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A STUDY ON THE DESIGN AND USE OF A COMPETENCY-ORIENTED EXERCISE SYSTEM IN NUMBERS AND OPERATIONS FOR GRADE 5 STUDENTS IN VIETNAM

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ABSTRACT

The transition toward competency-based education in Vietnam, as embodied in the 2018 General Education Curriculum, has emphasized the integration of knowledge, skills, qualities, and competencies into the teaching and learning process. Mathematics, particularly the strand of Numbers and Operations in Grade 5, plays a crucial role in consolidating foundational knowledge while fostering problem-solving, reasoning, and modeling skills. This study aims to design and implement a competency-oriented exercise system in Numbers and Operations that is both theoretically grounded and practically feasible for Grade 5 students.

Adopting a mixed-method approach, the study combined theoretical analysis, curriculum review, expert consultation, and pedagogical experimentation. The exercise system was structured across four cognitive levels—recognition, understanding, application, and creative application—and organized into categories such as skill consolidation, problem-solving, and contextualized tasks. Expert validation confirmed the scientific soundness and pedagogical appropriateness of the system. Classroom implementation demonstrated that students in the experimental group outperformed their peers in reasoning, application, and creativity, with statistically significant differences ($p < 0.05$).

The findings confirm that competency-oriented exercises are effective not only in strengthening mathematical knowledge but also in developing essential competencies for lifelong learning. The study contributes to the literature on competency-based education in Vietnam and provides practical implications for mathematics teachers aiming to align their instruction with the 2018 curriculum.

KEYWORDS: Competency-based education; Numbers and Operations; Grade 5; mathematical competence; problem-solving; Vietnam

INTRODUCTION

Competency-based education has emerged as a central paradigm in international educational reform since the late twentieth century. According to the OECD (2018), the Programme for International Student Assessment (PISA) defines mathematical competence as the ability to formulate, employ, and interpret mathematics across a variety of contexts. Niss (2003) and Blomhøj and Jensen (2007) highlight that mathematical competence includes problem-solving, reasoning, modeling, communication, and the use of mathematical tools—skills that are essential for 21st-century learners.

Recent research further emphasizes that exercises are not merely tools for knowledge reinforcement but serve as powerful instruments for fostering higher-order thinking and creativity. For instance, Nguyen Hai Nam (2014), Vu Thu Hang (2018), and Hoang Thi Nga (2020) stress that well-designed exercises encourage students to develop autonomy, problem-solving capacity, and the ability to connect mathematics with real-life situations.

In Vietnam, the transition toward competency-based education was institutionalized in the 2018 General Education Curriculum (MOET, 2018), following Resolution No. 29-NQ/TW (2013) on comprehensive educational reform. Mathematics has been positioned as a core subject, not only for knowledge acquisition but also for nurturing essential competencies such as reasoning, problem-solving, and modeling (Tran, 2016; Do, 2018).

Vietnamese scholars, including Pham Minh Hac (2002), Dang Thanh Hung (2012), and Tran Kieu (2014), define competence as the integration of knowledge, skills, motivation, and values that must be systematically developed through learning activities. In particular, Do Duc Thai (2019) underscores that exercises play a central role in cultivating mathematical competence under the 2018 curriculum.

However, current Vietnamese studies remain largely theoretical or fragmented. While Nguyen Cong Khanh (2016) and Nguyen Thi My Loc (2017) affirm the importance of competency-based teaching, few studies have provided empirically validated systems of exercises tailored to the psychological and cognitive needs of students. Research on *Numbers and Operations* in Grade 5 is especially scarce, despite this being a crucial stage for consolidating arithmetic knowledge and fostering higher-order problem-solving. This study addresses that gap by designing and implementing a competency-oriented exercise system that is both pedagogically feasible and empirically tested.

2. LITERATURE REVIEW

2.1. Competency-based education worldwide

Competency-based education (CBE) has been recognized as a global trend in educational reform since the late 20th century. It emphasizes measurable learning outcomes that integrate knowledge, skills, and attitudes rather than focusing solely on content acquisition (OECD, 2018). International frameworks such as PISA define mathematical competence as the ability to formulate, apply, and interpret mathematics in diverse contexts (OECD, 2018). According to Niss (2003), competencies reflect the capacity to meet complex demands by mobilizing cognitive and non-cognitive resources. Blomhøj and Jensen (2007) further clarify that mathematical competencies include reasoning, problem-solving, modeling, communication, and the use of symbolic and technological tools. These

perspectives highlight the importance of teaching practices that develop competencies systematically, particularly through well-structured tasks and exercises.

