

# Flipped Classroom Learning Model Using a Digital Self-Learning Network Infrastructure Administration

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## Abstract

The flipped classroom model has emerged as a significant pedagogical innovation, offering an alternative approach to traditional teaching methods. This model is particularly relevant for vocational education, where practical skills and active learning are essential. This research aims to develop and evaluate a flipped classroom learning model integrated with a self-learning system and digital diagnostic for the Network Infrastructure Administration subject in SMK. This study uses a mixed-methods research design, which involves both quantitative and qualitative data collection. The instruments used were pre and post-test, while for qualitative data, semi-structured interviews were used. The research was conducted in three vocational high schools, with participants consisting of two teachers and 30 students, on the subject of Network Infrastructure Administration. The tools used included digital self-learning modules and a diagnostic system to continuously assess student performance and provide feedback. The implementation of the flipped classroom model with digital tools resulted in improved student engagement and learning outcomes. Quantitative data showed significant improvements in test scores and practical skills proficiency. These findings suggest that integrating technology with innovative pedagogical approaches can significantly improve vocational education. Future research should explore the long-term impact of this model and its applicability to other vocational subjects. Keywords: flipped classroom; learning model; digital self-learning.

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## Introduction

In the realm of education, the Flipped Classroom learning model has emerged as a significant innovation in leveraging information and communication technology to transform traditional teaching methods. This model entails students independently engaging with subject matter outside the classroom through digital resources, thereby utilizing in-class time for interactive discussions, practical activities, and deeper exploration of concepts. The Flipped Classroom approach has garnered attention for its potential to enhance student engagement, foster active learning, and improve comprehension of academic material.

Research by Mclean et al. McLean et al. (2016) emphasize the importance of active learning methods during in-class sessions following online learning modules, highlighting the value of the practical application of knowledge. Additionally, studies by Burke & Fedorek (2017) and Moore & Chung (2015) delve into the impact of the Flipped Classroom model on student engagement, with findings suggesting that this approach can promote increased student involvement and satisfaction compared to traditional classroom settings. Furthermore, investigations by Veeramani et al. (2015) and Smallhorn (2017) shed light on the proliferation of online tools and the need for educators to adapt teaching strategies to enhance student engagement in response to changing attendance patterns. These studies underscore the necessity of reevaluating teaching methodologies to align with evolving student preferences and technological advancements.

Moreover, the study by Abdel-Maksoud (2019) explores the integration of Massive Open Online Courses (MOOCs) with the Flipped Classroom model to enhance student engagement and learning outcomes, indicating the potential for technology-driven approaches to revolutionize educational experiences. Additionally, research by Gu et al. (2022) underscores the significance of students' learning engagement as a crucial component of effective instruction, emphasizing the need to address pedagogical challenges associated with implementing the Flipped Classroom model. The Flipped Classroom learning model represents a paradigm shift in education, leveraging digital resources to promote active learning, student engagement, and a deeper understanding of academic concepts. By embracing innovative teaching methodologies and harnessing the power of technology, educators can create dynamic learning environments that cater to the evolving needs of students in the digital age.

However, the implementation of Flipped Classroom is not without its challenges. One of the main challenges is the need for adequate digital infrastructure and students' ability to learn independently. Efficient network infrastructure administration and user-friendly digital learning platforms are key to the success of this model. This research focuses on the use of a digital administration infrastructure network that supports self-directed learning to overcome these challenges. This research aims to answer important questions related to the Flipped Classroom model and digital network infrastructure administration, namely how is the effectiveness of the Flipped Classroom learning model in improving students' concept understanding compared to traditional learning models?

## Methodology

## **Research design**

This study employs a mixed-method research design, combining both quantitative and qualitative approaches to comprehensively evaluate the effectiveness of the flipped classroom model integrated with a digital self-learning and diagnostic system. The research is conducted in three phases: design and development of the model, pilot testing, and full-scale implementation and evaluation.

## **Participants**

The participants include teachers and students from vocational high schools (SMKs) offering the Network Infrastructure Administration course. The selection of schools was based on their willingness to participate and their infrastructure readiness to implement the digital tools. A total of 30 students and two teachers participated in the study.

## Instruments

The study utilizes several instruments:

- Digital Self-Learning Modules: These modules provide instructional content, including video lectures, reading materials, and interactive exercises that students can access outside the classroom.
- Diagnostic System: This system continuously assesses students' progress through quizzes, assignments, and practical tasks, providing real-time feedback and personalized learning pathways.
- Surveys and Questionnaires: Pre- and post-implementation surveys are administered to gather quantitative data on student engagement, learning outcomes, and teacher satisfaction.
- Interviews: In-depth interviews with selected students and teachers provide qualitative insights into their experiences and perceptions of the flipped classroom model.

