

Research Article

Factors affecting the effectiveness of math teachers' integrated teaching in secondary schools: The case of Vietnam

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Vietnam is in the innovation process of its curriculum, contents, and teaching methods, in which integrated teaching is focused on implementation at all levels of education. Therefore, it is necessary to study the factors affecting the effectiveness of subject teaching. This study aims to determine the main factors affecting the integrated teaching effectiveness of secondary school math teachers. Simultaneously, it proposes some solutions to improve math teaching quality. SPSS 26.0 software was used to support data analysis from a survey of 508 math teachers at 314 secondary schools in Vietnam. The results of seven analyzed variables show a strong correlation between them. Of the seven variables, six affect teachers' effectiveness of integrated teaching in secondary school math. The most influential factor is the teacher's perception of integrated teaching, followed by objectives and contents of secondary school math; salary, bonus, and remuneration policies for teachers; teaching environment; exploitation of learning materials and use of technology; and facilities. The study also shows that seniority, educational qualifications, and teaching locations do not significantly affect the effectiveness of integrated teaching. However, there is a difference between teachers and school administrators in the effectiveness of integrated teaching. The new findings of this study are useful references for math teachers and administrators in improving the quality of integrated teaching in secondary schools, teacher training institutions in developing training programs and learning outcomes, and policymakers in developing strategies to promote teaching effectiveness in secondary schools.

Keywords: Factors; Integrated teaching; Math teachers; Vietnam secondary schools

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1. Introduction

The socio-economic development of the country requires increasingly high-quality human resources with creative working capacity, problem-solving ability, and practical situations that require the mobilization and comprehensive application of knowledge and skills acquired from different fields (Thai & Dat, 2016). Therefore, there should be a harmonious integration of knowledge areas in teaching subjects in general schools to provide students with truly meaningful practical experiences, help them understand problems more deeply, recognize the connections

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between what is learned, and contribute to developing their capacities.

Mathematics education in general schools aims to help students understand the role of mathematics in real life, develop the ability to express ideas accurately, apply mathematical concepts and skills in daily life, and utilize them for work and development in modern society. Therefore, mathematical knowledge and skills need to be connected and integrated while simultaneously incorporating, integrating, and complementing various subjects and knowledge domains to ensure that students not only acquire mathematical knowledge and skills but also can apply and practice them in life, developing individuals with general mathematical competency and practical capabilities (Ministry of Education and Training [MoET], 2018a). Furthermore, the ability to establish mathematical connections can enhance learning motivation and positively improve problem-solving skills (Karakoç & Alacacı, 2015). Consequently, integrated teaching in mathematics is considered a mandatory requirement in general mathematics instruction. However, many teachers still struggle to implement effective teaching practices. Therefore, research investigating the factors that influence the effectiveness of integrated teaching among secondary school mathematics teachers is necessary to enhance and promote the quality of mathematics instruction promptly.

Until now, different factors affecting teachers' integrated teaching effectiveness have been considered and studied in several different aspects. According to Gueldenzoph et al. (1999), seniority affects the effectiveness of integrated teaching. Depending on the difficulty levels of lessons, new teachers make decisions based on their knowledge and experience (Tatto et al., 2017). This ability is somewhat low in the early years of teaching, and it may increase over the years as teachers become more confident in their teaching (Munby et al., 2001). However, Ismail et al. (2015) argue that besides seniority, gender, educational background, and field of study, their teaching contexts, teaching activities, and strategies also influence the effectiveness of math teaching. Larson (2002) finds that effective math teachers have something in common, whether they orient toward students' discovery or how to guide learning. After studying a series of factors affecting effective math teaching and learning strategies in upper secondary classes, Ingvarson et al. (2004) find that there are four main affecting factors, including knowledge, beliefs, understanding, and practice of math teachers; qualifications, professional development, and relevant personal experience. Wardat et al. (2022) suggest that some other factors affecting effective math teaching are school environment, math teachers' perception, support conditions for teachers, teachers' professional development experiences, and teachers' beliefs and understanding. Besides, Chu et al. (2015) and Hanushek (2011) emphasize that teacher quality is important in improving student achievement. High-quality teachers help students progress three times higher, so the relevant and immediate concern is to pay more attention to teacher training and professional development (Tashtoush et al., 2022). The research teams of Viet and Thao (2017) and Pham et al. (2023) affirm that facilities; salary, bonus, and remuneration; objectives and contents of subjects; students' attitudes and learning capacities affect teaching effectiveness; integrated teaching capacities of high school math teachers and university lecturers. However, these studies have not clarified the factors affecting the effectiveness of integrated teaching in secondary school math. Therefore, this study aims to identify the main factors affecting integrated teaching in secondary school math and propose some measures to determine which specific skills math teachers need to develop further in effective integrated teaching. Then, teachers can use them as a consideration for the implementation of planned improvement programs (Wawan & Retnawati, 2022). The results also serve as inputs for administrators to determine what training courses or workshops teachers need to attend to enhance the most important aspect of math teaching and learning in an effective, integrated way. Secondary school math teachers are also able to reflect on their own need for improvement in teaching strategies and the needs of their schools to address that issue and respond to the challenges of 21st-century education. In addition, the study's results also contribute to improving educational policies and practices to enhance the effectiveness of

integrated teaching in secondary schools. Hence, this study focuses on answering the following two main questions:

RQ 1) What are the main factors affecting the effectiveness of integrated teaching of secondary school math teachers?

RQ 2) What solutions can improve the effectiveness of integrated teaching in secondary school math in Vietnam?

