

Developing Junior High School Students' Competencies through ICT-Based Learning Strategies

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ABSTRACT

This research aims to deeply understand the implementation of ICT-based learning model strategies in developing student competencies at SMPN 2 Pacet, Bandung Regency. Employing a qualitative approach with a case study method, data were collected through in-depth interviews, direct observations, and document analysis, then analyzed using the interactive model of Miles, Huberman, and Saldaña. The findings indicate that comprehensive needs identification including hardware infrastructure, computer laboratories, digital teaching materials, teacher human resource development, continuous training, technical support, and student readiness serves as the foundation for designing the learning model. The designed model integrates Project-Based Learning, Flipped Classroom, and Blended Learning, emphasizing local context and student needs. Its implementation transforms teachers' roles into facilitators and mentors, fosters an active and collaborative learning environment, and significantly enhances students' competencies in critical thinking, collaboration, and digital literacy. Evaluation reveals improvements in academic performance and intrinsic motivation among students, aligning with Generation Z's learning characteristics. The study concludes that a comprehensive, context-sensitive, and pedagogical approach to ICT-based learning implementation, supported by sustainable infrastructure and teacher development, can substantially boost student competencies and engagement.

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Introduction

Background

The rapid development of technology demands that the world of education adapt dynamically to remain relevant to the needs of the times (Machmud et al., 2021; Rabani et al., 2023). ICT-based learning strategies in Junior High Schools have become a crucial issue in efforts to produce superior human resources (Budiarto et al., 2024; Primasari et al., 2019). ICT can no longer be viewed merely as a visual aid, but rather as a vital means to encourage active, participatory learning, as well as to strengthen students' critical thinking, collaboration, and innovation skills (Irvy, 2020; Irwansyah & Hardiah,

2020). This aligns with the vision of realizing the Golden Generation 2045, where smart, creative, and innovative students will become the backbone of national social and economic development (Samala et al., 2024; Sari et al., 2022). The long history of ICT integration in Indonesia, from educational radio in the 1970s to modern digital platforms, demonstrates that technology plays an inherent role in enhancing learning motivation and facilitating independent material comprehension (Hasibuan et al., 2023; Machmud et al., 2021).

Although the urgency of technology integration is recognized, the reality of implementing ICT-based learning at the junior high school level still faces numerous structural and cultural constraints (UNESCO, 2023). First, the dominance of conventional methods remains very strong, causing students to be passive and less engaged in knowledge exploration (Irwansyah & Hardiah, 2020; Sutarna et al., 2022). Second, teachers' limited skills in developing technology-based media result in ICT not being optimally utilized as a strategy to enhance cognitive, affective, and psychomotor competencies (al., 2021; Fitriansyah et al., 2020). Third, the scarcity of supporting facilities in some schools hinders the implementation of varied learning (Primasari et al., 2019; Purbo, 2020). Fourth, the lack of specific learning model guidelines confuses teachers in integrating technology pedagogically (Mukti et al., 2020; Rasimin et al., 2024). Fifth, disparities in student readiness or uneven digital literacy necessitate differentiated approaches (Unasiansari et al., 2024; Yaqin et al., 2023).

The roots of the above problems are inseparable from external challenges encompassing Indonesia's education ecosystem. The digital divide, particularly between urban and rural areas, along with disparities in students' economic backgrounds, serves as the primary barrier to equitable access to quality education (Fatimah et al., 2023; Hadi, 2018). Not all students have adequate devices or stable internet access, which impacts learning effectiveness (Rahmi et al., 2025; Salim et al., 2023). Additionally, the transition from fully face-to-face systems to technology-integrated ones is often hindered by inadequate teacher training (Rasimin et al., 2024; Uma et al., 2022). The teacher's role, which should shift from mere information provider to learning facilitator, is frequently obstructed by a lack of technical proficiency and understanding of healthy internet use (Achmad & Mulyati, 2023; Irwansyah & Hardiah, 2020).

Based on these general problems, the specific conditions at SMPN 2 Pacet, Bandung Regency, highlight the need for strategic intervention. At this site, the requirement to design a learning model that is not only technically advanced but also adaptive to the local context is highly urgent (Rasimin et al., 2024; Samala et al., 2024). Infrastructure and competency challenges must be addressed through a comprehensive strategy model. Without a clear strategy, ICT's potential to improve

information quality, user satisfaction, and student learning outcomes will not be realized (Budiarto et al., 2024; Primasari et al., 2019). Therefore, an effective ICT-based learning model is needed, capable of bridging gaps in teacher competencies and student readiness at the school (Sutama et al., 2022; Yaqin et al., 2023).