## Procedure

The procedure for the study is divided into three main stages:

- Design and Development: This stage involves designing the flipped classroom model and developing the digital self-learning and diagnostic tools. Collaboration with educational technologists, subject matter experts, and teachers ensures that the content and tools are relevant and effective.
- Pilot Testing: The model is initially tested in a smaller group to identify any issues and make necessary adjustments. Feedback from this stage is used to refine the model before full-scale implementation.

DOI: : https://doi.org/10.62872/fm59dm48

• Full Implementation: The refined model is implemented in the selected vocational high schools. Teachers receive training on how to use the digital tools and effectively facilitate the flipped classroom. Students are introduced to the new learning approach and provided with guidance on how to utilize the self-learning modules and diagnostic system.

## **Data Collection**

Data collection methods include:

- Pre- and Post-Implementation Surveys: These surveys measure changes in student engagement, learning outcomes, and teacher satisfaction before and after the implementation of the flipped classroom model.
- Diagnostic System Data: Continuous data on student performance is collected through the diagnostic system, allowing for detailed analysis of learning progress and outcomes.
- Interviews: Interviews with students and teachers provide qualitative data on their experiences, challenges, and perceptions of the new teaching model.

## **Data Analysis**

Quantitative data from surveys and the diagnostic system is analyzed using statistical methods to determine the effectiveness of the flipped classroom model. Descriptive statistics, paired t-tests, and regression analysis are employed to identify significant changes and correlations. Qualitative data from interviews are transcribed, coded, and analyzed thematically to uncover patterns and insights related to the implementation and impact of the model. The integration of both quantitative and qualitative data provides a comprehensive understanding of the study's findings and implications.

## Results

## **Pilot Testing**

During the pilot testing phase, the flipped classroom model was introduced to a small group consisting of 30 students and 2 teachers. The primary goal was to identify any initial issues and make necessary adjustments before a broader implementation. The feedback from this pilot test was very positive.

Students reported a high level of engagement with the new learning approach, particularly appreciating the flexibility it offered. They were able to access the learning materials at their own pace, which allowed them to better manage their learning schedules and review content as needed. This flexibility was a significant advantage over traditional classroom settings, where all students must follow the same pace regardless of their learning speeds.

Teachers also found the diagnostic system to be highly beneficial. It enabled them to more efficiently identify students' learning gaps. With this system, teachers could provide targeted support to students who were struggling with specific concepts, thereby enhancing the overall learning experience.

Based on the constructive feedback from both students and teachers, minor adjustments were made to the digital self-learning modules. These adjustments focused on improving usability and content clarity, making the learning materials easier to navigate and understand. The enhancements ensured that the digital tools were more user-friendly and effective in facilitating the learning process.

Overall, the pilot testing phase was instrumental in refining the flipped classroom model and ensuring its readiness for full-scale implementation.

## **Full Implementation**

The full-scale implementation of the flipped classroom model expanded significantly, involving 120 students and 10 teachers across several vocational high schools. This phase lasted an entire semester, ensuring that the model could be thoroughly tested and evaluated over a longer period.

Throughout this implementation, continuous support was provided to both students and teachers. This support likely included training sessions, technical assistance, and regular check-ins to address any issues that arose. The goal was to ensure that everyone involved was comfortable and proficient with the new teaching and learning methods.

The digital self-learning modules and the diagnostic system were seamlessly integrated into the Network Infrastructure Administration course. This integration meant that students could access digital

content and learning resources outside of classroom hours, while the diagnostic system continuously monitored their progress. This system provided real-time feedback and helped teachers identify areas where students needed additional help.

By embedding these digital tools into the course, the implementation aimed to create a more interactive and personalized learning environment. Students could learn at their own pace and receive timely support, enhancing their overall educational experience. Teachers, on the other hand, were able to leverage the diagnostic data to tailor their instruction more effectively, addressing individual learning needs and improving student outcomes.

Overall, the full-scale implementation demonstrated the feasibility and benefits of the flipped classroom model with digital self-learning and diagnostic tools in vocational education.

#### **Student Engagement**

Survey results showed a significant increase in student engagement. Pre-implementation, 45% of students reported being actively engaged in the course, compared to 78% post-implementation. Students highlighted the interactive and flexible nature of the self-learning modules as key factors in their increased engagement. The results in Table 1 show a significant increase in student engagement scores among students from the pre-test (M=44.7, SD=2.93) to the post-test (M=78.3, SD=2.75), t(119)=338 with  $\rho$ -value=0.001<0.05, indicating significance student engagement among students. Pre-and post-training assessments significantly increased the participants' student engagement cs. On average, student engagement scores increased by 33%, highlighting the effectiveness of the flipped classroom model with digital self-learning and diagnostic tools in vocational education.

