple Distinguished School network for resources and best practices. It also held regular community engagement sessions to manage parental expectations.
3. Inner Setting	- Inconsistent Wi-Fi access in some classrooms - Limited time	- Varying norms of collaboration among teachers, with some	The school had strong technological infrastructure, but the culture of	The leadership implemented peer mentoring programs and

CFIR Domain	First-Order Barriers (External, Technical)	Second-Order Barriers (Internal, Pedagogical-Cultural)	Key Findings from Study	Observed Adaptation Strategies
	allocated for teacher professional development	departments being more siloed - Resistance to changing traditional teaching methods	innovation was not uniformly internalized across all teachers.	protected time for lesson study. Innovation grants were provided to encourage experimentation.
4. Characteristics of Individuals	- Teachers' initial lack of coding and AI technical skills - Students' limited access to devices at home for practice	- Teachers' deeply held beliefs about teacher-centered instruction - Students' low digital identity and aspiration, especially among those with no prior exposure	Teachers were generally comfortable with technology but struggled with student-centered pedagogies. Students were motivated but had varying skill levels.	Professional development focused on pedagogy-first approaches. Student-led projects and differentiated learning pathways were introduced to build confidence and skills.
5. Process of Implementation	- Ad-hoc training schedules that conflicted with teaching duties - Lack of on-demand technical support during implementation	- Limited teacher involvement in decision-making processes - Absence of structured routines for reflective practice and feedback	The implementation process was participatory but not systematically documented, leading to some inconsistencies.	The school established regular feedback loops through co-design workshops and documented iterative cycles of curriculum refinement.

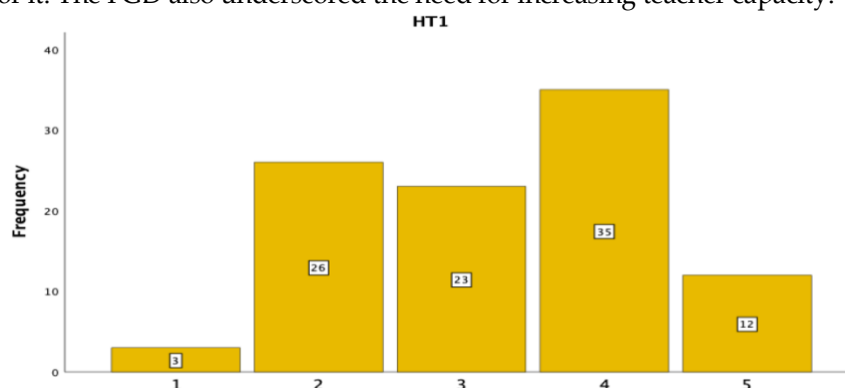
As illustrated in Table 5, first-order barriers were primarily technical and resource-oriented. For example, within the Inner Setting domain, inconsistent Wi-Fi access and limited training time posed initial hurdles. However, these were largely mitigated by the school's existing technological infrastructure and proactive leadership. In contrast, second-order barriers proved more persistent and complex. In the Characteristics of Individuals domain, while teachers quickly acquired technical skills through training (addressing first-order barriers), their transition to student-centered pedagogies required ongoing support and mentoring. Many teachers held traditional beliefs about instruction, viewing themselves as the primary knowledge dispensers rather than facilitators of active learning. This second-order barrier required not just training, but a shift in professional identity and pedagogical mindset.

Similarly, within the Inner Setting domain, the school's culture of innovation was a double-edged sword. While it encouraged experimentation, it also created implicit pressure on teachers to constantly innovate, leading to uneven collaboration and occasional resistance. The Outer Setting domain revealed that external expectations from parents and the district sometimes conflicted with the school's progressive, process-oriented approach. Parents, in particular, were concerned about immediate outcomes and employability skills, which sometimes led to tension between long-term pedagogical goals and short-term demands.

The process of implementation domain highlights how the school's adaptive strategies evolved over time. Initially, the focus was on addressing first-order barriers through resource allocation and training. However, as implementation progressed, the school recognized the need to address second-order barriers through more participatory and reflective practices. For instance, teacher involvement in curriculum co-design increased, and structured feedback sessions were institutionalized. This shift from a top-down,

resource-driven approach to a more collaborative, culture-sensitive process was critical for navigating the deeper pedagogical and belief-based challenges.

