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Empowering Future Mathematics Educators: How the Flipped Classroom Improves Self-Efficacy in Designing Teaching Materials

Siti Munawwarah
Yogyakarta State University

Aprilia Tina Lidyasari
Yogyakarta State University

Abstract: This study aims to (1) analyze the effect of implementing the SPADA Indonesia-based flipped classroom model on increasing the self-efficacy of prospective elementary school teachers in designing mathematics student worksheets, (2) compare the level of self-efficacy between students who participated in flipped classroom learning and conventional learning, and (3) examine the relationship between self-efficacy and students' ability to design student worksheet. This study used a quantitative approach with a quasi-experimental design involving 78 elementary school teacher education students from Yogyakarta State University who were divided into an experimental class (n = 40) and a control class (n = 38). The instruments included a self-efficacy questionnaire developed based on Bandura's theory (1997) and the teacher efficacy model of Tschannen-Moran and Hoy (2001), as well as a rubric for assessing Student Worksheet design. Data analysis was performed using the Wilcoxon Signed-Rank test, Mann–Whitney U test, and Spearman's correlation at a significance level of 0.05. The results showed that the implementation of the SPADA Indonesia-based flipped classroom had a significant effect on increasing student self-efficacy in all indicators, with a large effect on the aspects of mastery of elementary school mathematics material (SE1), the ability to design innovative student worksheet (SE2), and self-efficacy in facing learning design challenges (SE3). A comparison between the groups also showed that students in the flipped classroom had higher levels of self-efficacy than those in the conventional classroom. Although the correlation between self-efficacy and the ability to design student worksheet was weak, the SE2 indicator showed a significant positive relationship. These findings confirm that SPADA-based flipped classrooms not only strengthen self-efficacy and independent learning, but also facilitate reflective and collaborative experiences that contribute to improving the pedagogical competence of prospective teachers.

Keywords: Flipped Classroom, Self-efficacy, Student student worksheet, Prospective teachers

Introduction

Quality education in the 21st century requires teachers who not only master the subject matter but are also capable of designing and implementing meaningful learning. One important tool that supports the learning process, especially in mathematics, is the student worksheet. Student worksheet serves as a structured learning guide that helps students understand mathematical concepts systematically (Kurnia & Nurhayati, 2020). Therefore, the ability of prospective teachers to design effective student worksheet is one of the main pedagogical competencies that must be mastered, as they will play a role as learning designers in the future.

However, preliminary observations and studies of fifth-semester students in the Elementary School Teacher Education at Yogyakarta State University in the 2024/2025 academic year show that around 40% of students feel unable to compile mathematics student worksheet, and 68% admit to lacking self-efficacy due to limited mastery of concepts and experience in developing innovative teaching materials. This condition reflects the students' low self-efficacy, which is the belief in one's ability to perform tasks or achieve certain goals (Bandura, 1997). Low

self-efficacy can lead to low creativity and initiative among students in designing interesting and meaningful learning tools.

In the context of teacher education, self-efficacy is an important aspect that plays a role in determining the readiness and pedagogical competence of prospective educators. Previous studies have shown that *high self-efficacy* is closely related to learning motivation, self-confidence, and the innovative abilities of prospective teachers (Demir, 2020; Kula, 2022). Conversely, low self-efficacy has the potential to hinder exploration of new learning approaches and reduce students' effectiveness in implementing their pedagogical knowledge (Georgiou et al., 2020; Pressley, 2021). Therefore, learning strategies are needed that can optimally develop students' self-efficacy.

One model that has been proven to increase student self-efficacy is the flipped classroom model (Campillo-Ferrer & Miralles-Martínez, 2021; Heni & Ridlo, 2021). This model flips the traditional learning structure by placing independent learning activities outside the classroom through videos or digital modules, while face-to-face time is used for discussion, problem solving, and concept application (Schmidt & Ralph, 2016). Various international studies have shown that the implementation of the flipped classroom can increase student engagement, independence, and self-efficacy (Han & Hamzah, 2024; Sun et al., 2023). On the other hand, several other studies highlight the need for an appropriate implementation context for the flipped classroom to truly impact student self-efficacy and performance (Dikilitas & Fructuoso, 2023; Gallagher, 2023).