2. Literature Review

2.1. Theoretical and Conceptual Framework

2.1.1. Concept of integrated teaching

In 1968, the first international conference on science teaching, which was held in Varna, Bulgaria, focused on integration in science (Arcà & Vicentini-Missoni, 1981). The conference addressed the ideas of science integration. After that, Brown (1977) shows that integrated teaching can be described as follows: (1) the unity of all knowledge; (2) the conceptual unity of the sciences; (3) the unified process of scientific inquiry; and (4) the interdisciplinary study of teaching. It can be understood that integrated teaching is a teaching orientation that helps students develop their ability to mobilize and synthesize knowledge, skills, etc., from many fields to solve problems in learning and life effectively, carried out right in the process of acquiring knowledge and practicing skills (MoET, 2018a). Integrated teaching aims to form and develop learners' necessary capacities, especially the ability to apply knowledge to solve situations effectively arising from practice (Pham et al., 2023).

2.1.2. Concept of integrated teaching

In Vietnam, integration in teaching in general schools appeared quite early; however, in the past, it was not understood thoroughly and uniformly, but it was considered as the connection, contact, and interweaving of related issues together at that time (Son, 2017). Then, the integration issue was researched in the late 1980s of the 20th-century. From around 2000, integration was initially been implemented at different levels in general schools. To meet the requirements of fundamental and comprehensive innovation in Vietnamese education, the Ministry of Education and Training has implemented a fundamentally innovative general education program. This program includes deep integration in secondary schools, increased integration of subjects, creating more opportunities to choose learning content, turning the teaching and learning process into a self-learning process with optimal guidance and support from teachers in general schools, and enhancing the social activities of learners.

Math education in secondary schools aims to contribute to the formation and development of key qualities, general abilities, and mathematical abilities for students. It helps develop key knowledge and skills and creates opportunities for students to experience and apply mathematics in practice or create connections between mathematical ideas, math and practice, math and other subjects, and math and other educational activities (MoET, 2018b). Mathematics in Vietnamese secondary schools has many opportunities to be integrated in the following ways: intra-subject integration (or vertical integration), interdisciplinary and cross-subject integration (or horizontal integration), and integration by and through learning (Quang et al., 2018). Integrated teaching is effective when teachers organize and guide learners to mobilize and synthesize knowledge and skills from many fields to solve well-learning tasks or situations arising from practice and life. Thus, integrated teaching will create favorable conditions for learners to maximize their potential and help them succeed as future family heads, citizens, and workers.

2.2. Overview of Factors Affecting the Effectiveness of Integrated Teaching in Secondary School

Until now, there have been many studies on the effects of math education, especially for elementary or high school students. These studies have examined the effects of many goals and attempted to explain math performance based on many factors. Fer and Cırık (2006) finds that

teachers try to improve students' understanding and thinking skills by accumulating professional experience and contributing to students' success by providing feedback on learning problems. Cheung (2006) suggests that as teachers' experience increases, their level of professional self-efficacy also increases. Tschannen-Moran and Hoy (2001) also assert that experienced teachers are more professionally successful. Furthermore, there is evidence of a strong association between teachers' specialized content knowledge for teaching and their educational beliefs about teaching and their instructional planning, decision-making, and practices (Hill et al., 2012; Lester, 2007). However, if the key elements of training are not sufficient to make them competent, they cannot handle the changes that may occur (Demirel & Kaya, 2002). Low-quality teachers will affect many aspects, including students' achievements and learning process, because they play an important role in regulating the learning environment to help students be proactive in learning activities (McKnight et al., 2016). Furthermore, teaching practices also directly impact student learning outcomes naturally, and obviously, teacher qualifications are directly related to student learning outcomes (Aaronson et al., 2007).

Educational change depends on what teachers think and do (Fullan, 2007). They can use different teaching methods and techniques and manage the classroom more successfully (Tschannen-Moran & Hoy, 2001). Teaching experience also strongly influences their perception (Jimoyiannis & Komis, 2007). In addition, studies by Wardat et al. (2022) and Pham et al. (2023) also suggest that math teachers' perceptions affect classroom teaching and learning. Therefore, in our opinion, *the perception of secondary school math teachers affects the effectiveness of integrated teaching* (H₁).

The main goal of the current mathematics curriculum at the secondary level is to promote student-centered learning (MoET, 2018b). However, some researchers find that other factors, like instructional content, also need to be considered. Fouze and Amit (2017) show that a mathematics curriculum that integrates cultural and folk elements and values from daily life and society can enhance students' initiative in math learning and build mathematical competencies for students in the 21st-century (Gravemeijer et al., 2017). This means that *the objectives and contents of secondary school math can affect teachers' teaching effectiveness* (H₂).

The study by David (2016) shows that teachers significantly impact the quality of students' learning in approaching topics. The impacts are shown through students' attitudes and learning behaviors in absorbing knowledge learned in class (Maulana et al., 2013). On the other hand, students' skills and capacities positively influence learners' behavior - students who are diligent, proactive, and spend a lot of time studying will have higher learning outcomes than students who do not actively study (Dullas, 2018). Teachers' teaching skills also greatly impact and influence students' learning behavior through classroom lectures (Michalsky & Schechter, 2013). As another aspect, Fukumura et al. (2013) find that gender is an important factor that directly affects students' learning behavior. Therefore, *student characteristics can affect the effectiveness of integrated teaching of secondary school math teachers* (H₃).

Many researchers around the world have studied how satisfaction affects work performance (Luddy, 2005). Ellickson and Logsdon (2002) state that job satisfaction is the extent to which employees like their jobs. More simply, the more the work environment meets employees' needs, values, and personalities, the higher the level of job satisfaction is. Moreover, to create a good education system, there must be cooperation and mutual support between principals, teachers, and students (Ramdani et al., 2019). Thus, the teaching environment, including the relationships between teachers and students and between teachers and school leaders, can influence *the integrated teaching effectiveness of secondary school math teachers* (H₄).