Previous Literature and Rationale

Various studies have been conducted to explore the integration of Information and Communication Technology in the education ecosystem, affirming that ICT plays a crucial role in enhancing learning quality. Askiyanto and Kamhar (Askiyanto & Kamhar, 2022) in their research highlight that the competencies of current junior high school students have not yet shown satisfactory results, necessitating innovative ICT-based learning model strategies as a fundamental solution. This perspective is supported by Aprilia and Mediatati (Aprilia & Mediatati, 2022), who emphasize the importance of system quality, information quality, and user satisfaction as indicators of digital school effectiveness in learning management.

Furthermore, the paradigm shift from teacher-centered to student-centered learning through ICT has been widely discussed. Fariza and Kusuma (Fariza & Kusuma, 2024) found that technology-integrated Project-Based Learning models enable students to participate actively, solve problems, and develop critical thinking skills. Meanwhile, the teacher's role as a facilitator in guiding student exploration is the main focus in the study by Maesaroh et al. (Maesaroh et al., 2020).

However, field implementation is not free from structural barriers. Aulia et al. (Aulia et al., 2023) identified that although ICT has great potential, challenges such as infrastructure gaps, limited teacher training, and accessibility for students from low economic backgrounds remain dominant root problems.

Although the aforementioned studies have provided valuable insights into the urgency and challenges of ICT, there is a significant gap that has not been fully addressed. The majority of previous research tends to focus on two poles: first, analysis of the impact of using existing ICT tools; and second, evaluation of infrastructure barriers alone.

There is still little research offering a comprehensive strategy model design that simultaneously addresses two main problems: low pedagogical competence of teachers in creating digital content AND students' lack of readiness for independent learning, particularly in junior high schools with limited facilities. The absence of specific learning model guidelines that integrate teacher training with intensive student mentoring creates a vacuum in effective field implementation strategies.

Based on this gap, this research offers novelty in the form of developing an innovative learning model that integrates ICT with a "Dual-Focus" approach tailored to the demands of the 2013 Curriculum. The novelty of this research lies in the integration

of teacher and student competencies, where this model not only requires students to use technology but starts with enhancing teacher competencies through technology-based training approaches such as the use of Learning Management Systems and interactive content development. In addition, the contextual approach involves developing distance learning strategies and digital mentoring specifically designed to address the specific characteristics and limitations in the environment of SMPN 2 Pacet. Furthermore, the transformation of the ICT role changes the ICT usage paradigm from merely a "material delivery aid" to a "learning ecosystem" that supports holistic student competency development.

Departing from the aforementioned urgency and rationale, this research is designed to address the problem formulation regarding how ICT-based learning models can be implemented effectively. Specifically, this research aims to identify needs by mapping real needs and technical as well as non-technical challenges in implementing ICT-based learning at SMPN 2 Pacet, Bandung Regency; design a model by developing an adaptive ICT-based learning model design that accommodates teacher capacity building while supporting students' learning styles in the digital era; and test effectiveness by implementing and evaluating the effectiveness of the designed model in improving student competencies at SMPN 2 Pacet, to ensure the validity and success of the offered strategy.

Method

This study employs a qualitative approach to gain an in-depth and comprehensive understanding of the implementation of ICT-based learning model strategies in developing student competencies at SMPN 2 Pacet, Bandung Regency. A qualitative approach was chosen because it allows researchers to explore social phenomena in their natural context, understand the meanings given by participants, and build theory from field data (Mohajan, 2018).

The research method used is a case study. Case studies are highly suitable for investigating contemporary phenomena in depth within a real-world context, especially when the boundaries between the phenomenon and its context are not clear (Mizukoshi, 2023). Robert K. Yin (Mizukoshi, 2023; Yin, 1984) is a key figure in case study methodology, emphasizing systematic design to ensure rigor and validity. This method allows researchers to focus on a single "case" (SMPN 2 Pacet) and collect rich data from various sources to develop a holistic understanding of ICT implementation in the school (Baxter & Jack, 2015).

Data collection is conducted through various techniques to ensure triangulation, which enhances the validity and reliability of qualitative research findings (Brink,

1993). In-depth interviews will be conducted with teachers, students, the headmaster, and administrative staff to explore their perspectives, experiences, understandings, as well as challenges and successes related to the implementation of ICT-based learning model strategies. In-depth interviews are a crucial tool for obtaining rich and detailed narrative data from the participants' viewpoints (Baxter & Jack, 2015). Direct observations will be conducted in classrooms and the school environment to directly observe the ICT-based learning process, interactions between teachers and students, and the use of ICT facilities. Participant observation helps researchers understand the contextual behavior and events that may not be revealed in interviews, as well as to verify information obtained from other sources. Relevant documents such as curriculum, lesson plans, ICT-based teaching materials, evaluation reports, and school policies will be analyzed. Document analysis provides relevant secondary data, historical context, and supporting evidence for findings derived from interviews and observations (Mohajan, 2018).