In terms of limited conceptual understanding, both teacher interviews and student questionnaire responses highlighted technical challenges, such as understanding algorithms, coding logic, and debugging (typos). The questionnaire item HT1 had a significantly high score. Regarding teacher readiness, the Coding-AI Teacher admitted that material preparation is the main constraint because the subject is new, the language used is Swift (which not many people use), and there are very few communities for it. The FGD also underscored the need for increasing teacher capacity.

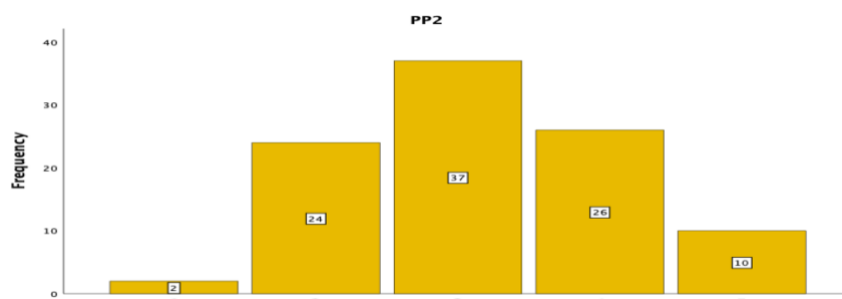


**Figure 3.** Chart of Students Obstacle and Challenge (HT1: I have difficulty understanding the concept of algorithms in coding)

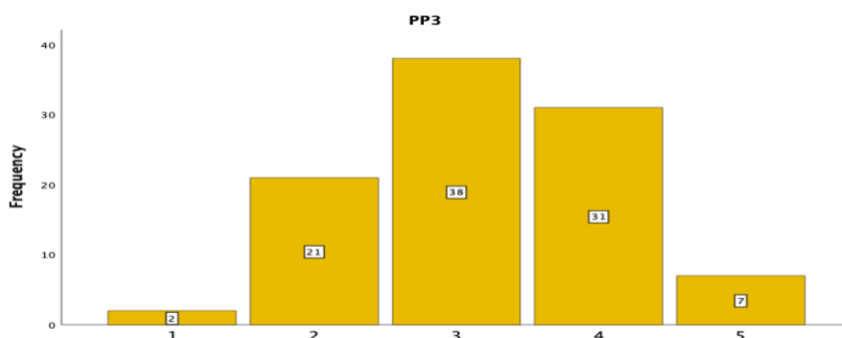
These findings are supported by previous research, which distinguishes between “first-order barriers” (external, such as technology and resources) and “second-order barriers” (internal, such as beliefs and pedagogical practices) (Liang et al., 2023). This study empirically demonstrates that, in contexts that have overcome first-order barriers, second-order barriers emerge as the primary, more complex inhibitors. This is reinforced by Papadakis’s argument that technology investment must be balanced with the development of teachers’ pedagogical capacity (Papadakis et al., 2016). The unique contribution of this research is to identify the “instant generation” nature and the lack of innate interest as specific manifestations of second-order barriers in the Indonesian context, which require more sophisticated approaches to differentiation and motivation beyond technical teacher training.

### 3.4. Strategies Developed by HelloMotion High School to Overcome Barriers

The research findings regarding the strategies used by HelloMotion High School to overcome barriers and challenges include integrating Coding-AI with the existing ICT subject, as well as conducting cross-curricular collaboration (with Visual Communication Design, Sociology, and Entrepreneurship). This is done to avoid overlap and to show the relevance of technology to other fields. There is a need for Project-Based and Game-Based Learning. Both teachers and students (from interviews and open-ended questionnaire responses) mentioned that project-based learning (such as creating games, digital campaigns, and AI-assisted design) and game-based approaches are highly effective. From the Questionnaire Data, Item PP2 (Coding practice with Swift is fun and challenging) and PP3 (PBL improves my computational thinking skills) received quite high positive average scores. Then, open-ended student responses such as “The game is fun,” “Learning while playing puzzle games,” and “coding learning is more interesting if made like a game” strongly support this qualitative finding.