In the context of elementary teacher education in Indonesia, studies on the application of the flipped classroom to develop self-efficacy in designing student worksheets are still limited. Previous studies have generally focused on improving conceptual learning outcomes or the technological skills of students (Algarni, 2025; Aslan, 2022; Heni & Ridlo, 2021; Samaila et al., 2024), without specifically examining how the integration of digital learning can strengthen students' self-efficacy in designing teaching materials especially the student worksheet. Meanwhile, national platforms such as ‘SPADA Indonesia’, developed by the Ministry of Education, Culture, Research, and Technology, provide great opportunities to effectively implement the flipped classroom model in higher education. SPADA allows students to access pre-class materials, engage in asynchronous discussions, and upload their student worksheet designs digitally (Wicaksana et al., 2021). However, research exploring the relationship between the use of SPADA, increased self-efficacy, and students' ability to design student worksheet is still rare in the national literature. Based on this description, this study aims to: 1) analyze the effect of the flipped classroom model on the increase in elementary school teacher education students’ self-efficacy in designing student worksheet, 2) compare the level of self-efficacy between the experimental and control classes, and 3) examine the relationship between self-efficacy and students' ability to design student worksheet.This study is expected to contribute to the development of digital learning theory and practice in teacher education, particularly in strengthening the self-efficacy and pedagogical competence of prospective teachers through the integration of the SPADA Indonesia-based flipped classroom model.

Literature Review

SPADA Indonesia-Based Flipped Classroom

The development of digital technology and online learning has changed the way students and lecturers interact in the learning process. One innovative pedagogical approach that has emerged is the flipped classroom, a learning model that reverses the traditional sequence of activities inside and outside the classroom (Bergmann & Sams, 2012). In this approach, students learn the basic material independently in advance through videos, modules, or online activities, while face-to-face time in class is used for discussion, collaboration, and application(Darmawati et al., 2023; Md Desa & Abd Halim, 2022; Yumuşak, 2020). This model provides space for more active, reflective, and student-centered learning.

In the context of Indonesian higher education, the implementation of the flipped classroom is increasingly relevant through the support of the SPADA Indonesia (Indonesian Online Learning System) platform developed by the Directorate General of Higher Education, Science, Technology, and Innovation. SPADA enables the integration of video content, discussion forums, online quizzes, and project-based assessments into a single system that is easily accessible to students. Through this integration, students can review material at any time, discuss with peers, and receive asynchronous feedback from lecturers. Research by Hamer & Lely (2020) and Rizki et al. (2022) shows that SPADA-based learning increases learning independence, active engagement, and student satisfaction with the learning process.

In addition to providing flexibility, SPADA-based flipped classrooms also provide a rich learning experience in the context of teacher education. A study by Latorre-Cosculluela et al. (2022) confirms that flipped classrooms provide learners with the opportunity to gain mastery experience—one of the main factors in shaping self-efficacy according to Bandura (1997). Pre-class activities such as watching videos or reading teaching materials independently allow students to build initial understanding, which is then reinforced through face-to-face activities such as case discussions or the design of student worksheet. Through these learning experiences, prospective teacher students not only master concepts but also develop the self-efficacy to apply them in the real context of elementary school learning.

