Developing Primary School Teachers' Competencies in Using Games in Teaching Oriented Towards Education for Sustainable Development: An Empirical Study

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ABSTRACT: This study aims to propose and verify the effectiveness of a training process for developing primary school teachers' competencies in using games in teaching oriented towards Education for Sustainable Development (ESD). Employing a pedagogical experimental method with a "one-group pretest-posttest" design on 20 teachers at Luong The Vinh Primary School, data were collected through a 13-item measurement scale and statistically analyzed using SPSS software. The results indicate that the 4-stage intervention program, based on the principles of "Learning by Design" and "Peer Coaching", significantly increased the teachers' average overall competency score from 2.06 to 4.40 points, showing a highly statistically significant difference (Sig. = 0.000). A prominent contribution of this research is helping teachers thoroughly resolve time constraints and the fear of "running out of lesson time" by applying microgame design techniques. Concurrently, the study creates a profound cognitive shift: elevating teachers from the habit of being "passive users" to becoming true "experience creators." Thereby, teachers master the skill of transforming games into simulation spaces, naturally and effectively helping primary school students develop a sustainable consciousness and responsibility toward the environment and society.

1. INTRODUCTION

In the educational context oriented towards the comprehensive development of qualities and competencies, integrating Education for Sustainable Development (ESD) right from the primary school level is an urgent requirement. At this age, children learn best through the process of exploration and experience. Therefore, games should not merely be viewed as entertaining warm-up activities, but need to be designed as safe "simulation spaces," where students directly make decisions and witness the consequences of their actions on the community and the environment.

However, teaching practices at schools reveal that this process is facing numerous barriers. Despite being deeply committed to innovation, many teachers remain hesitant to use games due to time pressure that easily leads to the fear of "running out of lesson time," a lack of scenario design skills, and, particularly, confusion in the debriefing phase after playing. As a result, the majority of teachers are still stuck in the role of "passive users," primarily downloading and using pre-existing games from the internet in their original forms instead of actively creating experiences tied to sustainable education goals.

Stemming from these practical limitations, this study is conducted to propose and verify a "hands-on" training process for teachers, based on the principles of "Learning by Design" and "Peer Coaching" right in the classroom. Instead of macro-level theories, the research focuses on guiding teachers to design short-duration microgames of 5-10 minutes themselves to thoroughly resolve the time barrier. The core contribution of this article is to provide empirical evidence on the successful transformation of teachers from a passive position to the role of true "experience creators," bringing education for sustainable development into the classroom in a natural and effective manner.

2. THEORETICAL BACKGROUND AND RESEARCH METHODOLOGY

2.1. Competency framework for using games in ESD teaching

In the context of modern education, using games to teach Education for Sustainable Development (ESD) requires teachers to master a complex system of knowledge and skills. Chen et al. (2020) refer to this system as "games literacy," which includes knowledge of game mechanics, the ability to design instructional guides, and the assessment of learning outcomes. Based on the synthesis of international research models, particularly the theoretical frameworks of Rulyansah et al. (2023) and Nousiainen et al. (2018), this study identifies that primary school teachers' competency in using games in ESD teaching consists of 4 core groups: Pedagogy and Design, Organization and Technology, Assessment, and Collaboration and Creativity.

2.1.1. Pedagogical and Design Competencies

This is the foundational competency group, requiring teachers to be capable of concretizing the Sustainable Development Goals (SDGs) into situations and rules within the game scenarios (Senka et al., 2024). Teachers need to effectively execute the planning process, which includes defining objectives, selecting games, and designing corresponding learning activities (Hayak & Avidov-Ungar, 2023). Instead of merely transmitting knowledge one-way, this competency helps teachers transform games into a "simulation space" or a "micro-society," where students are allowed to experiment, make decisions, and directly observe the consequences of their actions on the environment (Tsai et al., 2021; Resti et al., 2024).

2.1.2. Organizational and Technological Competencies

For games to truly deliver educational value, teachers need the competency to organize smoothly across 3 phases: before, during, and after playing (Bado, 2022). During gameplay, the teacher must act as a flexible facilitator, managing behaviors and maintaining students' concentration (Molin, 2017). Regarding the technological aspect, to overcome the classroom time pressure barrier, teachers need to proficiently use basic digital platforms to design microgames or hybrid games with a short duration of 5-10 minutes (Saimon et al., 2024; Jhang et al., 2025). Mastering technology allows games to be seamlessly integrated into the lesson flow without disrupting the lecture structure.