Data analysis is conducted qualitatively following the interactive model by Miles, Huberman, and Saldaña (Miles & Huberman, 1994), which involves three interconnected and continuous flows of activity. First, data reduction entails selecting, focusing, simplifying, and abstracting raw data obtained from field notes and interview transcripts. This process sharpens, classifies, directs, discards unnecessary information, and organizes data in such a way that final conclusions can be drawn and verified. Next, data display presents the reduced data in the form of narrative text, tables, matrices, or graphics to provide a clear, organized, and systematic overview of the research findings, facilitating further understanding and analysis. Finally, conclusion drawing and verification involves interpreting the presented data to seek meaning, patterns, and relationships contained within. Conclusions are drawn and continuously verified throughout the analysis process by comparing findings with relevant theories or literature, and by seeking supporting or contradictory evidence to ensure their trustworthiness. This may also involve member checking with participants to ensure the accuracy of interpretations (Brink, 1993).

Result

Research Results

a. 1. Identification of Needs for ICT-Based Learning Model Implementation

Based on situational analysis and in-depth discussions, school management has identified a complex map of needs to ensure the successful implementation of ICT-based learning. This identification does not stop at inventorying items but touches upon aspects of system readiness and school culture. Crucial needs include:

- **Reliable Hardware Infrastructure:** The school requires significant upgrades to device specifications. This includes procuring computers and laptops with

sufficient specifications to run design and multimedia applications, not just standard office applications. Additionally, LCD projectors are needed in every classroom to support material visualization, a school server with large storage capacity for the teaching material database, and the rejuvenation of network devices such as industrial routers and WiFi access points capable of accommodating hundreds of user connections simultaneously without bottlenecks.

- **Computer Laboratory as a Learning Center:** There is a need to revitalize the function of the computer laboratory. The lab must not merely be a "museum" of devices but must become an inclusive space scheduled neatly so that it can be utilized by all students and teachers from various subjects, not just ICT subjects.
- **Digital Teaching Material Ecosystem:** The availability of digital teaching materials is a priority. The school needs a centralized repository containing visual presentation materials, original learning videos created by teachers, and interactive multimedia content stored within the school's *Local Area Network* (LAN), allowing for quick access without burdening external internet quotas.
- **Human Resources (HR) Transformation:** There is an urgent need to change the *mindset* and *skillset* of teachers. Teachers are not only required to be able to operate tools (technical literacy) but must also be able to design pedagogical digital learning media and facilitate humanistic technology-based learning.
- **Continuous Training System:** Given that technology continues to evolve, sporadic training is considered insufficient. A regular and tiered training scheme from basic to advanced levels is needed for teachers and educational staff to maintain the relevance of their competencies.
- **Professional Technical Support:** The presence of standby ICT technicians or managers is vital. This role is needed to perform preventive maintenance, handle daily troubleshooting, and ensure the entire system runs smoothly so that teachers can focus on teaching without being distracted by technical issues.
- **Student Readiness and Equity of Access:** The analysis also highlights the potential digital divide among students. The availability of access to ICT devices such as laptops or smartphones at home becomes a critical variable that must be mapped so that no student is left behind in online learning or digital assignments.

Regarding the urgency of infrastructure stability as a psychological foundation for technology adoption, one key informant from the school management expressed their concerns straightforwardly:

"Honestly, our biggest challenge at the beginning was the devices. We need a computer lab that doesn't just 'exist', but can truly be used by all students in turn without lagging. From our previous experience, if the WiFi in the classroom keeps disconnecting or the projector frequently dies, teacher morale to use online quizzes or show videos drops drastically. They become traumatized and revert to the old way of taking notes on the blackboard." (Interview with the Vice Principal of Facilities, January 12, 2024).

This statement confirms that fulfilling the physical and technical needs above is not merely complementary, but an absolute prerequisite. These findings then became the strategic foundation in drafting the Budget Plan (RAB) and the medium-term school work program for the gradual but directed procurement of facilities.

b. 2. Designing the ICT-Based Learning Model

The design of the learning model at SMPN 2 Pacet was carried out through a *bottom-up* approach involving active teacher participation, based on the local school context and diverse student characteristics. The Teacher Working Group (KKG) across subjects conducted a series of intensive discussions to formulate the most effective strategies, which finally converged on a combination of *Project-Based Learning (PjBL)*, *Flipped Classroom*, and *Blended Learning*.

