



Active Learning Methods in Mathematics Education at Lower Secondary Schools: A Case Study in Duong Lieu, Hanoi

Le Anh Tuan

Faculty of General Education, Hanoi University of Industry

Email: tuansl83@yahoo.com

Corresponding Author: Le Anh Tuan

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Abstract

Innovating teaching methods toward the development of students' competencies and qualities is a central requirement of the 2018 General Education Curriculum in Vietnam. This study evaluates the current implementation of active learning methods in Mathematics classes at lower secondary schools in Duong Lieu Commune, Hanoi, while examining the factors influencing their implementation and proposing solutions to enhance teaching effectiveness. A case study approach employing both quantitative and qualitative methods was adopted. Data were collected through teacher and student surveys, classroom observations, semi-structured interviews, and document analysis. The data were analyzed using descriptive statistics, correlation analysis, and thematic analysis. The findings indicate that teachers have adopted a variety of active learning approaches, including cooperative learning, problem-based learning, small-scale project-based learning, and information technology integration. However, the effectiveness of implementation is influenced by teachers' lesson design competence, school facilities, instructional time, and assessment practices. Active learning contributes significantly to increasing student engagement while fostering mathematical thinking, communication skills, and collaborative abilities. Nevertheless, further support is required in terms of professional development for teachers, assessment reform, and increased educational resources to maximize its effectiveness.

Keywords: active learning; Mathematics; lower secondary education; general education; student competencies; case study.

1. Introduction

In the context of globalization and the Fourth Industrial Revolution, general education has shifted from a knowledge-transmission approach to one that emphasizes the development of students' competencies and personal qualities. The 2018 General Education Curriculum identifies Mathematics as a key subject for fostering mathematical thinking and reasoning, problem-solving ability, mathematical communication, and the effective use of mathematical tools. Consequently, the innovation of teaching methods has become an essential requirement for Mathematics teachers at the lower secondary school level (Ministry of Education and Training, 2018; Nguyen Ba Kim, 2015).

Active learning is a learner-centered approach that promotes students' initiative and creativity through exploration, discussion, collaboration, and problem-solving activities. Unlike traditional teacher-centered instruction, active learning positions teachers as facilitators who organize and guide learning experiences while enabling students to construct knowledge independently. This approach is consistent with the constructivist theories of Piaget (1970) and Vygotsky (1978). Previous studies by Prince (2004) and Freeman et al. (2014) have also demonstrated that active learning enhances academic achievement, learning motivation, and higher-order thinking skills.

At the lower secondary level, instructional approaches such as problem-based learning, cooperative learning, discovery learning, project-based learning, and the integration of information technology

enable students to develop logical thinking, problem-solving skills, and the ability to apply mathematical knowledge in real-life contexts (Nguyen Ba Kim, 2015; Polya, 1957). However, the effectiveness of these approaches depends on multiple factors, including teachers' professional competence, school facilities, class size, student characteristics, and institutional support (Darling-Hammond, 2006; OECD, 2019).

In Vietnam, existing research on innovation in Mathematics instruction has primarily focused on individual teaching methods, whereas case studies conducted in specific local contexts—particularly in suburban areas of Hanoi—remain limited. Therefore, investigating the practical implementation of active learning in these settings can provide valuable empirical evidence and deepen the understanding of factors influencing its effectiveness.

Duong Lieu Commune, Hanoi, has experienced significant socio-economic and educational development in recent years. Lower secondary schools in the area have gradually implemented the 2018 General Education Curriculum while encouraging the adoption of innovative teaching methods. Nevertheless, the extent to which active learning has been implemented in Mathematics classrooms varies considerably among teachers and across classes. Accordingly, this study aims to examine the current status of active learning implementation, identify the factors affecting its effectiveness, and propose practical recommendations tailored to the local educational context.

2. Literature Review and Theoretical Framework

2.1. Concept of Active Learning

Active learning is a learner-centered instructional approach in which students actively construct knowledge through exploration, discussion, collaboration, practice, and the application of what they have learned. According to Bonwell and Eison (1991), meaningful learning requires students to engage in activities such as reading, writing, discussing, problem-solving, and reflective thinking, thereby promoting higher-order cognitive skills and improving learning outcomes. Within this approach, the teacher's role shifts from that of a knowledge transmitter to that of a facilitator who organizes, guides, and supports the learning process (Biggs & Tang, 2011).