2.1.3. Assessment and Reflective Competencies

In ESD teaching, games are not used to determine winners and losers but serve as tools to measure awareness. This competency requires teachers to know how to develop evaluation criteria (rubrics) synchronized with learning objectives right from the design stage (Aykaç & Kögce, 2019). Most importantly, teachers must master the skill of organizing debriefing discussions after playing, guiding students to connect their experiences in the simulated space with practical societal issues (Bado, 2022). Furthermore, teachers also need self-reflective competency to analyze game structures and adjust their teaching strategies for subsequent sessions (Shah & Foster, 2015).

2.1.4. Collaboration and Creativity Competencies

To maintain the long-term effectiveness of this method, teachers cannot work in isolation. Creative competency requires teachers to actively adjust game rules and contexts to suit their classrooms instead of maintaining the habit of mechanically reusing pre-existing games (Romero & Barma, 2015). Simultaneously, collaborative competency is demonstrated through teachers' willingness to share game scenarios and experiences with colleagues. Building a professional learning community through the "peer coaching" (mentoring) model and small-group support directly in the classroom is the key to overcoming technical barriers and spreading sustainable educational values (Stieler-Hunt & Jones, 2019; Rulyansah et al., 2023).

2.2. Research Methodology

2.2.1. Research Design and Subjects

This study uses a pedagogical experimental method, applying the "One-group pretest-posttest design" model. This is an approach with proven effectiveness in studies on integrating games into education, similar to the experimental design by Jhang et al. (2025). The subjects participating in the experiment are a sample of 20 teachers (including both core teachers and general teachers) currently teaching directly at Luong The Vinh Primary School, Ho Chi Minh City. The experimental training process was integrated directly into the school's professional development sessions, lasting for 4 weeks in the first semester of the 2025-2026 academic year (1 session per week, 4 hours per session).

2.2.2. Measurement and Data Collection Tools

To accurately evaluate the transformation in teachers' competencies, the study applies the "Triangulation" method combining quantitative and qualitative approaches (Abdalla et al., 2018). Cross-referencing multiple data sources (from surveys and practical observations to the analysis of design products) is considered the most optimal and objective approach when measuring competencies related to Education for Sustainable Development (ESD) (Afzaal & Munir, 2025).

The core quantitative data collection tool is the "Teacher Opinion Survey," designed as a 5-level Likert scale (from 1: Poor/Unable to do to 5: Good/Able to guide others). This scale consists of 13 observed variables (denoted from C1 to C13), structured based on the framework of 4 core competency components proposed by Rulyansah et al. (2023), including: (1) Pedagogical & Design Competencies; (2) Organizational & Technological Competencies; (3) Assessment Competencies; (4) Collaboration & Creativity Competencies.

2.2.3. Experimental Procedure

The experimental process was strictly conducted in 3 steps:

Step 1 (Pre-test): Distribute the survey to 20 teachers to measure their current competency foundation and simultaneously identify the practical barriers they are facing. The collected results serve as the initial baseline data.

Step 2 (Experimental Intervention): Directly implement the 4-stage training program named "Creator Teachers: Games and Sustainable Development." Teachers will sequentially undergo the process of: changing awareness regarding ESD games (Stage 1), practicing the design of 5-10 minute microgames (Stage 2), practicing the skill of asking debriefing questions (Stage 3), and conducting practical teaching in the classroom under the peer coaching of core teachers without being graded for performance evaluation points (Stage 4).

Step 3 (Post-test): Redistribute the 13-item self-assessment survey to the teachers, while simultaneously collecting all the designed scenarios/games and observing the actual teaching sessions to serve as output data.

2.2.4. Data Processing Methods

All collected data were processed using SPSS statistical software. The study utilized two main tests:

1. Cronbach's Alpha Reliability Test: Aimed at evaluating the reliability and internal consistency of the 13-item measurement scale before conducting in-depth analysis.