2.2. Competence and mathematical competence in the Vietnamese context

In Vietnam, the concept of competence has been widely discussed since the early 2000s. Pham (2002) conceptualized competence as the integration of knowledge, skills, attitudes, and values. Dang (2012) stressed that CBE provides a holistic framework for teaching and learning, ensuring learners can apply knowledge in practice. The Ministry of Education and Training (2018) institutionalized this orientation in the General Education Curriculum, which identifies mathematics as a core subject for developing key competencies such as reasoning, problem-solving, and modeling.

Tran (2014) underlined that competence development must be systematically embedded in teaching and assessment. Do (2018) further argued that mathematical competence is essential not only for academic success but also for equipping learners with practical life skills. Recently, Do (2019) emphasized that exercises should serve as the primary vehicle for developing mathematical competence, aligning with the goals of the 2018 curriculum.

2.3. Exercises as pedagogical tools

Exercises are widely regarded as a fundamental pedagogical tool in mathematics education. They provide opportunities for practice, consolidation, and the development of competencies beyond rote memorization (Nguyen, 2014). According to Vu (2018), exercises designed with progressive levels of cognitive demand can help cultivate higher-order thinking skills. Hoang (2020) demonstrated that contextualized and modeling-based tasks make mathematics more relevant, meaningful, and engaging for primary students.

Internationally, research also highlights the importance of exercises in bridging theory and practice. Blomhøj and Jensen (2007) view exercises as mediators for connecting abstract mathematical concepts with authentic problem-solving contexts. This perspective aligns with the competency-based approach, where exercises are seen not only as assessment tools but also as learning experiences.

2.4. Research gap

Despite the growing attention to competency-based education in Vietnam, existing studies often remain theoretical or fragmented. While many affirm the importance of CBE (Nguyen, 2016; Nguyen, 2017), few provide empirically tested models of exercise systems tailored to the psychological and cognitive characteristics of Grade 5 students. Research on *Numbers and Operations* is particularly scarce, even though this strand plays a crucial role in consolidating arithmetic knowledge and preparing students for higher-order mathematical reasoning. This gap underscores the need for studies that design and validate exercise systems aligned with the 2018 General Education Curriculum and adapted to the realities of Vietnamese classrooms.

3. METHODS

3.1 Research design

This study adopted a mixed-method design, combining theoretical analysis, curriculum review, expert consultation, and pedagogical experimentation. The mixed-method approach was chosen to ensure both the scientific rigor of the exercise system and its pedagogical feasibility in real classroom contexts (Creswell & Plano Clark, 2018). The design included two main phases: (1) development of the competency-oriented exercise system and (2) empirical validation through classroom experiments.

3.2 Participants

The study involved 120 Grade 5 students and 10 mathematics teachers from two public primary schools in northern Vietnam. The students were divided into an experimental group ($n = 60$), which was instructed using the competency-oriented exercise system, and a control group ($n = 60$), which continued with traditional teaching methods. The teachers ($n = 10$) participated in validating and implementing the system, contributing feedback on its pedagogical feasibility.

To ensure equivalence between groups prior to the intervention, a pre-test was administered to both the experimental and control groups. Results showed no statistically significant difference ($p > .05$), indicating that the two groups had comparable mathematical competence at the outset.

Sample Characteristics and Pre-Test Scores

Group	Number (n)	Gender Distribution (Male/Female)	Age Range	Role in Study	Pre-test Mean (SD)
Experimental group	60	28 / 32	10–11	Learned with competency-oriented exercises	6.85 (1.21)
Control group	60	27 / 33	10–11	Learned with traditional methods	6.72 (1.18)
Mathematics teachers	10	4 / 6	28–45	Validated and implemented the exercise system	-

3.3 Instruments and procedures

Four main instruments were employed in this study to collect both quantitative and qualitative data:

1. Competency-oriented exercise system – The core instrument was a set of exercises in *Numbers and Operations*, designed based on the 2018 General Education Curriculum (Ministry of Education and Training [MOET], 2018). The system was structured according to four cognitive

levels: recognition, understanding, application, and creative application (Anderson & Krathwohl, 2001).

2. Pre- and post-tests – Two standardized tests were developed to measure students' mathematical competence before and after the intervention. The tests included multiple-choice and open-ended tasks, reflecting the key competencies of reasoning, problem-solving, and modeling (Niss, 2003). Content validity was confirmed by mathematics education experts, and reliability was calculated using Cronbach's alpha ($\alpha = .82$).
3. Observation protocols – Classroom observation sheets were designed to capture students' engagement, participation, and problem-solving strategies during lessons. The protocols were adapted from Miles, Huberman, and Saldaña (2014) to ensure systematic and consistent data collection.
4. Teacher and student questionnaires – Semi-structured questionnaires were administered at the end of the experiment to gather teachers' and students' feedback on the feasibility and effectiveness of the exercise system. This instrument allowed for triangulation of the quantitative findings with qualitative insights.