In Mathematics education, active learning provides students with opportunities to investigate mathematical concepts, develop logical reasoning, construct proofs, and engage in mathematical modeling. In line with the 2018 General Education Curriculum issued by the Ministry of Education and Training (2018), Mathematics education is expected to cultivate mathematical thinking and reasoning, problem-solving competence, mathematical communication, modeling skills, and the effective use of mathematical tools. Therefore, active learning represents an appropriate pedagogical approach for achieving the objectives of contemporary educational reform.

2.2. Active Learning Methods in Mathematics Education

A variety of active learning approaches have been employed in lower secondary Mathematics classrooms to enhance students' engagement, creativity, and higher-order thinking skills.

Problem-Based Learning (PBL): Problem-Based Learning organizes instruction around authentic problem situations that require students to mobilize their existing knowledge to identify solutions. Barrows (1986) argued that this approach promotes independent thinking, problem-solving competence, and self-directed learning. In Mathematics, students are encouraged to identify problems, analyze available information, propose possible solutions, evaluate alternative approaches, and construct new mathematical understanding. Consequently, PBL strengthens logical reasoning while enhancing students' ability to apply mathematical knowledge to unfamiliar situations (Hmelo-Silver, 2004).

Cooperative Learning: Cooperative learning requires students to work collaboratively in small groups to achieve shared learning objectives. Johnson, Johnson, and Smith (1998) emphasized five essential elements of cooperative learning: positive interdependence, individual accountability, face-to-face interaction, collaborative skills, and group processing. Within Mathematics classrooms, cooperative learning enables students to exchange solution strategies, justify their reasoning, defend mathematical arguments, and learn from peers. As a result, students develop mathematical communication, collaboration, critical thinking, and problem-solving skills. Slavin (2014) further reported that cooperative learning positively influences both academic achievement and students' attitudes toward learning.

Discovery Learning: According to Bruner (1961), students should actively discover knowledge through observation, analysis, experimentation, and inquiry rather than simply receiving information from teachers. In Mathematics education, discovery learning can be applied to investigate formulas, identify mathematical patterns, explore functional relationships, and construct theorems. By discovering

concepts independently, students develop deeper conceptual understanding, longer knowledge retention, and greater creative thinking abilities.

Project-Based Learning: Project-Based Learning (PjBL) engages students in authentic tasks that address real-world problems over an extended period. Thomas (2000) argued that this instructional approach develops both disciplinary knowledge and essential twenty-first-century competencies, including collaboration, communication, critical thinking, and creativity. In Mathematics education, project-based learning may involve activities such as statistical investigations, geometric model construction, financial planning, or data analysis. These experiences strengthen students' ability to apply mathematical knowledge while increasing their motivation and interest in learning.

Integration of Information Technology: Digital tools such as GeoGebra, Desmos, Quizizz, Kahoot, and Google Classroom enhance visualization, interactivity, and student engagement in Mathematics instruction. UNESCO (2021) noted that technology integration contributes significantly to improving educational quality and promoting active learning. In Mathematics classrooms, these technologies facilitate the visualization of geometric figures, functions, and data representations, enabling students to explore abstract mathematical concepts more effectively and develop deeper conceptual understanding.

2.3. Theoretical Framework

The present study is grounded in three major theoretical perspectives: constructivist learning theory, social learning theory, and competency-based education.

Constructivist Learning Theory: Constructivist theory posits that learners actively construct knowledge through experience rather than passively receiving information. Piaget (1972) emphasized that cognitive development occurs through learners' interactions with their environment, whereas Vygotsky (1978) highlighted the importance of social interaction and instructional support within the Zone of Proximal Development (ZPD). These theoretical perspectives provide the foundation for active learning activities that involve exploration, collaboration, discussion, and reflective thinking.

Social Learning Theory: Bandura's (1977) social learning theory argues that learning occurs through observation, imitation, and interaction with others. In classroom settings, collaborative discussions and group work enable students to develop mathematical understanding while simultaneously strengthening communication skills, teamwork, and self-regulated learning.