**Figure 4.** Chart of Students Learning Process (PP2: Coding practice with Swift is fun and challenging)



**Figure 5.** Chart of Students Learning Process (PP3: PBL improves my computational thinking skills)

The strategies implemented by HelloMotion High School, such as *Project-Based Learning* (PBL) and *Game-Based Learning* (GBL), have been shown to be effective individually. The use of PBL to enhance *computational thinking* (Item PP3) aligns with Saad's findings, which confirm that PBL is an effective approach to help students mastering technical concepts in practice (Saad, 2022)

Based on a comprehensive analysis of interviews, FGD, and student questionnaire data, it was found that HelloMotion High School has developed mature, multidimensional strategies to overcome various barriers to implementing Coding and Artificial Intelligence learning. The first strategy developed is to enhance teacher competence by forming a professional learning community. Based on an in-depth interview with the Coding-AI teacher, it was revealed that "By attending workshops and deepening material through searching for references, because basically, with this new subject, there are already several communities formed with the vision to help smooth the development regarding this Coding and AI subject". This strategy aligns with the Professional Learning Community (PLC) concept proposed by Battersby, which research shows that schools with strong PLCs achieve higher success rates in implementing educational innovations (Battersby & Verdi, 2015). This collaborative approach allows teachers to share resources and teaching strategies, thereby overcoming the limitation of teaching materials, which was a primary barrier.

The second strategy implemented is differentiated learning based on diagnostic assessment. The Coding-AI teacher explained that "*Diagnostic assessment is to measure and group students with the level of project difficulty in the class, not necessarily by making an application, or even understanding complex coding writing, but students can understand the flow and logic determination*". This approach is supported by several studies emphasizing the importance of *assessment for learning* in technology education (Bower et al., 2024; Celik et al., 2022). These studies show that differentiated learning can improve student achievement, including in STEM subjects, while accommodating students' diverse basic abilities, a challenge in implementation.

The third strategy that was indicated as effective is optimizing technology infrastructure through the *one student, one iPad* approach. Data from the student questionnaire showed that 46.46% of respondents stated that using an iPad and Swift Playgrounds extensively improved their understanding of programming concepts (PP1).

Based on these three strategies, HelloMotion High School has developed an Integrative Strategy Model that includes teacher capacity building, differentiated learning, and technology optimization. This model was shown to be effective in overcoming implementation barriers, as evidenced by a 44.44% student agreement rate in the questionnaire and significant improvements in computational thinking competence, as reported in learning outcome reports. The success of this model lies not only in its comprehensiveness but also in its ability to create a mutually supportive and sustainable learning ecosystem.

#### 4. CONCLUSION

This case study investigated the early implementation of a national coding and AI education policy at HelloMotion High School, illustrating how macro-level directives are translated into practice within a digitally proactive institutional context. The findings indicate that implementation was shaped by context-sensitive adaptation, driven largely by leadership and teacher agency, leading to gains in students' computational thinking while simultaneously exposing a literacy–aspiration gap that underscores the non-linear relationship between skill acquisition and identity formation. Key challenges were not material but pedagogical and attitudinal, reflecting second-order barriers that constrained deeper engagement. While adaptive approaches such as peer mentoring, project-based learning, and iterative curriculum co-design proved valuable in addressing these challenges, they did not fully resolve disparities in student participation and outcomes. These findings suggest that policymakers should prioritize flexible frameworks that accommodate local adaptation alongside sustained investment in teacher capacity; school leaders should cultivate collaborative and innovation-oriented cultures; and teachers should engage in continuous, pedagogy-centered professional development that extends beyond technical proficiency. However, the study's single-site design, focus on a technologically advanced school, reliance on self-reported data, and limited temporal scope constrain the generalizability and longitudinal insight of the findings. Future research should therefore adopt longitudinal and comparative multi-site designs to examine the evolution of literacy–aspiration gaps, the persistence of second-order barriers, and the interplay between teacher development and student identity formation in coding and AI education.

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