Self-Efficacy in Instructional Design

The concept of self-efficacy was first proposed by Bandura (1997) as an individual's belief in their ability to organize and carry out the actions necessary to achieve certain results. In the context of teacher education, self-efficacy is defined as prospective teachers' belief in their ability to design, implement, and evaluate learning effectively(Menno et al., 2024; Narayanan et al., 2023; Rezaull Karim et al., 2021). Individuals with high self-efficacy tend to choose challenging tasks, persevere longer when faced with difficulties, and have a more positive solution orientation (Demir, 2020; Kula, 2022; Sofeia, 2023). In the learning design process, self-efficacy plays an important role because it determines how prospective teachers interpret challenges in designing teaching tools. Students with high self-efficacy will be more willing to experiment with innovative learning strategies, integrate technology, and reflect on their design outcomes for continuous improvement(Caner & Aydin, 2021; Chen et al., 2024). Conversely, prospective teachers with low self-efficacy tend to avoid complex tasks or rely on instructor instructions without developing personal creativity.

The flipped classroom model has been proven effective in increasing self-efficacy through various psychological mechanisms. Studies by Algarni (2025) and Sun et al. (2023) show that active involvement in pre-class activities and collaboration in class can strengthen students' perceptions of their own abilities. In SPADA-based learning, students gain vicarious experience through design examples from peers, as well as social persuasion from feedback from lecturers and peers. These three factors (*mastery experience, vicarious experience,* and *social persuasion)* are the main pillars of *self-efficacy* formation according to Bandura's theory (1997). Thus, it can be anticipated that the application of SPADA-based flipped classrooms will increase students' self-efficacy in their ability to design teaching materials, including student worksheet based on the elementary school curriculum.

Ability to Design Teaching Materials

The ability to design teaching materials, especially student worksheet, is an important competency that prospective elementary school teachers must possess. The design of worksheets requires the integration of content knowledge, pedagogical knowledge, and technological knowledge as described in the TPACK (Technological Pedagogical and Content Knowledge) framework by Mishra and Koehler (2006). In practice, prospective teachers must be able to develop learning activities that are appropriate to the characteristics of the students, determine the right learning approach, and use technology to improve the effectiveness and appeal of the worksheets. Several studies on teaching material development in Indonesia show that students with good TPACK competencies tend to produce more innovative and contextual student worksheet designs (Hanifah et al., 2024; Pane et al., 2022; Sulistyarini et al., 2022). However, this ability does not only depend on academic knowledge alone, but also on self-efficacy to try, evaluate, and revise the design. In this case, self-efficacy acts as a psychological factor that encourages students to dare to make creative design decisions.

A study by Chen (2024), confirms that students with high self-efficacy perform better in learning design tasks because they have a sense of responsibility for their work and more mature reflective abilities. Thus, it can be assumed that increasing self-efficacy through the flipped classroom model will have a positive impact elementary school teacher education students' ability to design student worksheet. Through pre-class activities and online collaboration using SPADA, students gain inspiration, examples, and opportunities to practice that enrich their creative process.

Conceptual Integration and Hypothesis Formulation

Based on a synthesis of theory and previous research results, it can be formulated that the SPADA Indonesia-based flipped classroom has the potential to become a learning environment that encourages the formation of

student self-efficacy in designing teaching materials. This model provides a combination of learning autonomy, social collaboration, and real-world practical experience that supports the internalization of self-efficacy in one's abilities. Increased self-efficacy, in turn, plays an important role in strengthening students' ability to produce high-quality, creative student worksheet designs that meet the needs of elementary school students.

This framework of interrelationships between variables is based on Bandura's social cognitive learning theory (1997), which explains that interactions between personal factors, behavior, and the environment determine learning outcomes. In this context, the flipped classroom (learning environment) influences self-efficacy (personal factor), which then impacts the ability to design student worksheet (behavior/performance). Thus, the relationship between these three variables can be explained theoretically and empirically. In accordance with the objectives of this study, the hypothesis formulated is; (H1) The SPADA Indonesia-based flipped classroom model has a significant effect on increasing the self-efficacy of elementary school teacher education students in designing student worksheet. (H2) There is a difference in the level of self-efficacy between students who participate in SPADA-based flipped classroom learning and students who participate in conventional learning. (H3) There is a positive relationship between self-efficacy and students' ability to design student worksheet.