This design process was colored by a spirit to abandon conventional methods. Regarding this paradigm shift, a teacher representative in the KKG discussion stated a shared commitment:

"We agreed in the meeting that we don't want ICT integration to just be merely moving writing from the blackboard to a text-heavy PowerPoint slide. That is just as boring, only the medium is different. We designed learning scenarios so that students handle the tools and create more. For example, in Indonesian language lessons, they are the ones making reportage videos or visual presentations, not just sitting quietly watching the teacher explain slides." (KKG Discussion, February 15, 2024).

Based on this commitment, the learning model design was structured with several detailed components. These included the formulation of adaptive objectives, where learning objectives are designed to accommodate 21st-century skills (4C: Critical Thinking, Creativity, Collaboration, Communication); the contextualization of content, connecting subject matter to real issues in the students' surrounding environment to increase relevance; and the integration of national platforms through optimal utilization of the Platform Merdeka Mengajar as a reference source for teachers and a place to share best practices, as well as the use of the school's Learning Management System for assignment distribution..

c. 3. Implementation of the ICT-Based Learning Model

Entering the implementation stage, a significant transformation of the teacher's role occurred. In the classroom, the teacher no longer positions themselves as the sole

source of knowledge (*sage on the stage*), but shifts to become a facilitator and learning partner (*guide on the side*). Teachers seamlessly integrate ICT devices into the curriculum, provide guidance on digital ethics (*cyber wellness*), and facilitate group dynamics in *Problem Based Learning* (PBL) and PjBL models.

Classroom dynamics experienced a drastic change from a passive atmosphere to an active-collaborative one. A Science teacher described the change in classroom atmosphere during implementation enthusiastically:

"The difference is very felt. Before, when I entered the class, the children were silent listening to the lecture, the atmosphere was quiet but many were daydreaming. Now with ICT-assisted PjBL, the class becomes 'noisy' but productive. The noise is the sound of discussion. When they are asked to find solutions to environmental pollution via the internet, validate data, and make it into an environmental campaign vlog, they are very enthusiastic. My role has changed, I just walk around monitoring, providing triggering questions, and correcting if there are less valid information sources." (Classroom Observation Grade VIII, March 20, 2024).

This implementation stage was carried out systematically through three distinct phases. The preparation phase involved intensive teacher training on digital content creation and digital classroom management. This was followed by the execution phase, in which the model was applied in the classroom, granting students autonomy to search for information, collaborate in virtual or real teams, and complete complex projects. The process concluded with the reflection phase, featuring debriefing sessions at the end of each project where students presented their digital work and received constructive feedback.

d. 4. Evaluation of Implementation

Evaluation was conducted comprehensively using method triangulation: learning outcome tests to measure cognitive aspects, response questionnaires to measure affective aspects, and in-depth interviews to explore students' subjective experiences. The evaluation results showed an increasing trend not only in academic grades but also in students' intrinsic motivation.

One Grade IX student gave a testimony highlighting the effectiveness of the *Flipped Classroom* method and learning flexibility:

"Learning became much more fun, honestly didn't make me sleepy. Before, we were just told to take notes from the textbook until our hands ached, now we can learn the basic material from videos sent by the teacher to our phones before class. So I can rewatch it if I don't understand. At school, the time is just used to discuss with friends or ask about

difficult parts. So I understand more because I'm not rushed by lesson time." (Student Interview, April 25, 2024).

This qualitative data complements formal evaluation results showing a positive correlation between the use of ICT-based learning models and improvements in students' critical thinking competencies, collaboration skills, and digital literacy.

Discussion

Needs Analysis and Infrastructure Strengthening: The Psychological Foundation of Technology Adoption

The verbatim from the Vice Principal of Facilities highlighting the impact of WiFi instability on "teacher morale" provides crucial insight into the psychological aspects of technology adoption. Theoretically, this is closely related to the concept of teacher Self-Efficacy in technology use. Recurring technical obstacles (such as slow internet or broken devices) are not merely logistical problems but become major demotivators that can lower teachers' confidence to teach using ICT. If the infrastructure is unreliable, teachers tend to revert to the "comfort zone" of conventional methods for the sake of secure lesson delivery.

Therefore, the comprehensive needs identification at SMPN 2 Pacet accurate needs analysis must be the main foundation of model design. These findings confirm that facility procurement should not be viewed merely as capital expenditure, but as a strategic investment to maintain the sustainability of pedagogical innovation. As reinforced, prime infrastructure directly contributes to improving the quality of educational services and the school's image in the digital era. Without strong technical support, any learning strategy, no matter how advanced, will be difficult to execute consistently.