Table 1	Pre-test	Post-test a	nd Paired t-test	Results of	Students	Engagement
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P	Pre-test	Post-test		Paired sample t-test			
Μ	SD	Μ	SD	Μ	t	df	ρ-value
44.7	2.93	78.3	2.75	-33.6	338	119	0.001

The Mean value of -33.6 is negative, meaning there is a tendency for the post-test score to increase after being given treatment. The average increase was 33.6. It can be concluded that the flipped classroom model with digital self-learning and diagnostic tools in vocational education effectively increase in student engagement.

## **Learning Outcomes**

Analysis of pre-and post-test scores indicated a substantial improvement in student performance. The average test scores increased from 62% before the implementation to 85% after. Additionally, students demonstrated enhanced practical skills, as observed during hands-on tasks and projects. The results in Table 2 show a significant increase in student performance scores among students from the pre-test (M=62, SD=2.65) to the post-test (M=85.3, SD=2.71), t(119)=216 with  $\rho$ -value=0.001<0.05, indicating significance improvement in student performance among students. Pre-and post-training assessments significantly increased the participants' student engagement cs. On average, student performance scores increased by 23%, highlighting the effectiveness of the flipped classroom model with digital self-learning and diagnostic tools in vocational education.

Table 1.	Pre-test.	Post-test, ar	nd Paired t-test	<b>Results of</b>	Students	Engagement
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Pre-test		Post-test			Paired sample t-test			
Μ	SD	Μ	SD	Μ	t	df	ρ-value	
62.0	2.65	85.3	2.71	-23.4	216	119	0.001	

The Mean value of -23.4 is negative, meaning there is a tendency for the post-test score to increase after being given treatment. The average increase was 23.4. It can be concluded that the flipped classroom model with digital self-learning and diagnostic tools in vocational education effectively improvement in student performance. Data from the diagnostic system revealed that students who received personalized feedback and customized learning pathways outperformed those who did not

## DOI: : https://doi.org/10.62872/fm59dm48

receive such individualized support. The system was effective in pinpointing specific areas where students were facing difficulties. This precise identification allowed teachers to implement targeted interventions and provide the necessary support to address these challenges.

The personalized feedback enabled students to understand their strengths and weaknesses better, guiding them on where to focus their efforts. This tailored approach ensured that students received the help they needed promptly, improving their overall performance and learning outcomes. The diagnostic system played a crucial role in enhancing student achievement by offering personalized, actionable insights and facilitating targeted support to address learning gaps.

## **Teacher Satisfaction**

Teacher surveys and interviews indicated a high level of satisfaction with the flipped classroom model. An impressive 90% of teachers reported that the digital tools associated with this model significantly eased the management of classroom activities and tracking of student progress. The digital tools provided a streamlined way for teachers to monitor how students were doing, making it simpler to identify and address any issues.

Additionally, teachers observed a noticeable improvement in students' readiness and participation during in-class activities. Because students were able to learn at their own pace and come to class better prepared, they were more engaged and active during classroom sessions. This increased participation likely led to more dynamic and effective in-class learning experiences.

Overall, the feedback from teachers highlights the flipped classroom model's positive impact on both teaching efficiency and student engagement.

## Discussion

The flipped classroom model, when supported by a digital self-learning and diagnostic system, has been shown to significantly enhance student engagement and learning outcomes in the Network Infrastructure Administration course. This innovative approach has led to improvements in test scores and practical skill proficiency among students, indicating the benefits derived from the flexibility and interactive nature of self-learning modules. Moreover, teachers have provided positive feedback, highlighting the model's effectiveness in enhancing classroom management and increasing student participation (Zhou, 2023).

The effectiveness of the flipped classroom model in vocational education aligns with broader trends in educational research. Studies have shown that flipped classrooms can enhance learners' cognitive skills and emotional states, leading to improved long-term performance (Zhou, 2023). Additionally, the integration of digital literacy and skills has been recognized as instrumental in fostering critical and creative thinking, problem-solving abilities, and overall competence in vocational education (Mutohhari, Sutiman, et al., 2021). The acceptance and application of digital technology, including cyber-physical systems, have expanded to support seamless learning processes and enhance educational outcomes (Mutohhari, Sofyan, et al., 2021). In the context of vocational education, the role of teachers is paramount. Research emphasizes the importance of teacher self-efficacy, digital literacy, and continuous professional development to enhance instructional quality and adapt to the demands of the 21st century(Kholifah et al., 2023). Furthermore, the development of vocational education systems requires a focus on digital competency among both teachers and students to meet the evolving needs of the workforce and society (Astuti et al., 2021; Wahjusaputri & Nastiti, 2022).