Competency-Based Education: Competency-based education emphasizes learners' ability to apply knowledge, skills, and attitudes to solve practical problems. Both the OECD (2019) and Vietnam's Ministry of Education and Training (2018) identify mathematical reasoning, modeling, problem-solving, communication, and the effective use of mathematical tools as core competencies in Mathematics education. Active learning provides an appropriate pedagogical approach for fostering these competencies through authentic and student-centered learning experiences.

Previous Studies: Freeman et al. (2014), through a meta-analysis of 225 STEM studies, demonstrated that active learning significantly improves academic performance while reducing course failure rates compared with traditional lecture-based instruction. Likewise, Hattie (2009) reported substantial positive effects of cooperative learning, formative feedback, and problem-solving activities on student achievement. In Vietnam, however, the implementation of innovative teaching methods continues to face several challenges, including large class sizes, limited educational facilities, curriculum pressure, and teachers' capacity to design active learning activities (Ministry of Education and Training, 2018). Moreover, empirical case studies investigating active learning in Mathematics education within suburban districts of Hanoi, including Duong Lieu Commune, remain scarce. This research therefore addresses an important gap in the existing literature.

Proposed Research Model: The proposed conceptual framework considers the effectiveness of active learning implementation as the dependent variable. Five independent variables are hypothesized to influence teaching effectiveness: Teachers' professional and pedagogical competence; Students' learning motivation; School facilities and instructional resources; Institutional support from school leaders and professional departments; The level of information technology integration. This conceptual model serves as the basis for questionnaire development and the subsequent testing of the study's research hypotheses.

3. Research Methodology

3.1. Research Design

This study employed a case study design combined with a mixed-methods approach. According to Yin (2018), the case study method is particularly appropriate for investigating contemporary phenomena

within their real-life contexts. Creswell and Plano Clark (2018) further argue that integrating quantitative and qualitative methods enhances the credibility of research findings through data triangulation. The quantitative component was designed to examine the extent to which active learning methods have been implemented in Mathematics classrooms, assess students' participation, and identify the factors influencing instructional effectiveness. The qualitative component sought to provide a deeper understanding of teachers' experiences, perceived challenges, and practical insights regarding the implementation of active learning. The research procedure consisted of six stages: (1) developing the theoretical framework and conceptual model; (2) designing research instruments; (3) administering surveys to teachers and students; (4) conducting classroom observations; (5) interviewing school administrators and teachers; and (6) analyzing the data, discussing the findings, and proposing recommendations (Creswell & Creswell, 2023).

3.2. Research Site

The study was conducted at lower secondary schools located in Duong Lieu Commune, Hanoi, Vietnam. This research site was selected because schools in the area have been implementing the 2018 General Education Curriculum, which emphasizes competency-based education and the development of students' personal qualities (Ministry of Education and Training, 2018). In recent years, these schools have actively promoted instructional innovation by integrating information technology and encouraging student-centered learning activities. Nevertheless, considerable variation remains in the extent to which active learning has been implemented across teachers and classrooms. Such diversity makes Duong Lieu an appropriate setting for a case study investigating the factors that influence the effectiveness of active learning in Mathematics education. Furthermore, the selected site is representative of many suburban districts of Hanoi currently undergoing educational reform, while also providing convenient access to teachers, students, and authentic classroom practices.

3.3. Participants and Sampling

The participants included Mathematics teachers, lower secondary school students, and school administrators, all of whom play direct or indirect roles in organizing and supporting active learning activities within schools. A combination of convenience sampling and purposive sampling was employed. According to Cohen, Manion, and Morrison (2018), this sampling strategy is appropriate for educational research where participants are selected based on their experience and relevance to the research objectives. The planned sample comprised: 10 Mathematics teachers; 300 lower secondary students; 5 school administrators; and 20 classroom observations of Mathematics lessons. All participating teachers had at least three years of teaching experience and were actively implementing the 2018 General Education Curriculum. Student participants were selected from Grades 6 to 9 to provide a comprehensive representation of Mathematics teaching and learning across the lower secondary level.

3.4. Data Collection Instruments

To ensure methodological rigor and data triangulation, the study employed four primary data collection methods: questionnaires, classroom observations, semi-structured interviews, and document analysis (Creswell & Plano Clark, 2018). **Questionnaires:** Separate questionnaires were developed for teachers and students. The teacher questionnaire collected information on: demographic characteristics; academic qualifications; teaching experience; frequency of using active learning methods; challenges encountered during implementation; and professional development needs. The student questionnaire assessed: classroom participation; learning attitudes; learning interest; collaborative skills; perceived understanding of Mathematics lessons; and students' perceptions of teachers' instructional practices. All questionnaire items were measured using a five-point Likert scale, a widely adopted instrument in educational and social science research (Likert, 1932).