Method

This study uses a quantitative approach with a quasi-experimental design. This design was chosen because the researcher did not have full control over the randomization of subjects, but it still allowed for a comparison of results between the experimental and control groups. The research population included all 247 students in the fifth semester of the Elementary School Teacher Education Program at Yogyakarta State University for the 2024/2025 academic year. The research sample was determined using non-randomized equivalence-based sampling, which involved two parallel classes with relatively equivalent academic abilities. Class B (n = 40) was designated as the experimental group that received treatment in the form of the application of the SPADA Indonesia-based flipped classroom model, while class C (n = 38) served as the control group that followed conventional learning. The selection of the two classes was done purposively, taking into account the similarity of lecturers, curriculum, and lecture schedules to minimize the potential for selection bias between groups. Table 1 shows the demographic distribution of the research subjects.

Table 1. Demographics of research subjects

Category	Experimental (n=40)	Control (n=38)	Total
Gender			
Male	8 (20%)	7 (18.4%)	15 (19.2%)
Female	32 (80%)	31 (81.6%)	63 (80.8%)
Experience in creating student worksheet			
Ever	15 (37.5%)	13 (34.2%)	28 (35.9%)
Never	25 (62.5%)	25 (65.8%)	50 (64.1%)
Average GPA	3.66	3.65	3.655

Demographic data shows that the characteristics of both groups are relatively similar. Most participants are 20 years old and female, which is in line with the general profile of elementary school teacher education students. The average Grade Point Average (GPA) of both classes is also relatively comparable (experimental 3.66 and control 3.65), indicating homogeneous academic abilities before the treatment was given. The majority of students had no prior experience in designing student worksheet, so this study provided them with an initial opportunity to develop these competencies through flipped classroom learning and conventional learning.

The research instruments consisted of a self-efficacy questionnaire and a rubric for assessing performance in creating elementary school mathematics worksheets. The self-efficacy questionnaire was developed by the researcher based on Bandura's theory (1997) and the teacher efficacy model by Tschannen-Moran and Hoy (2001), which emphasizes individuals' belief in their ability to carry out learning tasks. This instrument contains 15 statements representing three main aspects, namely 1) students' self-efficacy in their ability to master elementary school mathematics material, 2) self-efficacy in designing innovative student worksheet, and 3) self-efficacy in facing the challenges of designing learning tools.

The instrument has been validated by lecturers who are experts in mathematics education and learning evaluation to ensure the suitability of the indicators and clarity of the wording, then empirically tested on 31 elementary school teacher education students in class E fifth semester. The test results showed that all items of the met the

validity criteria (r_count > 0.30) with a Cronbach's Alpha reliability coefficient of 0.919, indicating very high internal consistency and the suitability of the instrument for use in the main study. The performance assessment rubric was used to assess students' ability to design student worksheet after treatment. This rubric was developed with reference to the guidelines of Permendikbudristek Number 7 of 2022, covering aspects of content suitability, clarity of learning steps, design creativity, integration of mathematical concepts, and integration with learning technology. The validation results by expert lecturers showed a feasibility level of 91.6%, indicating that the rubric was very feasible to use to assess students' worksheet design performance.

The data were analyzed using nonparametric inferential statistics with the help of SPSS version 26.0 software. The Kolmogorov–Smirnov and Levene tests were used to examine the assumptions of normality and homogeneity of the data. The results showed that the data were not normally distributed and were not homogeneous (Sig. < 0.05), so hypothesis testing was performed using the Wilcoxon Signed-Rank Test to measure the increase in self-efficacy in each group, the Mann–Whitney U Test to compare the differences *in* self-efficacy between the experimental and control groups, and Spearman Rank Correlation to test the relationship between self-efficacy and students' ability to design student worksheet. All analyses were performed at a significance level of $\alpha = 0.05$.