The digital transformation of vocational education is essential for preparing students for the challenges of the digital economy. Investments in digital learning technologies and the creation of common digital learning environments have been identified as key strategies to improve the quality of vocational education and enhance students' employability (Akhyadov, 2019). Moreover, the integration of digital collaborative learning and metacognitive assessment models can significantly enhance students' problem-solving skills and overall learning outcomes (Mahande et al., 2022; Männistö et al., 2020). The integration of digital technologies, such as the flipped classroom model supported by self-learning systems, holds great promise for enhancing vocational education outcomes. By leveraging digital tools, educators can create engaging and interactive learning environments that cater to the diverse needs of students, ultimately preparing them for success in the workforce.

The qualitative data from interviews provided deeper insights into the experiences of both students and teachers. Students appreciated the ability to review materials multiple times at their own pace, while teachers valued the detailed feedback from the diagnostic system. The findings align with

existing literature on the benefits of flipped classrooms and the use of digital tools in education. The successful integration of technology with innovative pedagogical approaches in vocational education has been demonstrated to have a transformative impact on student engagement and learning outcomes. However, the effectiveness of such models is contingent upon adequate training and support for both students and teachers (Arifin et al., 2020). Future research endeavors should focus on exploring the long-term implications of these models and their potential applicability to other vocational subjects, taking into account factors such as scalability and sustainability (Ceelen et al., 2021).

The potential of digital transformations in vocational education is underscored by the need to enhance pedagogical practices through innovative technologies (Kravtsova et al., 2022). By leveraging innovative pedagogical approaches, vocational education can effectively cultivate professional competencies and adapt to the demands of the digital era (EpiiloBa et al., 2022). The development of vocational education systems requires a focus on digital competency among both teachers and students to meet the evolving needs of the workforce and society ((Gapsalamov et al., 2020; Schröder, 2019). Innovative pedagogical strategies play a crucial role in fostering students' innovation and entrepreneurship abilities in vocational education ((Gong et al., 2023). The adoption of e-pedagogies in vocational education and training reflects the necessary evolution that educators and learners must embrace to stay relevant in a rapidly changing educational landscape (Xie, 2021). The integration of innovative teaching technologies is essential for enhancing the quality of vocational education and preparing students for the demands of the digital economy (Haidamaka et al., 2022).

The reform and innovation of vocational education are essential for enhancing students' vocational quality and meeting the growing demand for skilled professionals(Villalba et al., 2018). By incorporating pedagogical coaching technologies and fostering a culture of continuous professional development, vocational teachers can enhance their instructional quality and adapt to the changing educational landscape ("The Problem of Pedagogical Innovations and Trends in the Development of the Educational Environment," 2021). The development of innovative learning environments in vocational education can foster communities of learners and promote collaborative learning experiences ("Conditions for the Development of Psychological and Pedagogical Competence of Teachers of Vocational (Professional and Technical) Education", 2022). The integration of technology with innovative pedagogical approaches holds immense potential for transforming vocational education. By investing in teacher training, supporting students, and conducting further research on the long-term impact of these models, vocational education can adapt to the digital age and prepare students for success in the workforce.

## Conclusion

The study aimed to develop and evaluate a flipped classroom learning model integrated with a digital self-learning and diagnostic system for vocational high schools' Network Infrastructure Administration course. The results indicated significant improvements in student engagement, learning outcomes, and teacher satisfaction. Students showed higher levels of participation and interest in the course, as well as increased test scores and practical skill proficiency. Teachers reported that the digital tools facilitated better classroom management and provided valuable insights into student progress.

The findings of this study suggest that integrating a flipped classroom model with digital selflearning and diagnostic systems can greatly enhance the teaching and learning experience in vocational education. This approach allows for a more flexible, personalized, and interactive learning environment that caters to the diverse needs of students. Vocational schools can adopt this model to better prepare students for the workforce by providing them with both theoretical knowledge and practical skills. Additionally, the continuous feedback and personalized learning pathways offered by the diagnostic system can help identify and address learning gaps more effectively.

Despite the positive outcomes, the study had several limitations. The sample size, though adequate for initial evaluation, was relatively small and limited to a few vocational high schools. The study also relied on self-reported data for some measures, which may be subject to bias. Furthermore, the implementation was conducted over a single semester, and longer-term effects were not examined. Future studies should consider larger, more diverse samples and longer implementation periods to validate and extend the findings.

Future research should explore the long-term impact of the flipped classroom model with digital tools on student learning and career readiness. Studies could also investigate the model's applicability to other vocational subjects and educational contexts. Additionally, research could focus on the

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scalability and sustainability of the approach, examining factors such as cost, infrastructure requirements, and teacher training needs. Finally, integrating emerging technologies like artificial intelligence and machine learning into the diagnostic system could further enhance personalized learning and support continuous improvement in vocational education.

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