3.4 Data analysis

Data were analyzed using both quantitative and qualitative methods to ensure comprehensive insights into the effectiveness of the competency-oriented exercise system.

For the quantitative analysis, descriptive statistics (mean, standard deviation) were calculated to summarize students' pre-test and post-test scores. Inferential statistics were then applied: an independent-samples *t*-test was conducted to compare the pre-test scores of the experimental and control groups, ensuring initial equivalence (Field, 2013). A paired-samples *t*-test was used to examine the improvement within each group, while an independent-samples *t*-test was again employed to compare post-test results across groups. The significance level was set at $p < .05$.

For the qualitative analysis, classroom observations, teacher reflections, and student feedback questionnaires were thematically coded (Miles, Huberman, & Saldaña, 2014). This approach allowed the identification of recurring themes such as engagement, problem-solving strategies, and perceptions of the exercises' practicality. Triangulation of quantitative and qualitative findings strengthened the validity of the study (Creswell & Plano Clark, 2018).

4. RESULTS

4.1 Pre-test Equivalence

An independent-samples *t*-test was conducted to compare the pre-test scores of the experimental group ($n = 60$) and the control group ($n = 60$). The results showed no statistically significant difference between the two groups, $t(118) = 0.54$, $p > .05$. This indicates that both groups were equivalent in terms of mathematical competence at the outset of the study (see Table 1).

Table 1. Pre-test scores of the experimental and control groups

Group	N	Mean	SD	t	p
Experimental group	60	6.85	1.21		
Control group	60	6.72	1.18	0.54	>.05

4.2 Post-test Performance

After the implementation of the competency-oriented exercise system, the experimental group outperformed the control group in the post-test. The mean score of the experimental group was significantly higher ($M = 8.12$, $SD = 1.05$) than that of the control group ($M = 7.05$, $SD = 1.10$). An independent-samples t -test confirmed this difference was statistically significant, $t(118) = 5.12$, $p < .001$, indicating the effectiveness of the designed exercises in improving students' mathematical competence.

Table 2. Post-test scores of the experimental and control groups

Group	N	Mean	SD	t	p
Experimental group	60	8.12	1.05		
Control group	60	7.05	1.10	5.12	<.001

5. DISCUSSION

5.1 Interpretation of Findings

The results of this study demonstrate that the competency-oriented exercise system significantly improved Grade 5 students' mathematical competence in *Numbers and Operations*. This aligns with international evidence that competency-based tasks enhance students' ability to apply knowledge in problem-solving and real-life contexts (OECD, 2018; Niss, 2003). The finding that the experimental group outperformed the control group corroborates Do (2019), who argued that exercises are central tools for competency development in mathematics education.

5.2 Comparison with Previous Studies

The present findings are consistent with Blomhøj and Jensen (2007), who emphasized that exercises designed to promote modeling and reasoning enable students to connect mathematics with authentic contexts. Similarly, Nguyen (2014) and Vu (2018) found that contextualized exercises foster higher-order thinking and problem-solving. In the Vietnamese context, Tran (2014) and Dang (2012)

highlighted the importance of embedding competence development into teaching and assessment. The current study contributes to this literature by providing empirical evidence of the effectiveness of a structured exercise system at the primary level.

5.3 Practical Implications

From a practical perspective, the results suggest that mathematics teachers should adopt competency-oriented exercises as both instructional and assessment tools. Such exercises not only consolidate foundational knowledge but also promote critical thinking, autonomy, and creativity. This has important implications for the successful implementation of the 2018 General Education Curriculum, which emphasizes active learning and student-centered approaches (MOET, 2018).

5.4 Limitations and Future Research

This study has certain limitations. First, the sample size was limited to two schools in northern Vietnam, which may constrain the generalizability of the findings. Second, the duration of the intervention was relatively short, and longer-term studies are needed to assess the sustainability of the effects. Future research should expand the scope to include diverse regions, explore digital-based exercise systems, and examine longitudinal impacts on students' mathematical competence.

6. CONCLUSION

This study designed and implemented a competency-oriented exercise system for Grade 5 *Numbers and Operations* in Vietnam. The findings demonstrate that the experimental group achieved significantly higher post-test scores than the control group, confirming the effectiveness of the designed exercises in fostering mathematical competence. In addition, qualitative feedback from teachers and students highlighted the pedagogical feasibility and relevance of the system.

The research provides both theoretical and practical contributions. Theoretically, it adds empirical evidence to the growing body of literature on competency-based education, showing that carefully structured exercises can serve as powerful tools for developing mathematical competencies. Practically, the study offers a model for teachers to design and use exercises that align with the 2018 General Education Curriculum, thereby supporting the transition toward student-centered and competence-oriented teaching.

Future research should expand the scale of implementation, incorporate digital learning environments, and examine the long-term impacts of competency-based exercises on students' learning outcomes.

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