The current education system cannot avoid integrating technology into the learning environment (Monaghan, 2004). Current technology has changed teaching and learning methods due to its constant advancements (Azizi et al., 2022). National Council of Teachers of Mathematics [NCTM] emphasizes that using technology in mathematics lessons is necessary and that technology must be adapted to the teaching-learning process (2000). In a smart classroom

environment, students' experiences with information technology and their preferences for interaction can positively influence their computational thinking skills. Daily Internet use positively affects students' creativity (Wu et al., 2017). It is further revealed that increased Internet use will ultimately improve computational thinking skills (Durak & Saritepeci, 2018). Furthermore, Ćurčić et al. (2018) suggest that with available software integrating mathematics with natural teaching knowledge, students can achieve excellent learning quality and grasp knowledge more fully. From the above results, the study assumes that *the exploitation of learning materials and the use of technology can affect the integrated teaching effectiveness of secondary school math teachers* (H₅).

Ellickson and Logsdon (2002) show that job satisfaction is the level of contentment that employees feel about their jobs, and then they are willing to strive their best to make their jobs better and better. Therefore, schools need to have appropriate policies to serve and meet both the material and spiritual needs of the teaching staff; they need to pay careful attention and encourage the working spirit of all teachers so that teachers will feel secure in their work, have time to invest in professional development, have plans and implement effective teaching (Viet & Thao, 2017). In addition, the research results of Pham et al. (2023) and Nguyen (2009) point out that salary, bonus, and remuneration policies for teachers have an impact on the integrated teaching effectiveness of high school math teachers and university lecturers. Thus, it is shown that *salary, bonus, and remuneration policies for math teachers affect the integrated teaching effectiveness of secondary school math teachers* (H₆).

Many researchers state that student learning is influenced by learning environment factors such as curriculum, teacher support, teaching facilities, etc. Dogan (2012) observes that students in active learning environments tend to have different opinions from those of students who are not exposed to such environments. Schools' physical facilities, equipment, and libraries are also important factors that promote students' learning behavior. When the facilities are guaranteed and meet the needs of learners, it will create interest and encourage better learning processes (Pham et al., 2023). As a result, *facilities and teaching equipment can affect the effectiveness of integrated teaching in secondary school math* (H₇).

3. Method

3.1. Research Design

Quantitative research methods are often used in large-scale survey studies (Bryman, 2016; Cohen et al., 2018), and the collected data is analyzed using statistical tools to test hypotheses and draw accurate and reliable conclusions (Johnson & Christensen, 2019). This method is also used when research focuses on examining causal relationships and measuring the effects of specific factors in the educational environment (Cohen et al., 2018; Creswell, 2014). Therefore, in the current research design, quantitative research methods were used to survey 508 mathematics teachers at 314 secondary schools, and SPSS 26.0 statistical software was used to analyze the collected data through regression analysis, correlation, and ANOVA testing. The research design of the study aims to detect factors affecting the integrated teaching effectiveness of secondary school math teachers and propose some measures to promote the effectiveness of integrated teaching in secondary school math.

3.2. Sample and Data Collection

Data was collected from January 24, 2024, to March 22, 2024. The online survey is an appropriate data collection method (Wright, 2006) for teachers participating in the survey in different regions of Vietnam. We conducted the online survey by sending questionnaires via Google Forms to some math teachers' forums and some secondary schools in Vietnam. The respondents were all math teachers in secondary schools. We received 545 responses from math teachers in 314 secondary schools, of which 508 were valid. The other 37 responses were discarded due to missing or inappropriate information. Other information collected for research purposes will be presented in the following sections.

Table 1 shows the characteristics of the survey samples: 508 teachers currently teaching at secondary schools participated in answering the questionnaire. Most of them were female teachers (80.5%) compared to 19.5% of male ones. Of these, 14.4% were teachers working in difficult areas, and 15.2% were teachers in management positions. For professional qualifications, the majority of teachers participating in the study had a university degree (90.9%) compared to 9.1% of them with a postgraduate degree. For working experience, 40.6% had less than 3 years, 12.4% had 3 to 5 years, 10.6% had 5 to 10 years, and 36.4% had over 10 years. Most teachers were in charge of 1 (40.4%) to 2 classes (36%); about 11% of teachers were in charge of 3 classes (10.8%) and 4 classes (12.8%).

Table 1
Characteristics of research sample (N=508)

| <i>Characteristics</i> | <i>Quantity</i> | <i>Ratio %</i> |
|-------------------------------|-----------------|----------------|
| Gender | | |
| Male | 99 | 19.5 |
| Female | 409 | 80.5 |
| Difficult location | | |
| No | 435 | 85.6 |
| Yes | 73 | 14.4 |
| Qualification | | |
| Bachelor | 462 | 90.9 |
| Postgraduate | 46 | 9.1 |
| Being a manager | | |
| No | 431 | 84.8 |
| Yes | 77 | 15.2 |
| Seniority | | |
| < 3 years | 206 | 40.6 |
| 3 - 5 years | 63 | 12.4 |
| 6 - 10 years | 54 | 10.6 |
| > 10 years | 185 | 36.4 |
| Number of grades being taught | | |
| 1 grade | 205 | 40.4 |
| 2 grades | 183 | 36.0 |
| 3 grades | 55 | 10.8 |
| 4 grades | 65 | 12.8 |

The survey consists of two parts. Part one aims to collect personal information, such as gender, work location, management position, training level, and working experience. Part two includes questions to collect teachers' self-assessment opinions on the effectiveness of integrated teaching and seven factors affecting its efficacy.

The teachers self-assessed the effectiveness of integrated teaching through seven questions. The scale used a 5-level Likert scale (1 = Very poor to 5 = Good). The higher the average score on the scale, the better the effectiveness of integrated teaching. The reliability of this scale has a Cronbach's Alpha coefficient of 0.961 (Table 2). We measured seven factors affecting the effectiveness of integrated teaching of secondary school math teachers: Teachers' perception of integrated teaching; Objectives and contents of secondary school math; Facilities; Teaching environment; Salary, bonus, and remuneration policies for teachers; Student characteristics; Exploitation of learning materials and use of technology through a 5-level Likert scale (1 = Not affected at all to 5 = Completely affected). All scales have good reliability with Cronbach's Alpha coefficient ($\alpha > 0.9$) (Table 2), which proves that the seven scales are suitable for data analysis, and the items in the structure have the same scope and meaning (Cronbach, 1971; Taber, 2018).