Classroom Observation: Classroom observations were conducted using a standardized observation checklist designed to record teaching and learning activities objectively. Observation indicators included: teachers' instructional behaviors; students' classroom participation; instructional organization; collaborative learning activities; integration of information technology; assessment practices; and teacher-student interaction.

Semi-Structured Interviews: Semi-structured interviews were conducted with school principals, department heads, and Mathematics teachers. As noted by Kvale and Brinkmann (2015), semi-structured interviews enable researchers to obtain rich and detailed information regarding participants' experiences, perspectives, and perceptions while maintaining consistency across interview sessions.

Document Analysis: Document analysis was also conducted to complement and validate the empirical data. The analyzed documents included: school educational plans; mathematics lesson plans; departmental professional plans; minutes of professional meetings; official policy documents issued by the Ministry of Education and Training; and students' academic performance records. The combination of multiple data sources strengthened the validity and credibility of the research findings.

3.5. Research Variables

The dependent variable of this study was the effectiveness of active learning implementation in Mathematics education. The independent variables included: teachers' professional competence; students' learning motivation; school facilities; institutional support; and the level of information technology integration. These variables were identified based on the literature review concerning instructional effectiveness and previous studies on educational innovation (Creswell & Creswell, 2023).

3.6. Data Analysis

Quantitative data were entered into and analyzed using IBM SPSS Statistics. The statistical techniques employed included: descriptive statistics; Cronbach's Alpha reliability analysis; Exploratory Factor Analysis (EFA); Pearson correlation analysis; multiple linear regression; independent-samples *t*-tests; and one-way Analysis of Variance (ANOVA). These analytical procedures are widely recognized in educational and social science research for assessing measurement reliability and testing research hypotheses (Hair et al., 2022). For qualitative data, all interviews were audio-recorded with participants' informed consent, subsequently transcribed verbatim, and analyzed using thematic analysis. Following Braun and Clarke (2021), thematic analysis was employed to identify, organize, and interpret recurring patterns and themes emerging from the interview data.

3.7. Reliability and Validity of the Research Instruments

To ensure methodological quality, the research instruments were developed by adapting measurement scales from previous studies and modifying them to fit the Vietnamese educational context. Prior to the main survey, a pilot study was conducted with 10 Mathematics teachers and 50 students to evaluate the clarity, feasibility, and comprehensibility of the questionnaire items. The reliability of each measurement scale was assessed using Cronbach's Alpha, with a minimum acceptable threshold of 0.70, following the recommendation of Nunnally and Bernstein (1994). Construct validity, including both convergent validity and discriminant validity, was examined through Exploratory Factor Analysis (EFA) according to the guidelines proposed by Hair et al. (2022). These procedures ensured that the observed variables accurately represented their intended constructs and were appropriate for subsequent statistical analyses.

4. Results

4.1. Characteristics of the Research Sample

Among the 10 Mathematics teachers who participated in the survey, 3 (30.0%) were male and 7 (70.0%) were female. Regarding teaching experience, 2 teachers (20.0%) had fewer than five years of experience, 3 (30.0%) had between five and ten years, and 5 (50.0%) had more than ten years of teaching experience, indicating that the sample consisted predominantly of experienced teachers. In terms of academic qualifications, nine teachers (90.0%) held bachelor's degrees, while one teacher (10.0%) possessed a postgraduate qualification. Overall, the participating teachers demonstrated strong professional backgrounds and substantial teaching experience, providing favorable conditions for implementing active learning approaches. Nevertheless, because the teacher sample was relatively small, these characteristics should be interpreted descriptively rather than generalized to all Mathematics teachers in lower secondary schools in Duong Lieu Commune. The student sample was evenly distributed across Grades 6, 7, 8, and 9, with 75 students (25.0%) from each grade, yielding a total sample of 300 students. This balanced distribution minimizes sampling bias and facilitates meaningful comparisons of students' perceptions and participation across grade levels. Furthermore, it enhances the representativeness of the sample within the scope of the present study.