Results and Discussion

Results

Descriptive Statistics

The descriptive analysis results are presented in Table 1, which shows an increase in self-efficacy (SE) scores in the experimental class after the implementation of the flipped classroom model. The average SE1 score increased from 74.97 to 78.67, SE2 from 77.18 to 81.28, and SE3 from 74.10 to 79.33. An increase was also seen in the student worksheet (SW) design ability score, with an average of 85.32 and a standard deviation of 4.12. This trend indicates that students became more confident in designing student worksheet after participating in flipped classroom learning, which provides opportunities for independent learning before face-to-face sessions.

Table 1. Descriptive statistics

	N	Min	Max	Mean	Std. Dev
SE1_Pre	78	48	100	74.97	9.035
SE2_Pre	78	44	100	77.18	9.821
SE3_Pre	78	36	100	74.10	11,086
SE1_Post	78	60	100	78.67	10,703
SE2_Post	78	60	100	81.28	9.935
SE3_Post	78	44	100	79.33	10,522
SW	78	78	93	85.32	4.120

Testing Normality and Homogeneity Assumptions

Table 2. Results of normality and homogeneity tests

	Class Type	Sig. Normality	Conclusion	Sig. Homogeneity	Conclusion
SE1_Pre	Experiment	.138	Normal	.081	Homogeneous
	Control	.000	Not Normal		
SE2_Pre	Experiment	.000	Not Normal	.764	Homogeneous
	Control	.000	Not Normal		
SE3_Pre	Experiment	.002	Not Normal	.224	Homogeneous
	Control	.000	Not Normal		
SE1_Post	Experiment	.024	Not Normal	.000	Not Homogeneous
	Control	.000	Not Normal		
SE2_Post	Experiment	.000	Not Normal	.000	Not Homogeneous
	Control	.000	Not Normal		
SE3_Post	Experiment	.023	Not Normal	.000	Not Homogeneous
	Control	.000	Not Normal		
SW	Experiment	.000	Not Normal	.017	Not Homogeneous
	Control	.000	Not Normal		

Before testing the hypothesis, a normality assumption test was conducted using Kolmogorov–Smirnov and a homogeneity test using Levene. The test results in Table 2 show that most of the data are not normally distributed ($p < 0.05$), both in the experimental and control classes, so the analysis was continued using non-parametric tests. Meanwhile, the results of the homogeneity test showed that the pretest data was homogeneous ($p > 0.05$), while the posttest and student worksheet data showed heterogeneity ($p < 0.05$).

The Effect of the Flipped Classroom Model on Self-Efficacy

The Wilcoxon test in Table 4 shows that all self-efficacy indicators in the experimental class experienced a significant increase with a large effect: SE1 ($r = 0.576$), SE2 ($r = 0.593$), and SE3 ($r = 0.519$). In contrast, no significant differences were found in the control class ($p > 0.05$). According to Cohen's conventions, these effect sizes fall within the large range ($r > 0.5$), indicating practically meaningful improvements beyond statistical significance.

Table 3. Wilcoxon test results

Class	Indicator	Z	Sig. (2-tailed)	r	Description
Experiment	SE1	-3.754	.000	0.576	Significant Effect
	SE2	-3.285	.001	0.593	Significant Effect
	SE3	-3.757	.000	0.519	Significant Effect
Control	SE1	-0.446	0.656	0.072	Not significant
	SE2	-0.217	0.828	0.035	Not significant
	SE3	-0.708	0.479	0.115	Not significant

Differences in Self-Efficacy Between the Experimental and Control Classes

The Mann–Whitney test results (see Table 3) show significant differences in the SE1 indicator ($Z = -2.240$; $p = 0.025$), SE2 ($Z = -2.281$; $p = 0.005$), and total self-efficacy ($Z = -2.195$; $p = 0.028$) between the experimental and control classes. However, the SE3 indicator did not show a significant difference ($p = 0.077$), though a positive trend was evident. This differential impact suggests that the flipped classroom model more immediately enhances content mastery and practical design skills, while developing resilience against pedagogical challenges may require more prolonged exposure or additional support mechanisms.