Table 2
Reliability and characteristics of the scales

| Scales | Cronbach's alpha reliability | n | AS | SD |
|--|---------------------------------|---|------|------|
| Self-assessment of integrated teaching effectiveness | 0.961 | 7 | 3.92 | 0.67 |
| Teachers' perception of integrated teaching | 0.956 | 8 | 3.77 | 0.72 |
| Objectives and contents of secondary school math | 0.914 | 4 | 4.02 | 0.72 |
| Facilities | 0.914 | 4 | 3.92 | 0.70 |
| Teaching environment | 0.902 | 5 | 4.07 | 0.67 |
| Salary, bonus, and remuneration policies for teachers | 0.920 | 7 | 3.97 | 0.71 |
| Student characteristics | 0.925 | 4 | 4.06 | 0.71 |
| Exploitation of learning materials and use of technology | 0.927 | 3 | 4.11 | 0.75 |

Note. n: Number of questions; AS: Average score; & SD: Standard deviation.

3.3. Data Analysis

Data was collected after the survey was cleaned and analyzed using SPSS 26.0 software, a T-test, an independent sample test, and a one-way ANOVA. The results were analyzed descriptively according to the mean score of quantitative variables, frequency, and percentage of qualitative variables. Next, correlation and regression analysis were performed to examine the relationship and level of influence of independent variables: Teachers' perception of integrated teaching; Objectives and contents of secondary school math; Facilities; Teaching environment; Salary, bonus, and remuneration policies for teachers; Student characteristics; Exploitation of learning materials and use of technology on the dependent variable "Effectiveness of integrated teaching in mathematics of secondary school teachers." The coefficient β (Beta) was calculated with a significance level of less than .05.

4. Results

4.1. Factors Affecting the Effectiveness of Integrated Teaching of Secondary School Math Teachers

The self-assessment results of integrated teaching effectiveness of secondary school math teachers are presented in Table 3.

Table 3
Secondary School Math Teachers Self-assess the Effectiveness of Integrated Teaching

| Characteristics | Mean | p |
|-----------------------------------|--------------|-------|
| Gender ^(a) | Male | .747 |
| | Female | |
| Difficult location ^(a) | No | .464 |
| | Yes | |
| Qualification ^(a) | Bachelor | .135 |
| | Postgraduate | |
| Being a manager ^(a) | No | <.001 |
| | Yes | |
| Seniority ^(b) | < 3 years | .146 |
| | 3 - 5 years | |
| | 6 - 10 years | |
| | > 10 years | |
| Teaching grade ^(b) | grade 6 | .734 |
| | grade 7 | |
| | grade 8 | |
| | grade 9 | |

Note. (a): Using t-test; (b): Using One way ANOVA test.

The results of Table 3 show that managers (from the deputy head of a professional group and above) have higher integrated teaching effectiveness than teachers who do not do management tasks. On the other hand, the factors of gender, professional level, working area, and seniority of teachers have little effect on the integrated teaching effectiveness of secondary school math.

4.2. Factors affecting the effectiveness of integrated teaching of secondary school math teachers

Of the abovementioned seven factors that may influence the teaching effectiveness of secondary school math teachers, none of them should be considered in isolation, as their influence may become significant when mediated by other factors (Ifinedo et al., 2020). Therefore, it is necessary to consider the correlation between them.

Table 4

Correlation between integrated teaching effectiveness of secondary school math teachers and influencing factors^(a) (N = 508)

| Factors | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|--|--------|--------|--------|--------|--------|--------|--------|-----|
| (1) The effectiveness of integrated teaching | 1 | | | | | | | |
| (2) Teacher's perception of integrated teaching (X ₁) | .611** | 1 | | | | | | |
| (3) Objectives and contents of secondary school math (X ₂) | .579** | .623** | 1 | | | | | |
| (4) Student characteristics (X ₃) | .480** | .410** | .596** | 1 | | | | |
| (5) Teaching environment (X ₄) | .562** | .416** | .594** | .687** | 1 | | | |
| (6) Exploitation of learning materials and use of technology (X ₅) | .572** | .430** | .615** | .645** | .682** | 1 | | |
| (7) Facilities (X ₆) | .502** | .399** | .476** | .614** | .669** | .640** | 1 | |
| (8) Salary, bonus, and remuneration policies for teachers (X ₇) | .535** | .443** | .527** | .537** | .621** | .589** | .522** | 1 |

Note. (**): Significance level $p < .01$; (a): Spearman's correlation coefficient.

The results of the correlation analysis in Table 4 show that seven factors are included in the analysis model. All influencing factors have a positive correlation from medium to strong (Field, 2009) with the effectiveness of integrated teaching with its significance level of $p < .01$. Moreover, these influencing factors also have a positive correlation from medium to strong with each other, which proves that the data and figures collected are suitable for the survey model.

Table 5

Table of model analysis results

| Model | R | R ² | Adjusted R ² | Standard error of estimates | Durbin-Watson |
|-------|------|----------------|-------------------------|-----------------------------|---------------|
| 1 | .703 | .495 | .488 | 0.482 | 1.896 |

Note. Dependent variable Y: Effectiveness of integrated teaching; Predictive factors: X₁, X₂, X₃, X₄, X₅, X₆, X₇.

The analysis results in Table 5 show that the adjusted R^2 value (Adjusted R Square) accurately reflects the model's suitability for the whole. The adjusted R^2 value of .488 (or 48.8%) is significant for the linear regression model between the integrated teaching effectiveness of secondary school math teachers and the seven factors affecting it. In particular, the above results explain 48.8% of the change in variable Y due to independent variables, and the remaining 52.2% of the variation is due to other variables. However, the results also show that the independent variables all positively influence the integrated teaching effectiveness of secondary school math teachers, with a reliability of 99%.