2. Paired Samples T-Test: Aimed at comparing the mean scores of the 4 competency groups before and after the experiment. The statistical significance level was set at a 95% confidence level to confirm whether the score discrepancy is due to the intrinsic impact of the training program or merely a random error.

3. RESEARCH RESULTS

3.1. Experimental Procedure: "Creator Teachers: Games and Sustainable Development"

In this study, we designed a highly practical experimental procedure (Giam & Trang, 2026), taking place over 4 sessions, to help teachers develop their competencies in using games in teaching, transitioning from passive game users to true content creators through the following 4 stages:

Stage 1: Activating and raising awareness (Session 1) The first objective is to change teachers' preconceptions. By directly playing the role of players and analyzing a sample game on Education for Sustainable Development (ESD), teachers will realize that games are not merely for entertainment or warm-ups. In essence, it is a "micro-society", where students are forced to make trade-offs between personal and community interests, make their own decisions, and clearly witness the consequences of their actions on the environment.

Stage 2: Designing and creating games (Session 2) To break the habit of merely downloading pre-existing games from the internet, teachers are guided to manually design 5-10 minute "microgames" using familiar tools such as Quizizz, Kahoot, or PowerPoint. This short game design solution not only helps seamlessly integrate environmental protection messages into the lesson but also thoroughly resolves primary school teachers' fear of "running out of lesson time."

Stage 3: Practicing pedagogical and reflective skills (Session 3) The value of an educational game lies in the debriefing phase after playing – a step that teachers often overlook. In this stage, teachers practice the skill of asking debriefing questions at two levels: level 1 is asking about emotions and coordination in the game; level 2 is guiding students to connect the situations in the game with real-life environmental issues. This skill helps transform temporary fun into profound lessons of responsibility.

Stage 4: Practical implementation and peer coaching (Session 4) Finally, the knowledge is put into practical application in the classroom. Core teachers will observe actual teaching sessions solely to provide on-the-spot support for technological issues, absolutely not grading for performance evaluation points to relieve psychological pressure. All game scenarios are then uploaded to the school's shared resource repository, helping to reduce the lesson preparation workload for subsequent years and building a sustainable sharing learning community.

In summary, this 4-step procedure is a logical pathway from theory to practice, ensuring that teachers not only "know" but can also "do," confidently delivering to students lessons that are both vivid and foster a consciousness of sustainable development.

3.2. Evaluation of Experimental Effectiveness

To objectively and comprehensively evaluate the impact level of the 4-stage training program, the study applies the "Triangulation" method combining quantitative and qualitative approaches (Abdalla et al., 2018). Cross-referencing multiple data sources is the optimal approach to measure complex competencies in Education for Sustainable Development (ESD) (Afzaal & Munir, 2025). However, within the scope of this article, the evaluation results primarily focus on the change in quantitative scores of the subject group consisting of 20 teachers through a "Pre-test - Post-test" design.

3.2.1. Evaluating the Reliability of the Measurement Scale

The game usage competency scale in the study consists of 13 observed variables, structured based on the framework of 4 core components by Rulyansah et al. (2023). To ensure accuracy before comparison, the study ran the Cronbach's Alpha reliability test.

Table 1: Results of Cronbach's Alpha reliability test Before and After training

Competency Group	Symbol	Observed variable content (Summary)	Item-total correlation (Pre-test)	Item-total correlation (Post-test)
A. Pedagogical & Design Competencies	C1/S1	Defining objectives and transforming them into game rules	0.447	0.562
	C2/S2	Integrating Education for Sustainable Development (ESD) content	0.249*	0.749
	C3/S3	Designing situations that force students to make decisions	0.753	0.492
	C4/S4	Developing logical game-integrated lesson plans	0.561	0.368
B. Organizational & Technological Competencies	C5/S5	Using digital platforms (Quizizz, Kahoot...)	0.679	0.722
	C6/S6	Managing discipline in a dynamic environment	0.521	0.718
	C7/S7	Flexibly handling technical issues	0.654	0.439
	C8/S8	Organizing debriefing discussions after playing	0.819	0.575
C. Assessment Competencies	C9/S9	Developing evaluation criteria (Rubrics)	0.572	0.647
	C10/10	Evaluating collaborative attitudes and soft skills	0.724	0.574
D. Collaboration & Creativity Competencies	C11/S11	Actively adapting pre-existing games	0.721	0.747
	C12/S12	Sharing resources with colleagues	0.702	0.795
	C13/S13	Collaborating to develop game-based learning projects	0.533	0.950
		Overall Cronbach's alpha coefficient	**0.902**	**0.910**