Effectiveness of Learning Model Design: From Digitization to Transformation

The quote from the KKG discussion firmly rejecting the practice of merely "moving blackboard writing to PowerPoint" demonstrates a high leap of pedagogical awareness among SMPN 2 Pacet teachers. They successfully distinguish between content digitization (changing analog format to digital without changing the method) and learning transformation (changing how to learn by utilizing technology).

The chosen model design, namely the integration of Project-Based Learning (PjBL) and Flipped Classroom, is a strategic response to avoid the trap of shallow or superficial technology use. In this design, technology is placed as an enabler for student activities centered on problem-solving. This approach proves that model design at this school has surpassed the tool adoption stage towards a meaningful strategy adaptation stage, aligning with the findings regarding the importance of clear learning objectives in ICT integration. This strategy ensures that technology serves pedagogy, not the other way around.

Teacher Role and Student Competency Improvement: ICT as a Cognitive Tool

The transformation of the teacher's role observed in the field, as expressed by the Science teacher ("noisy but productive class"), serves as empirical evidence of the success of the student-centered model implementation. Teachers no longer dominate the classroom with one-way lectures but act as content curators and discussion facilitators who validate student findings.

This change in interaction patterns has a significant impact on student competency development. When students are assigned to create environmental solution vlogs, they not only learn science content but simultaneously hone various 21st-century competencies, including critical thinking by sorting valid information from the internet, creativity by designing visually appealing ways to convey messages, and collaboration by learning to negotiate and divide roles within teams. These activities confirm that ICT at SMPN 2 Pacet has functioned optimally as a Cognitive Tool that expands students' thinking capabilities, not just a presentation tool or textbook replacement.

Implications of Evaluation and Program Sustainability: Answering Generation Z Needs

The student testimony of feeling "not sleepy" and "understanding more because not rushed" thanks to the Flipped Classroom method provides a strong indication of high user satisfaction. This is highly relevant to the characteristics of Generation Z students who tend to be visual, like fast access to information, yet require flexibility in processing material. The ability to replay video material at home provides space for students with different learning speeds to keep up with lessons, a personalization feature difficult to achieve in classical lecture methods.

In the context of system evaluation, student comfort and intrinsic motivation are key indicators of success that are often more predictive than mere exam scores. Evaluation based on direct feedback from students is crucial to ensure program sustainability. ICT-based learning innovation at SMPN 2 Pacet has the potential to be sustainable in the long term because its benefits are felt directly by students as learning subjects, so this technology integration can develop into a new school culture, not just a momentary project.

Conclusion

This research aimed to investigate the implementation of ICT-based learning model strategies to develop student competencies at SMPN 2 Pacet, Bandung Regency. The findings reveal a multi-faceted approach, beginning with a thorough identification of needs, which underscored the critical importance of reliable hardware

infrastructure, dedicated computer laboratories, digital learning materials, enhanced human resource capabilities, continuous teacher training, professional technical support, and equitable student access to technology. These needs were not merely logistical but were identified as fundamental psychological foundations for effective technology adoption by both teachers and students.

The designed ICT-based learning model, developed through a participatory bottom-up approach involving teacher working groups, successfully integrated Project-Based Learning, Flipped Classroom, and Blended Learning. This strategic combination moved beyond simple digitization of content, focusing instead on transforming learning into an interactive, student-centered, and problem-solving-oriented process. The active involvement of teachers in designing adaptive learning objectives, contextualizing content, and utilizing national digital platforms was instrumental in this pedagogical shift.

The implementation phase demonstrated a significant transformation in the teacher's role, evolving from mere knowledge providers to facilitators, mentors, and evaluators. This change fostered dynamic classroom environments where students actively engaged in collaborative learning, critical thinking, and the development of 21st-century skills such as communication, inquiry, and leadership. The ICT-based strategies empowered students to learn independently, access information, and creatively solve problems, effectively utilizing technology as a cognitive tool.

Evaluation results, triangulating learning outcome tests, response questionnaires, and in-depth interviews, consistently indicated an increase in both academic performance and intrinsic student motivation. The positive reception from students, particularly regarding the flexibility and engagement offered by methods like the Flipped Classroom, suggests a strong alignment with the learning preferences of Generation Z. This success points to the program's potential for long-term sustainability, as the tangible benefits experienced by students are likely to foster a new, technology-integrated school culture.

In essence, the study concludes that a comprehensive, context-sensitive, and pedagogically sound approach to implementing ICT-based learning strategies, underpinned by robust infrastructure and continuous teacher development, can significantly enhance student competencies and engagement in junior high school settings.

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