Table 6
ANOVA^a

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|-------|------------|----------------|-----|-------------|--------|--------------------|
| 1 | Regression | 113.877 | 7 | 16.268 | 69.897 | <.001 ^b |
| | Residual | 116.373 | 500 | 0.233 | | |
| | Total | 230.249 | 507 | | | |

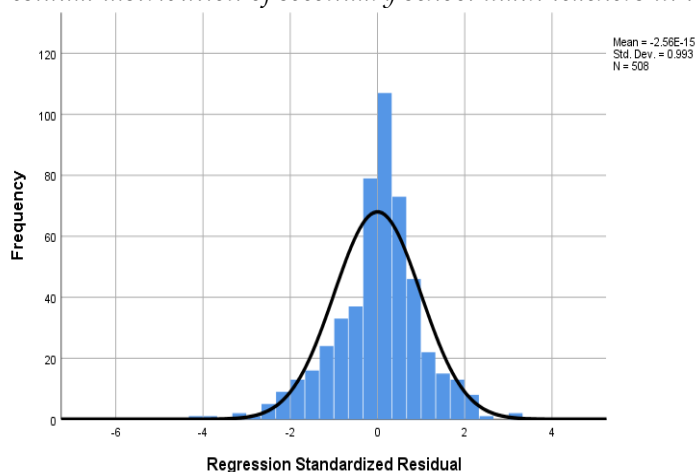
Note. ^a: Dependent Variable: Effectiveness of integrated teaching; ^b: Predictors: (Constant), X₁, X₂, X₃, X₄, X₅, X₆, X₇.

Particularly, Table 6 also shows the results of the F test to evaluate hypotheses about the appropriateness of the regression model. In Table 6, the sig value of the F test is less than .01, therefore, the multiple regression model satisfies the conditions for evaluating and testing the appropriateness of the research results.

Moreover, the distribution of variables in the observed sample follows a normal distribution, ensuring sufficient conditions for conducting regression analysis between independent variables affecting the integrated teaching effectiveness of secondary school math teachers and the dependent variable of integrated teaching effectiveness of teachers (Chart 1 aims to assess the suitability of the analyzed regression model).

Figure 1

Residual distribution of secondary school math teachers in the research sample



To accurately conclude the influence level of factors on the effectiveness of integrated teaching of secondary school math teachers, the research team conducted a regression analysis with the dependent variable Y - integrated teaching effectiveness and the independent variables X₁, X₂, X₃, X₄, X₅, X₆, X₇. The values of the factors used for analysis are the sum of the observed variables that have been tested. Regression analysis was performed using the overall regression method of variables with SPSS version 26.0 software. The testing results of the regression model between factors affecting teaching effectiveness are shown in Table 7 and Figure 2.

Table 7
Summary of the multivariate regression model ^b(coefficients)

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Tolerance | VIF |
|---------------------------|-----------------------------|------------|---------------------------|--------|-------|-----------|-------|
| | B | Std. Error | Beta | | | | |
| 1 (Constant) ^a | 0.637 | 0.154 | | 4.135 | <.001 | | |
| X ₁ | 0.244 | 0.041 | 0.259 | 5.987 | <.001 | 0.539 | 1.855 |
| X ₂ | 0.172 | 0.048 | 0.184 | 3.565 | <.001 | 0.379 | 2.640 |
| X ₃ | -0.021 | 0.047 | -0.022 | -0.442 | .669 | 0.418 | 2.390 |
| X ₄ | 0.124 | 0.056 | 0.123 | 2.195 | .029 | 0.322 | 3.107 |
| X ₅ | 0.094 | 0.046 | 0.105 | 2.055 | .040 | 0.391 | 2.560 |
| X ₆ | 0.090 | 0.045 | 0.093 | 1.983 | .048 | 0.457 | 2.190 |
| X ₇ | 0.130 | 0.044 | 0.137 | 2.961 | .003 | 0.471 | 2.123 |

Note. ^a: Predictors: X₁; X₂; X₃; X₄; X₅; X₆; X₇; ^b: Dependent variable; Y - Integrated teaching effectiveness of secondary school math teachers

Table 7 shows that the variables X₁, X₂, X₃, X₄, X₅, X₆, X₇ all meet the acceptance criteria (Tolerance > 0.2) (Weisburd & Britt, 2014). Furthermore, the t-test results evaluate the hypothesis of the significance of the regression coefficients and the coefficients of the independent variables in the model with VIF < 4, which proves that the model does not violate the multicollinearity assumption (Hair et al., 2013). The standard regression values of the independent variables in the model are statistically significant. Specifically, there are six closely influencing factors: X₁, X₂, X₄, X₅, X₆, and X₇, and the remaining factor of X₃ has almost no influence on the dependent variable in the regression model ($p > .05$). With six influencing factors, the standardized Beta coefficients in the order of secondary school math teachers' perception of integrated teaching ($\beta = 0.259$ with $p < .01$); Objectives and contents of secondary school math ($\beta = 0.184$ with $p < .01$); Salary, bonus, and remuneration policies for teachers ($\beta = 0.137$ with $p < .05$); Teaching environment ($\beta = 0.123$ with $p < .05$); Exploitation of learning materials and use of technology ($\beta = 0.105$ with $p < .05$) and Facilities ($\beta = 0.093$ with $p < .05$).

Analysis results of regression model:

$$Y = 0.259X_1 + 0.184X_2 + 0.123X_4 + 0.105X_5 + 0.093X_6 + 0.137X_7$$

From the above analysis, it is concluded that the theoretical model is consistent with the research data. Figure 2 summarizes six out of seven factors that affect the effectiveness of integrated teaching of secondary school math teachers.