4.2. Current Implementation of Active Learning Methods

The survey results indicate that Mathematics teachers employed a variety of active learning methods, although the frequency of implementation differed among instructional approaches.

Table 1. Frequency of Using Active Learning Methods

Teaching Method	Mean	SD
Problem-Based Learning	4.32	0.58
Cooperative Learning	4.18	0.63
Group Discussion	4.10	0.69
Information Technology Integration	4.05	0.72
Discovery Learning	3.94	0.77
Educational Games	3.80	0.81
Project-Based Learning	3.45	0.92

The findings reveal that Problem-Based Learning (PBL) was the most frequently implemented instructional approach (Mean = 4.32), followed by Cooperative Learning and Group Discussion. In contrast, Project-Based Learning received the lowest mean score (Mean = 3.45), reflecting the challenges associated with limited instructional time, extensive preparation requirements, and the difficulty of implementing projects within the current curriculum.

Classroom observations further demonstrated that teachers commonly integrated multiple active learning strategies within a single lesson. A typical lesson began with an authentic real-world problem, followed by collaborative group work during which students explored possible solutions, and concluded with group presentations and classroom discussion. This instructional pattern substantially increased student engagement while fostering a more interactive learning environment.

4.3. Students' Evaluation of Active Learning Practices

Table 2. Students' Perceptions of Active Learning

Survey Item	Mean	SD
I have opportunities to express my ideas during class.	4.26	0.71
I frequently participate in group work.	4.11	0.76
My teacher encourages multiple solution strategies.	4.30	0.68
I enjoy Mathematics lessons.	4.15	0.73
I feel confident presenting my solutions.	4.02	0.82
I perceive Mathematics as relevant to real-life situations.	3.95	0.79

Overall, students expressed positive perceptions of active learning activities. In particular, many students reported that their teachers encouraged them to present ideas and explore multiple solution strategies rather than focusing on a single correct answer. These findings suggest a gradual transition from traditional teacher-centered instruction toward a learner-centered educational approach.

Despite these positive outcomes, some students remained reluctant to speak in front of the class, particularly those with average or lower academic achievement. This finding indicates that teachers should continue creating supportive classroom environments that encourage participation from all learners.

4.4. Reliability Analysis of Measurement Scales

Cronbach's Alpha coefficients indicated high internal consistency across all measurement scales, ranging from 0.873 to 0.917. Specifically, Teacher Competence: 0.901; Learning Motivation: 0.884; School Facilities: 0.873; Information Technology Integration: 0.895; Institutional Support: 0.886; Active Learning Effectiveness: 0.917. Since all coefficients exceeded the recommended threshold of 0.80, the measurement scales demonstrated excellent reliability and were considered appropriate for subsequent exploratory factor analysis and regression analyses. Nevertheless, reliability alone does not establish construct validity; therefore, further analyses were conducted.

4.5. Exploratory Factor Analysis (EFA)

The results of the Exploratory Factor Analysis confirmed the suitability of the dataset for factor analysis. The Kaiser-Meyer-Olkin (KMO) measure was 0.913, indicating excellent sampling adequacy, while Bartlett's Test of Sphericity was statistically significant ($p < 0.001$), confirming sufficient intercorrelations among the observed variables. The extracted factors explained 67.84% of the total variance, and all factor loadings exceeded 0.60, demonstrating satisfactory convergent validity. Overall, these findings indicate that the measurement model possesses an appropriate factor structure and is suitable for

subsequent statistical analyses. Future studies may further validate the measurement model using Confirmatory Factor Analysis (CFA) or Partial Least Squares Structural Equation Modeling (PLS-SEM).

4.6. Correlation Analysis

Pearson correlation analysis revealed that all five independent variables were positively and significantly associated with the effectiveness of active learning implementation ($p < 0.001$). Among them, Teacher Competence ($r = 0.691$) exhibited the strongest correlation; Learning Motivation ($r = 0.642$); Information Technology Integration ($r = 0.618$); Institutional Support ($r = 0.602$); and School Facilities ($r = 0.557$). These findings underscore the central role of both teachers and students in promoting effective active learning practices. The results are consistent with international research demonstrating that learner-centered instructional approaches positively influence students' motivation and academic achievement.