Table 4. Mann Whitney U test results

Indicator	Z	Sig. (2-tailed)	Description
SE1_Post	-2.240	.025	Significant Difference
SE2_Post	-2.281	.005	Significant Difference
SE3_Post	-1.766	.077	No Significant Difference
Total_SE-Post	-2.195	.028	Significant Differences

Correlation Between Self-Efficacy and Student Worksheet Design Ability

The results of the Spearman Correlation test in Table 5 show that only the SE2 indicator shows a significant relationship with the ability to design student worksheet ($rs = 0.226$; $p = 0.046$). Meanwhile, SE1, SE3, and the total self-efficacy do not show a meaningful relationship ($p > 0.05$). This indicates that although self-efficacy plays a role in supporting the ability to design student worksheet, the improvement of this ability is also influenced by other factors such as pedagogical understanding and direct practical experience.

Table 5. Correlation test results between self-efficacy and student worksheet design ability

Variable	N	rs	Sig	Interpretation
SE1_Post - SW	78	0.153	0.180	Weak correlation, not significant
SE2_Post – SW	78	0.226	0.046	Weak correlation, Significant
SE3_Post – SW	78	0.144	0.209	Weak correlation, Not significant
Total_SE - SW	78	0.157	0.170	Weak correlation, not significant

Disscussion

This study aimed to investigate the effect of the flipped classroom model on students' self-efficacy and its relationship with their ability to design student worksheets (SW). The findings provide substantial evidence supporting the effectiveness of the flipped classroom approach in enhancing students' self-efficacy and skills in designing mathematics student worksheet.

The descriptive analysis revealed a consistent increase in all three self-efficacy (SE) indicators (SE1, SE2, and SE3) in the experimental class following the implementation of the flipped classroom model. This upward trend suggests that the structure of the flipped classroom, which emphasizes independent learning prior to face-to-face sessions, fosters a sense of preparedness and mastery among students. The opportunity to engage with learning materials autonomously likely contributed to building their confidence in their own capabilities, a core component of Bandura's self-efficacy theory (Bandura, 1997). These results align with recent studies that confirm the flipped classroom model can increase prospective teachers' self-efficacy through guided independent learning, conceptual reflection, and project-based collaborative activities (Alkandari & Alabdulhadi, 2023; Aslan, 2022; Muhibbuddin et al., 2020).

The results of the inferential analysis further solidify these observations. The Wilcoxon signed-rank test confirmed that the improvements in self-efficacy within the experimental class were statistically significant, with large effect sizes ($r > 0.5$) for all three SE indicators. These findings are consistent with the research by Chen et al. (2024) and Gallagher (2023), which states that flipped learning can increase student motivation and self-efficacy because it provides autonomy in learning and the opportunity to repeat material as needed. Pre-class activities that require exploration of videos, digital resources, and independent reflection encourage the formation of mastery experiences, which are one of the main factors in shaping self-efficacy. In contrast, no significant changes were observed in the control class. This stark difference underscores the active role of the flipped model in driving these gains, rather than mere maturation or external factors.

When comparing the outcomes between the experimental and control groups using the Mann-Whitney U test, significant differences were found in the post-test scores for SE1, SE2, and the total self-efficacy score. This indicates that the flipped classroom model was more effective than traditional methods in boosting students' confidence, particularly in areas related to content mastery and practical application. However, the non-significant difference in SE3 post-test scores between the groups is noteworthy. This finding suggests that certain aspects of self-efficacy, possibly related to resilience or coping with specific pedagogical challenges, may require more sustained intervention or different instructional support mechanisms beyond the flipped classroom structure alone. This aligns with the concept that self-efficacy is domain-specific and its development can be uneven across different tasks (Zimmerman, 2000).