Figure 2

Regression analysis results on Integrated teaching effectiveness of secondary school math teachers

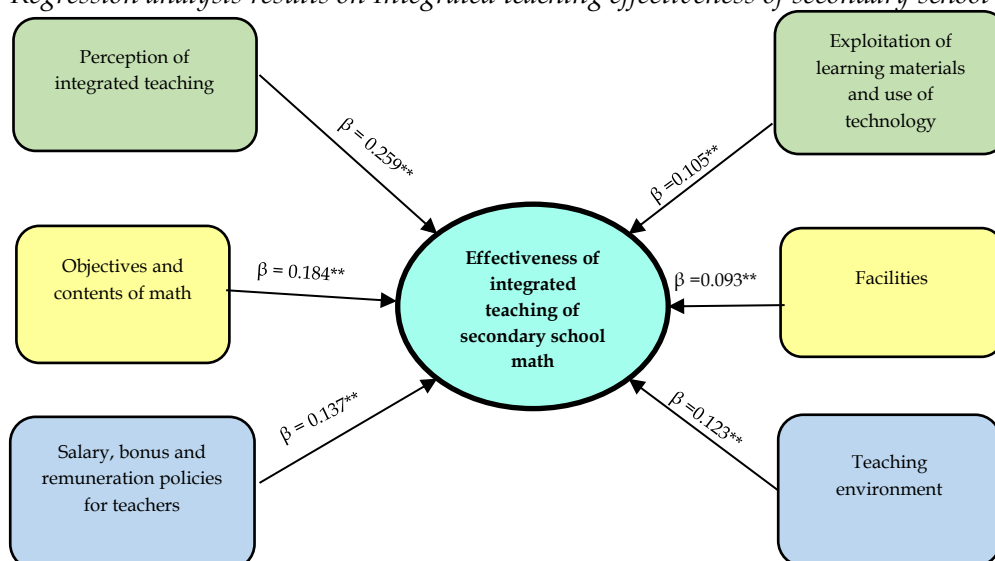


Figure 2 shows the importance of the factors depending on the regression coefficient's absolute value. The factors with the larger absolute value have more influence on the results of integrated teaching. Therefore, it can be affirmed that the effectiveness of integrated teaching by secondary school math teachers is most influenced by the factor of perception of integrated teaching ($\beta = 0.259$). The second is objectives and contents of secondary school math ($\beta = 0.184$); the third is teacher salary, bonus, and remuneration policies ($\beta = 0.137$).

Finally, the analysis results with seven independent variables and one dependent variable show that six independent variables affect the effectiveness of integrated teaching of secondary school math teachers. When these factors increase, the effectiveness of integrated teaching increases. Compared with the research hypothesis given in section 2.2 above, we see that H_1 , H_2 , H_4 , H_5 , H_6 , and H_7 are accepted (but H_3 is not accepted). This means that teacher training and development institutions, policy agencies, and management agencies need to make efforts to improve the accepted factors to improve the integrated teaching effectiveness of secondary school math teachers.

5. Discussion

The research results show that the perception of integrated teaching of secondary school math teachers has the greatest influence on the effectiveness of integrated teaching ($\beta = 0.259$). This result is consistent with the results of previous studies (Pham et al., 2023; Wardat et al., 2022). Once the problem is perceived, the viewpoints and implementation methods are deeply understood, and teachers have the basis to be confident and proactive in implementing effective teaching (Hanh et al., 2023). It is possible to organize training courses, short-term training, etc. to help them change their thinking and teaching views in line with the general spirit of integration in teaching mathematics in secondary schools. With successful experience, their integrated teaching capacity is increased, which positively and significantly impacts teachers' teaching performance. Teachers' competence will affect classroom management and teaching methods (Ramdani et al., 2019). In particular, teachers with a good perception of integrated teaching are often highly educated. They can use different teaching methods and manage the classroom more successfully.

This study finds that the objectives and contents of math have an influence on the effectiveness of integrated teaching of secondary school math teachers, which is consistent with the practice of general education in Vietnam. One of the objectives of the secondary school math program is forming and developing key mathematical knowledge and skills, the ability to solve problems with interdisciplinary and cross-disciplinary integration between math and other subjects, creating opportunities for students to experience and apply mathematics to real life; Helping students have enough minimum capacity to explore issues related to mathematics throughout their lives independently (MoET, 2018b). Therefore, the correct determination of the objectives of math education is a contribution to the innovation of the current general education program in Vietnam (Thai & Dat, 2016). Moreover, the above results are consistent with the views of many scientists, Bao (2016) and Tra (2015), when discussing the effectiveness of integrated teaching in secondary schools.

This study also finds that the teaching environment affects the integrated teaching effectiveness of secondary school math teachers. This result is suitable for the findings of the research team Ismail et al. (2018), who suggest that students under the instruction of ineffective teachers will not make adequate academic progress. Confident teachers create a comfortable atmosphere for students and maintain interaction and contact with students, which can increase student engagement in learning (Durksen et al., 2017). Teachers' teaching qualities, such as classroom management and cognitive activation, also affect students' motivation to learn (Burić & Kim, 2020). Creating a favorable learning environment plays an important role in shaping the quality of math learning outcomes. The teaching environment, including the interaction between teachers and schools, has a positive relationship with student learning outcomes (Kamaruddin et al., 2009). In particular, principal leadership, organizational culture, and teacher capacity positively and

significantly influence teacher performance. In addition, colleagues also have a significant impact on teachers' teaching effectiveness. Therefore, building and maintaining good relationships with colleagues will help teachers and colleagues progress in their work (Viet & Thao, 2017).

The study also points out that salary, bonus, and remuneration policies for math teachers affect the integrated teaching effectiveness of secondary school math teachers. This result is considered to be consistent with the results of many previous studies (Pham et al., 2023; Viet & Thao, 2017). Policies and support from the management agency affect teachers' ability to integrate with teaching. These policies have provided teachers with regulations, instructions, support, and encouragement to implement integration in their lectures. In addition, training courses, teaching resources, teaching aids, and materials will motivate the spirit, create confidence and motivation, and help teachers to organize integrated teaching effectively. In addition, salaries, bonuses and allowances, income factors that meet the needs of life, diverse welfare policies, and thoughtful care for teachers affect teaching effectiveness (Viet & Thao, 2017). Simultaneously, financial resources need to be allocated reasonably and used effectively to improve the lives of civil servants gradually. These are considered welfare policies, health and safety policies, and services to serve and meet the teaching staff's material and spiritual needs. Then, teachers can be completely assured in their work, love their profession, and promote effective professional activities.