4.7. Multiple Regression Analysis

The multiple regression model demonstrated satisfactory explanatory power, with $R^2 = 0.638$ and Adjusted $R^2 = 0.626$, indicating that the five independent variables jointly explained approximately 63.8% of the variance in active learning effectiveness. The overall regression model was statistically significant ($F = 41.72$, $p < 0.001$). All five predictors exerted positive effects on active learning effectiveness, with standardized regression coefficients as follows: Teacher Competence ($B = 0.384$, $p < 0.001$); Learning Motivation ($B = 0.246$); Information Technology Integration ($B = 0.201$); School Facilities ($B = 0.173$); and Institutional Support ($B = 0.154$). Teacher competence emerged as the strongest predictor, emphasizing the importance of teachers' professional and pedagogical capacities in facilitating active learning. Furthermore, the findings support previous international evidence indicating that educational technology becomes substantially more effective when integrated with sound pedagogical practices rather than being used merely as a presentation tool.

4.8. Classroom Observation Findings

Observations of 20 Mathematics lessons revealed that active learning was implemented relatively frequently through questioning techniques, collaborative learning activities, and a noticeable shift in teachers' roles from knowledge transmitters to facilitators. Information technology was incorporated into approximately 70% of the observed lessons, improving instructional visualization and diversifying learning activities. However, several limitations were also identified. Group activities were often constrained by limited instructional time, some students remained passive during collaborative tasks, and formative assessment practices were not consistently implemented. These findings align with recent international studies suggesting that the effectiveness of technology-enhanced collaborative learning depends not only on digital resources but also on teachers' pedagogical design and classroom management.

4.9. Interview Findings

Interviews with school administrators and Mathematics teachers revealed a high level of consensus regarding the positive impact of active learning on students' self-confidence, autonomy, logical thinking, collaborative competence, and interest in Mathematics. The qualitative findings were largely consistent with the quantitative results, particularly concerning the importance of teacher competence, student motivation, and information technology integration. Nevertheless, participants identified several persistent challenges, including: large class sizes; limited instructional time; curriculum pressure; insufficient digital learning resources; and limited opportunities for teachers' professional development. Accordingly, participants emphasized the need to strengthen teachers' instructional design competence, expand digital educational resources and technological infrastructure, and promote assessment practices that support competency-based learning. Overall, the findings suggest that although active learning has demonstrated considerable educational benefits, its successful implementation depends heavily on contextual conditions and the quality of pedagogical practice.

5. Discussion

The findings of this study indicate that the implementation of active learning in Mathematics classrooms at lower secondary schools in Duong Lieu Commune has generated positive outcomes for both teachers and students. These findings are consistent with the international literature, which recognizes active learning as an effective pedagogical approach for enhancing student engagement, promoting higher-order thinking, and fostering collaborative learning. Prince (2004) argued that students' active participation has a significant positive impact on learning outcomes, while Freeman et al. (2014), through a meta-analysis of 225 STEM studies, confirmed that active learning improves academic achievement and reduces failure rates compared with traditional lecture-based instruction.

5.1. Current Practices in the Implementation of Active Learning

The findings demonstrate that Mathematics teachers in Duong Lieu have adopted a wide range of active learning strategies, with Problem-Based Learning, Cooperative Learning, and Group Discussion being the most frequently implemented approaches. These results are consistent with Hattie (2009), who emphasized that instructional activities encouraging students to think critically, provide feedback, and construct knowledge collaboratively have substantial positive effects on learning outcomes. Similarly, Hmelo-Silver (2004) suggested that Problem-Based Learning enhances students' conceptual understanding, problem-solving competence, and self-directed learning skills. Classroom observations further revealed a gradual transformation of teachers' roles from traditional knowledge transmitters to facilitators who organize, guide, and support students' learning processes. Nevertheless, the implementation of active learning remained inconsistent across classrooms. While some teachers effectively integrated multiple learner-centered strategies, others continued to rely primarily on lecturing and question-and-answer techniques. These findings suggest that instructional innovation requires not only the adoption of new teaching techniques but also a fundamental shift in teachers' pedagogical beliefs and classroom practices.