The results indicate that the measurement scale achieved excellent reliability. At the pre-test stage, the overall Alpha coefficient reached 0.902. Post-test, this coefficient continued to increase to 0.910, with all 13/13 observed variables having item-total correlation coefficients ranging from 0.368 to 0.950, far exceeding the standard threshold. Notably, variable C2 (Integrating ESD content into the scenario), despite having a slightly low initial correlation coefficient (0.249), was retained to ensure the continuous content validity of the sustainable development objective. Based on these results, the dataset is completely valid for conducting further in-depth tests.

3.2.2. The Transformation in Teachers' Competencies

Comparing the mean scores of the 13 criteria before and after the training (on a 5-point scale) reveals a breakthrough shift in the teachers' competencies:

Table 2: Descriptive statistics on the change in mean scores of skills Before and After the experiment

Competency Group / Observed variable symbol	Mean (Pre-test)	Mean (Post-test)	Increase
Group A: Pedagogical & Design Competencies	**1.99**	**4.23**	**+2.24**
C1/S1: Defining objectives into game rules	2.35	4.20	+1.85
C2/S2: Integrating ESD content into scenarios	2.00	4.15	+2.15
C3/S3: Designing situations that force students to think	1.90	4.20	+2.30
C4/S4: Planning lessons without "running out of lesson time"	1.70	4.35	+2.65
Group B: Organizational & Technological Competencies	**2.10**	**4.44**	**+2.34**
C5/S5: Using digital platforms (Quizizz, Kahoot...)	2.10	4.25	+2.15
C6/S6: Managing discipline in a dynamic classroom	2.15	4.55	+2.40
C7/S7: Flexibly handling technical issues	1.90	4.45	+2.55
C8/S8: Organizing debriefing discussions after playing	2.25	4.50	+2.25
Group C: Assessment Competencies	**1.93**	**4.25**	**+2.32**
C9/S9: Developing evaluation criteria (Rubrics)	1.75	4.10	+2.35
C10/S10: Evaluating soft skills and collaboration	2.10	4.40	+2.30
Group D: Collaboration & Creativity Competencies	**2.20**	**4.67**	**+2.47**
C11/S11: Adapting pre-existing games to be suitable	2.25	4.45	+2.20
C12/S12: Sharing resources with colleagues	2.20	4.75	+2.55

C13/S13: Collaborating with colleagues to develop projects	2.15	4.80	+2.65
OVERALL MEAN SCORE	**2.06**	**4.40**	**+2.34**

Development of overall competencies: Before the intervention, the teachers' overall mean score reached only 2.06 points (Poor level), clearly reflecting the practical barrier when they lacked design skills. However, after 4 training sessions, this figure surged to 4.40 points (surpassing the Good level, approaching the Excellent level).

Thoroughly resolving time and content barriers (Pedagogical & Design Competency Group): The skill of "Planning lessons without running out of lesson time" (C4) had the most spectacular increase, from 1.70 to 4.35 points. This proves that the strategy of using microgames (5-10 minutes) demonstrated its practical effectiveness. Simultaneously, the skill of integrating ESD elements (C2) also increased strongly from 2.00 to 4.15 points.

Mastering the classroom space (Organizational & Assessment Competency Group): Games only truly deliver educational value when the debriefing phase is well-executed (Bado, 2022). The data shows that the skill of "Organizing debriefing discussions after playing" (C8) increased strongly from 2.25 to 4.50 points, confirming that teachers have mastered the technique of asking questions that connect experiences with environmental realities.

Positive effects from the learning community (Collaboration & Creativity Competency Group): This is the group that achieved the highest score after the experiment (4.67 points). The transition from the performance evaluation observation format to on-the-spot "peer coaching" eliminated psychological barriers, helping skills such as sharing resources (C12) reach 4.75 points and collaborating in project development (C13) reach 4.80 points.