The study concludes that the exploitation of learning materials and the use of technology affect the integrated teaching effectiveness of secondary school math teachers. This result is considered to be consistent with previous research results (Baki, 2006; Hollebrands, 2007). In a technology-equipped teaching environment, learning becomes easier, and shortcomings are eliminated through feedback. Students have a chance to enhance their individual and active learning, creativity, and equality of opportunity and develop their self-determination (Woolfolk & Margetts, 2012). Moreover, students participating in a learning environment supported by information technology will contribute to the design of effective educational programs (Shroff et al., 2019). However, some studies disagree with our results, for example, Ertmer's (2005) studies reveal that teachers report negative beliefs and attitudes towards technology because they previously could not absorb technology and mathematics education, so they are not ready to use technology. On the other hand, teachers state that it is challenging and laborious for them to apply and use technology in classes, which can cause an excessive workload for them (Karagiorgi & Charalambous, 2004). Therefore, some teachers are resistant to educational innovation and resist changes. Teachers show that they feel reluctant to use technology in their classrooms because it may waste time and reduce the effectiveness of courses. Thus, to overcome this problem, teachers need support in preparing exercises and designing activities and have instructions on how to use technology effectively, which may require support from teachers of information technology. In addition to the use of information technology, the exploitation of learning materials also affects the effectiveness of integrated teaching. Adequate training courses for teachers to use teaching resources effectively must also be provided (Ucang, 2018).

Our study also shows that facilities and equipment for teaching in general schools affect the integrated teaching effectiveness of secondary school math teachers, which is considered to be in line with the study of Okafor et al. (2016) that the characteristics of school facilities are also one of the issues which significantly affect students' mathematics learning. Students' performance will be improved by providing a favorable learning environment consistent with the focus on classroom facilities. They also reveal that good indoor air quality, comfortable visibility, and adequate learning space are basic factors that can affect students' learning outcomes. However, facilities can harm the teaching-learning process, which can lead to absenteeism and poor teaching (Uline & Tschannen-Moran, 2008). Only when facilities are guaranteed and meet learners' needs will it create interest and encourage better learning. Then, it will increase the effectiveness of subject teaching, including integrated teaching in mathematics.

In addition to the above results in the regression model, from the results of Table 3, the study discovers a very interesting point: teachers with a major in math who work as managers have

higher integrated teaching effectiveness in secondary school math than teachers who only work as teachers. This is also suitable for the reality in secondary schools of Vietnam. Specifically, the managers (9.1%) in our survey include teachers at the position of deputy head of a professional group or higher with a major in math. They participate in educational activities with math groups. They always self-study and self-improve to upgrade their professional and managerial capacity and have a standard qualification of a teacher at their teaching levels according to the provisions of the law on education. They have taught for at least 05 years at that level. This means they have good professional and pedagogical capacity in math and can organize effective cooperative teaching.

Based on this study's results and main findings, we propose some measures to increase the effectiveness of integrated teaching of secondary school math.

Measure 1. Raising math teachers' perception of integrated teaching of secondary school math

To change teachers' teaching, we must first help them change their perceptions, thoughts, and perspectives. When their perception changes, teachers will inevitably teach proactively and creatively. Educational managers can gradually raise teachers' perception of integration in math teaching through (Hanh et al., 2023): (1) providing documents, materials, etc., at home and abroad on integrated teaching in subjects; (2) fostering knowledge about integrated teaching of secondary school math, creating conditions for teachers to participate in training courses on how to organize integrated teaching. Experts and researchers with an in-depth understanding of integrated teaching should be invited to schools to talk and share about implementation methods through specific, typical examples in teaching secondary school math. (3) Organizing lesson design competitions and teaching lessons in an integrated way of math teaching. Competition and rewards are always a way for teachers to demonstrate their professional capacity through their products.

Measure 2. Guiding math teachers on how to integrate teaching secondary school math

Teachers are people who do the teaching, so they need to focus highly on their teaching objectives in the classroom (Hiebert & Morris, 2012). To get effective integrated teaching, teachers should connect individual knowledge of secondary school math with several other subjects in a unified whole. On that basis, students form a complete perception of the objective world (Hanh et al., 2023). Teachers can also combine some necessary content in some ways to form and develop learners' capacity by integrating additional necessary content into the inherent contents of secondary school math.

Measure 3. Creating a positive environment in integrated teaching of secondary school math to increase students' learning effectiveness

Muhonen et al. (2018) suggest that highly effective teachers will promote student achievement. Teachers can promote positive engagement in integrated learning environments by maintaining high-quality instruction through the use of student-centered approaches, ensuring teacher-student interaction and student engagement in integrated lessons, effectively using ICT in teaching and learning, using innovative, differentiated and appropriate teaching techniques that align with the integrated learning strategies of the subject; maintaining classroom management; ensuring appropriate assessment and monitoring student progress; providing up-to-date and high-quality subject content materials; and maintaining discipline throughout the organization of integrated learning. Math teachers should also adapt their teaching practices to create an interactive atmosphere that is conducive to learning mathematics and can improve student engagement and performance in the classroom (Mamolo & Sugano, 2020). Students then perform and achieve maximum learning outcomes when exposed to a positive learning environment.

Measure 4. Creating teachers' confidence when applying technology in integrated teaching of secondary school math

Some previous studies show that teachers are unable to use technology in their courses because they feel incompetent and do not have enough information about technology (Çakır & Yıldırım, 2009). Some other teachers say that they have negative beliefs and attitudes towards technology because they were not able to absorb information technology and mathematics education before, so they are not ready to use information technology. In this case, to effectively implement the application of technology in integrated teaching, first of all, teachers should be informed of the utmost important technology and its very important pedagogical function. Then, it is suggested that it is essential for math teachers to collaborate with computer teachers in schools. This cooperation helps math teachers increase their understanding and gain more skills in applying information technology in integrated teaching, then helping to organize effective teaching. Finally, the need for training programs to improve teachers' technology skills is very important for successful integration (Hamdi & Yunus, 2017).