Regarding the relationship between self-efficacy and practical skills, the Spearman's correlation analysis yielded a nuanced picture. A significant, though weak, positive correlation was found only between the SE2 indicator and student worksheet design ability. This implies that the specific beliefs captured by SE2 (e.g., confidence in one's ability to organize and execute tasks related to design) are more directly translatable into the performance of designing worksheets. This supports the research by Zarouk et al. (2020) and Lee et al. (2020) which states that individuals with high self-regulated learning are more successful in achieving complex learning outcomes, including in design-based or development tasks. The lack of significant correlation for SE1 and SE3 suggests that while general self-efficacy is beneficial, the actual ability to design effective learning materials is a complex skill. This phenomenon can be explained by the view that self-efficacy is not the only determinant of performance, but interacts with other factors such as conceptual knowledge, practical experience, and the support of a learning environment (Li et al., 2023; Wei et al., 2022; Yokoyama, 2019). It is heavily influenced by other critical factors, such as depth of pedagogical content knowledge, creativity, and direct, hands-on experience, factors that may not be fully captured by self-efficacy measures alone (Shulman, 1986).

Conclusion

This study concludes that the application of the flipped classroom model has a significant effect on increasing students' self-efficacy in designing elementary school mathematics worksheets. The test results show a significant difference between the experimental and control classes in most self-efficacy indicators, with a large effect size. This improvement is particularly evident in the aspects of task strategy and student persistence in completing the design. Meanwhile, the relationship between self-efficacy and the ability to design worksheets was weak, indicating that self-efficacy is not the only factor that determines the quality of the design results. Other factors such as pedagogical understanding, practical experience, and instructional guidance also influence the results.

Overall, the flipped classroom model has been proven to create a more independent and reflective learning experience and empower students as future professional educators.

Recommendations

Practically, the results of this study have implications for elementary education lecturers to implement the flipped classroom as a learning strategy that supports the development of pedagogical competencies of prospective teachers. This model allows for the integration of online and offline activities that enrich the learning experience and strengthen students' self-efficacy in producing innovative teaching tools. From an institutional perspective, these results also emphasize the importance of developing digital learning resources and project-based learning design training as part of the teacher education curriculum. For further research, it is recommended that the measurement of design skills be based not only on student worksheet products, but also on students' design thinking processes and pedagogical reflections. In addition, longitudinal studies can be conducted to observe the sustainability of the flipped classroom's influence on the self-efficacy and professional performance of prospective teachers in the field.

This study has several limitations. First, the reliance on self-reported measures for self-efficacy might be subject to bias. Second, the research was conducted in a specific academic context, which may limit the generalizability of the findings. Third, the heterogeneity of variance in the post-test and SW data, while addressed using non-parametric tests, indicates differences in group dynamics that future studies could investigate further. Future research should; 1) Utilize mixed-methods approaches to triangulate self-efficacy data with qualitative insights from interviews or observations, 2) Investigate the specific components of the flipped classroom (e.g., the type of pre-class activities, in-class collaborative structures) that most potently influence different aspects of self-efficacy, 3) Explore longitudinal effects to determine if the gains in self-efficacy and SW design ability are sustained over time, 4) Examine the specific factors beyond self-efficacy that more strongly predict the quality of student-designed worksheets.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPESS journal belongs to the authors.

* During the preparation of this manuscript, the authors utilized Grammarly to assist with language editing and improving readability. The AI-generated content was rigorously reviewed, revised, and validated by the authors to ensure alignment with the study's scientific integrity. The authors take full responsibility for the accuracy, ethical compliance, and originality of the final content. AI tools were not involved in data interpretation, hypothesis formulation, or decision-making processes related to this research.

Conflict of Interest

* The authors have no conflicts of interest to declare.

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Author(s) Information

Siti Munawwarah
Yogyakarta State University, Jl. Colombo Yogyakarta No.1, Karang Malang, Caturtunggal, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55281, Indonesia.
Contact e-mail: *sitimunawwarah.2023@student.uny.ac.id*

Aprilia Tina Lidyasari
Yogyakarta State University, Jl. Colombo Yogyakarta No.1, Karang Malang, Caturtunggal, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55281, Indonesia.

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