3.2.3. Hypothesis Testing of Program Effectiveness (Paired Samples T-Test)

To confirm that the above score increase is not due to random error, the study conducted a Paired Samples T-Test (at a 95% confidence level) with the following research hypotheses:

Null hypothesis (H0): There is no statistically significant difference in the mean scores evaluating the game usage competencies of teachers at Luong The Vinh Primary School before and after participating in the training program.

Alternative hypothesis (H1): There is a statistically significant difference in the mean scores evaluating the game usage competencies of teachers at Luong The Vinh Primary School after participating in the training program compared to before participation.

Table 3: Paired Samples T-Test results comparing the 4 competency groups Before and After the intervention

Observed Variables (Competency Group)	Time	Mean	Std. Deviation	Mean Diff	t	df	Sig. (2-tailed)
A. Pedagogical & Design Competencies	Pre-test	1.9875	0.440	-2.237	-15.246	19	**0.000**
	Post-test	4.2250	0.420				
B. Organizational & Technological Competencies	Pre-test	2.1000	0.540	-2.337	-15.056	19	**0.000**
	Post-test	4.4375	0.465				
C. Assessment Competencies	Pre-test	1.9250	0.654	-2.325	-11.461	19	**0.000**
	Post-test	4.2500	0.573				
D. Collaboration & Creativity Competencies	Pre-test	2.2000	0.643	-2.466	-14.091	19	**0.000**
	Post-test	4.6667	0.495				
OVERALL COMPETENCY IN USING GAMES	**Pre-test**	**2.0615**	**0.475**	**-2.334**	**-16.051**	**19**	**0.000**
	Post-test	**4.3962**	**0.428**				

The overall test results show that the Sig. (2-tailed) value = 0.000 < 0.05. Therefore, the study has sufficient scientific basis to reject the null hypothesis (H0) (no difference) and accept the alternative hypothesis (H1). The score increase in all 4 core competency groups is statistically significant (Group A: from 1.98 to 4.22; Group B: from 2.10 to 4.43; Group C: from 1.92 to 4.25; Group D: from 2.20 to 4.66).

These quantitative evidences firmly confirm that: The 4-stage intervention procedure based on the principles of "Learning by Design" and "Peer Coaching" has truly resolved pedagogical barriers, directly changed habits, and comprehensively enhanced the teachers' competencies in using games oriented towards ESD.

4. DISCUSSION

The experimental results, with the increase in teachers' overall competency score from 2.06 to 4.40, are not merely statistical numbers. Behind the significance level (Sig. = 0.000) lies a profound transformation in the mindset and pedagogical habits of the teaching staff. The greatest contribution of this research does not lie in introducing a new theory about games, but in the fact that

we have successfully resolved practical limitations right in the classroom through the 4-stage training program. Below are the core values summarized from the experimental process:

4.1. Thoroughly resolving the time barrier through the "Microgame" strategy

In teaching practice, the biggest fear that makes teachers hesitate to use games is the situation of "running out of lesson time," especially when the duration of a primary school lesson is limited to only 35 minutes. Instead of designing large-scale, complex games, this study proposed a breakthrough solution: guiding teachers to manually design Microgames lasting only 5 to 10 minutes. This strategy has proven its outstanding effectiveness as the criterion of "Planning lessons without running out of lesson time" increased from 1.70 to 4.35 points. Microgames are cleverly integrated into the lesson flow as a short challenge segment, helping students both solve learning tasks and receive sustainable development messages without disrupting the lesson's time structure. This is a highly practical contribution, making the game-based learning method feasible and manageable for all teachers.

4.2. Intrinsic Transformation: From "passive users" to "experience creators"

A long-standing reality is that teachers often tend to "download" pre-existing games from the internet and use them in their original forms. This leads to a situation where games are often misaligned with lesson objectives and completely devoid of Education for Sustainable Development (ESD) elements.

Through the "Learning by Design" principle, the study has broken this passive habit. We have helped teachers realize that: games are not merely for entertainment, but a "micro-society," a safe simulation space. Here, by manually customizing the game rules, teachers have cleverly integrated situations that force students to make decisions and trade-offs between personal interests and environmental benefits. The successful transformation of teachers' roles into "experience creators" is the most solid foundation for implementing education for sustainable development at the grassroots level.