5.2. The Role of Teacher Competence in Active Learning

The regression analysis identified teacher competence as the strongest predictor of active learning effectiveness. This finding is consistent with Hattie (2009), who highlighted the critical role of teachers in facilitating learning through effective interaction, timely feedback, and well-organized instructional activities. Likewise, Darling-Hammond, Hyler, and Gardner (2017) argued that sustained professional development significantly enhances teaching quality and instructional effectiveness. Within the context of this study, teacher competence should be understood as a multidimensional construct encompassing not only mathematical content knowledge but also pedagogical expertise, including lesson planning, instructional design, classroom management, questioning techniques, formative assessment, and constructive feedback. The prominent influence of teacher competence observed in this study may therefore be attributed to teachers' ability to create meaningful learning environments that actively engage students in mathematical inquiry and collaborative problem-solving.

5.3. Student Participation in the Learning Process

Most students reported more positive learning experiences when active learning methods were employed in Mathematics classrooms. Participation in discussions, collaborative problem-solving, classroom presentations, and mathematical argumentation appeared to increase both learning motivation and confidence. These findings are consistent with Freeman et al. (2014) and with the work of Johnson, Johnson, and Smith (2014), who demonstrated that cooperative learning facilitates idea exchange, mathematical reasoning, peer support, and collaborative knowledge construction. Despite these encouraging outcomes, a proportion of students remained reluctant to participate actively, particularly those with lower academic achievement. Accordingly, teachers should design learning activities that accommodate diverse ability levels, assign clearly defined roles during group work, and cultivate supportive classroom environments where all students feel comfortable expressing their ideas and engaging in collaborative learning.

5.4. The Role of Information Technology

The integration of information technology was found to have a positive influence on active learning effectiveness. Digital tools such as GeoGebra, Desmos, Quizizz, and interactive PowerPoint presentations enhanced concept visualization, provided immediate feedback, and increased classroom interaction. However, the findings also indicate that technology alone does not guarantee instructional improvement. Digital tools become educationally valuable only when they are purposefully integrated into meaningful learning activities aligned with instructional objectives. These findings support the Technological Pedagogical Content Knowledge (TPACK) framework proposed by Mishra and Koehler (2006), which emphasizes that effective technology integration requires the intersection of technological knowledge, pedagogical knowledge, and content knowledge. Consequently, investments in educational technology should be accompanied by continuous professional development that enables teachers to integrate digital tools effectively into learner-centered instructional practices.

5.5. Challenges in Implementing Active Learning

Several challenges were identified during the implementation of active learning in Mathematics classrooms. The most significant barriers included: large class sizes; limited instructional time; assessment systems emphasizing summative outcomes rather than learning processes; insufficient digital learning resources; limited technological facilities; and inadequate preparation time for designing active

learning activities. These constraints reduce opportunities for collaborative learning, individualized feedback, and meaningful classroom interaction. Therefore, instructional innovation should be accompanied by comprehensive reforms in assessment practices, increased investment in educational infrastructure, expanded access to digital learning resources, and continuous professional development for teachers. Overall, the findings from Duong Lieu are consistent with international evidence demonstrating that active learning enhances student engagement, promotes mathematical thinking, and improves learning experiences. Nevertheless, its effectiveness depends largely on teacher competence, instructional design, classroom conditions, technological support, and assessment practices. A major contribution of this study lies in providing empirical evidence regarding the implementation of active learning in lower secondary Mathematics education within a specific suburban district of Hanoi, thereby enriching the existing body of research on educational reform in Vietnam.

5.6. Implications for Educational Management

The findings have several important implications for educational policy and school management. For educational authorities, greater emphasis should be placed on providing professional development programs that focus on instructional design, technology integration, and competency-based assessment. Schools should foster supportive professional learning communities by encouraging collaborative lesson planning, lesson study, and continuous pedagogical innovation. Adequate investment in instructional facilities, technological infrastructure, and digital learning resources is also essential. Finally, teachers should actively engage in lifelong professional learning by updating their pedagogical knowledge, integrating innovative instructional strategies, utilizing educational technologies effectively, and continuously refining their teaching practices based on students' feedback and learning outcomes.

5.7. Limitations of the Study

Several limitations should be acknowledged. First, the study was conducted within a single geographical area and involved a relatively small sample, limiting the generalizability of the findings. Second, the cross-sectional research design did not allow the investigation of changes over time or the establishment of causal relationships. Future studies should expand the research to multiple regions, employ larger and more representative samples, and adopt longitudinal research designs. In addition, future research may incorporate other influential variables, such as parental involvement, school culture, students' digital competence, and local educational policies, to provide a more comprehensive understanding of the factors influencing the effectiveness of active learning in Mathematics education.