Measure 5. Developing salary, bonus, and material remuneration policies to create good conditions for teachers to improve their expertise and increase the effectiveness of integrated teaching in secondary schools

The success of teachers' performance can be determined by the level or intervention of school leadership, which is certainly mediated by variables such as self-efficacy, commitment, and job satisfaction (Joo, 2020). To facilitate professional development and improve the effectiveness of integrated teaching, appropriate policies, bonuses, and material benefits must be strategically implemented. These measures can create an environment conducive to continuous learning and improvement among educators. They ultimately benefit student outcomes. At the same time, to facilitate teachers' professional development, programs must be relevant, long-term, and actively engage teachers in their learning process. In addition, financial incentives should be provided for teachers to participate in professional development then they can promote teachers' participation and commitment to improving their teaching practices (Nasution et al., 2024).

Measure 6. Preparing appropriate facilities and equipment for organizing integrated teaching in secondary school math

To effectively organize integrated math teaching at the secondary school level, appropriate facilities and equipment are essential. These resources not only enhance the learning experience but also facilitate interdisciplinary connections, which are important for developing students' mathematical understanding. In particular, essential technologies are needed in integrated teaching so that these tools enable effective presentations and collaborative learning, which significantly motivate students and improve their mathematics achievement (Hamdi & Yunus, 2017). Classrooms must create spaces that promote interdisciplinary teaching, allowing connections between mathematics and other subjects such as computer science, biology, and physics (Murzabaev et al., 2024). The library must have diverse instructional materials to support integrated learning approaches to promote students' comprehensive understanding.

6. Conclusion

Based on the verified theoretical model, the factors affecting the effectiveness of integrated teaching in secondary school math have achieved reliability and acceptable value. This study has identified six factors affecting the effectiveness of integrated teaching of math teachers and proposed six measures to contribute to improving the effectiveness of integrated teaching of secondary school math. Of the seven factors included in the survey, the results show that six factors affect the effectiveness of integrated teaching of secondary school math teachers in order from most to least: Perception of secondary school math teachers about integrated teaching; Objectives and contents of secondary school math; Salary, bonus and remuneration policies for teachers; Teaching environment; Exploitation of teaching materials and use of technology in

teaching; Facilities and teaching equipment. The factor of Characteristics of students has little influence on the effectiveness of integrated teaching of secondary school math teachers. Accordingly, it is necessary to pay attention to policymakers and managers in secondary schools about the importance of sending math teachers to training courses, short-term refresher courses, and workshops to train them on how to use integrated teaching strategies and programs, which contributes to raising their awareness. Moreover, this is also considered a good treatment for them. Besides, the teaching environment affects the effectiveness of integrated teaching, so teachers need to adjust their teaching, ensure the interaction between teachers and students, and the participation of students in integrated lessons, especially the use of creative teaching techniques suitable for integrated teaching strategies. Besides, there needs to be a positive connection between colleagues and the attention and orientation of the school board to create a favorable teaching environment. The use of information technology in teaching is inevitable today; however, many teachers are not ready to use it. Hence, it is possible to organize training courses on the application of information technology in teaching. Further, there needs to be a connection between math teachers and computer science teachers to improve the current situation of secondary school math teachers. Finally, school facilities and equipment should be concerned in the direction of enhancing the effectiveness of integrated teaching in general and integration in teaching secondary school math in particular.

Our study also reveals that teachers who work in management positions have higher teaching effectiveness than teachers who only teach mathematics. Besides, teachers' qualifications, work location, gender, and seniority have almost no effect on the effectiveness of integrated teaching in secondary school math. Teachers who work in management positions are often of good expertise and qualities and meet the criteria prescribed by the Vietnamese education law. They always improve their expertise, skills, and study to improve their qualifications, contributing to improving the quality of education. Therefore, it is necessary to take measures to develop expertise and improve teachers' educational levels. They can have effective impacts on students' learning, thereby educating students to develop comprehensively in terms of qualities and abilities and contributing to training high-quality human resources for society to adapt to the fluctuations of the socio-economic environment.

7. Limitations and Recommendations

With only 508 math teachers in 314 secondary schools, the current study's survey sample did not represent all teachers in Vietnam. In addition, the study only addressed factors affecting integrated teaching in secondary mathematics and did not specifically classify factors affecting the effectiveness of integrating math teaching with other subjects. The study did not account for factors beyond the teacher's control (e.g., family culture, race, learner beliefs, socioeconomic status) and limit any deviations from non-random placement.

The results obtained from this study are valuable to the current research team. In addition, some missing points from some previous documents have been filled in. Thus, this study provides more useful insight for future studies. From the research results, we recommend that more similar studies should be conducted to determine the factors affecting other teaching methods (flipped classroom teaching, differentiated teaching, project-based teaching...) on the effectiveness of math teaching in high schools to take timely measures to improve the effectiveness of math teaching. Moreover, researchers can use our results to conduct similar studies in some other subjects in general schools to discover interesting points with high theoretical value and have many meaningful recommendations for developing studies on the effectiveness of integrated teaching in subjects. It thereby contributes to improving teaching and learning quality in general schools in different countries.

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Declaration of interest: The authors declare that no competing interests exist.

Data availability: Data generated or analyzed during this study are available from the authors on request.

Ethical declaration: The study followed our university's ethical guidelines, issued in Decision No. 190/QĐ-ĐHSPHN2, dated 07/04/2017, ensuring all necessary ethical considerations. Informed consent was obtained from participants after explaining the research purpose and procedures. The consent form emphasized voluntary participation, the right to withdraw at any time, and assured confidentiality and anonymity. Participant information was kept confidential. Only researchers could access securely stored data on password-protected devices and use it exclusively for research purposes.

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