4.3. Awakening the true educational value of games through the "Debriefing" skill

Many lessons utilizing games often end with declaring winning and losing teams and awarding prizes. This completely wastes the value of games in education for sustainable development. Our study strongly intervened in the post-game phase by training teachers in the skill of organizing debriefing discussions at 2 levels: from emotions to practical connections.

The breakthrough in the debriefing organization criterion (from 2.25 to 4.50 points) indicates that teachers have mastered the art of asking questions. Instead of asking, "Did you have fun playing?", teachers now know how to ask: "If in real life we also exhausted resources like your group just did in the game, what would the consequences be?". It is exactly these reflective questions that serve as the true key to transforming a superficial fun activity into a profound awareness of community and environmental responsibility for students.

4.4. The power of a psychologically safe environment from the "Peer Coaching" model

An unexpected yet highly humane highlight of the study is that the Collaboration and Creativity competency group achieved the highest score after the experiment (4.67 points). This result affirms the success of changing the observation format.

For a long time, teachers have been very afraid of applying new things (such as technology and digital games) in demonstration lessons out of fear that technical issues would lead to deducted performance evaluation points. By applying the "Peer Coaching" model – meaning core teachers observe lessons solely to assist with computer errors, facilitate the classroom, and absolutely not to grade – we created an absolutely psychologically safe space. When the fear of being evaluated disappeared, teachers not only dared to experiment and make mistakes to correct them, but they also voluntarily contributed numerous dedicated game scenarios to the school's shared resource repository.

In summary, through this study, we affirm that: For education for sustainable development to truly enter the classroom, we do not need distant macro-level theories. What teachers need are easy-to-implement "microgames," a specific instructional procedure, and a professional environment ready to support them.

5. CONCLUSION

Based on the quantitative analysis results and practical implementation, this study affirms that the 4-stage training program "Creator Teachers: Games and Sustainable Development" has brought outstanding effectiveness. The strong transformation in the overall competency score of the teaching staff from 2.06 to 4.40 (with a significance level of Sig. = 0.000) is not merely a positive statistical result, but also a clear testament to the intrinsic transformation in the mindset and pedagogical skills of those directly teaching in the classroom.

Through this study, we have provided practical contributions that directly resolve limitations at the grassroots level:

First, the study has broken the biggest barrier for teachers, which is time pressure and the fear of "running out of lesson time." By providing a solution that guides teachers to manually design microgames lasting only 5 to 10 minutes, we have proven that games can be seamlessly integrated into the main lesson flow without disrupting the lesson's time structure.

Second, the study has created a spectacular role transformation. We have helped teachers abandon the habit of being "passive users" – mechanically downloading pre-existing games from the internet – to become true "experience creators." Teachers now know how

to actively encode messages about environmental protection and social responsibility into game rules, transforming games into a safe simulation space for students to experiment and learn to take responsibility for their decisions.

Third, the study has redefined the true value of games through the art of debriefing. We affirm that games are not used to determine winners and losers, but their greatest educational value lies in the reflective questions after playing. Teachers mastering the facilitation skill, helping students connect their emotions in the virtual space with practical environmental and societal issues, is the key to forging a sustainable development consciousness.

Finally, the vitality of this method is maintained thanks to a safe professional learning community. Our bold transition of the observation format from "evaluating and grading for performance evaluation points" to an on-the-spot "peer coaching" model has completely eliminated teachers' psychological pressure regarding the fear of making mistakes and technological incidents. As a result, a rich digital game resource repository has been voluntarily shared and jointly utilized by the teaching staff.

In summary, the study has filled the gap for a "hands-on" training model right at the general education school, precisely meeting the teaching method innovation requirements of the 2018 General Education Program and the digital transformation trend. For Education for Sustainable Development goals to not merely remain on paper, teachers need to be equipped with easy-to-apply tools, a clear procedure, and a professional community ready to support them. When properly "empowered," each teacher will truly become an experience creator, delivering joyful lessons and nurturing a generation of students responsible for the future.

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