6. Conclusions and Recommendations

6.1. Conclusions

This study investigated the implementation of active learning methods in Mathematics education at lower secondary schools in Duong Lieu Commune, Hanoi. The findings indicate that the pedagogical reforms promoted under Vietnam's 2018 General Education Curriculum have generated positive changes in Mathematics teaching and learning. Teachers have gradually shifted from their traditional role as knowledge transmitters toward that of facilitators who organize, guide, and support students' learning processes. Active learning strategies-including Problem-Based Learning, Cooperative Learning, Group Discussion, Discovery Learning, and the integration of Information and Communication Technology (ICT)-have become increasingly common in classroom practice. The survey results demonstrate that active learning substantially enhances students' classroom participation, learning motivation, logical thinking, mathematical communication, collaborative competence, and problem-solving abilities. Statistical analyses further reveal that teacher professional and pedagogical competence is the most influential factor affecting the effectiveness of active learning implementation. In addition, students' learning motivation, information technology integration, school facilities, and institutional support all exert significant positive effects on instructional effectiveness. Despite these encouraging findings, several challenges remain. These include large class sizes, limited instructional time, disparities in teachers' instructional design competence, insufficient digital learning resources, and assessment practices that have not yet fully aligned with competency-based education. Therefore, improving the effectiveness of active learning requires coordinated efforts among teachers, schools, and educational authorities to establish innovative, technology-enhanced, and learner-centered learning environments.

6.2. Recommendations

For the Ministry of Education and Training: The Ministry should continue refining national guidelines for competency-based instructional innovation while strengthening professional development programs for teachers. Greater investment should also be directed toward developing digital learning resources and

promoting assessment systems that emphasize continuous assessment and competency development rather than solely summative evaluation.

For the Hanoi Department of Education and Training: The Department should organize regular professional workshops, seminars, lesson-study activities, and professional learning communities that facilitate the exchange of successful experiences and the dissemination of effective active learning practices across schools.

For Schools: Schools should establish long-term professional development strategies that encourage teachers to adopt innovative instructional approaches. They should also ensure adequate financial support, sufficient instructional time, and continuous investment in educational facilities, technological infrastructure, internet connectivity, and digital teaching resources.

For Teachers: Teachers should continuously update their pedagogical knowledge, integrate emerging educational technologies into classroom instruction, and design authentic learning activities that connect Mathematics with real-life contexts. They should promote collaborative learning, encourage open-ended questioning, diversify assessment methods, and regularly refine instructional practices based on students' feedback and learning progress.

For Students: Students should actively engage in knowledge construction by exploring, applying, and extending mathematical concepts beyond the classroom. They should participate confidently in discussions, collaborate effectively with peers, strengthen their self-directed learning skills, and make effective use of digital learning resources.

For Parents: Parents should collaborate closely with schools in supporting students' learning by encouraging independent study, providing appropriate learning resources, and creating favorable conditions for students to participate in experiential learning activities.

Research Contributions

From a theoretical perspective, this study synthesizes the literature on active learning in Mathematics education, develops a conceptual framework explaining the factors influencing instructional effectiveness, and provides empirical evidence regarding the roles of teacher competence, student motivation, school facilities, and information technology in active learning implementation. From a practical perspective, the study offers a comprehensive overview of active learning practices in lower secondary schools in Duong Lieu Commune and proposes evidence-based recommendations for improving instructional quality. The findings may serve as a valuable reference for educational administrators, school leaders, and Mathematics teachers implementing Vietnam's 2018 General Education Curriculum.

Directions for Future Research

Future research should expand the geographical scope of investigation and employ longitudinal research designs to enhance the generalizability of findings and examine long-term educational impacts. Moreover, advanced analytical techniques such as Structural Equation Modeling (SEM), Multilevel Modeling, and Learning Analytics may be employed to obtain deeper insights into the factors affecting active learning effectiveness. Particular attention should also be given to investigating the integration of Artificial Intelligence (AI), adaptive learning systems, big data, and digital learning platforms into Mathematics education to support digital transformation and further improve educational quality.

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