MODESTUM EURASIA Journal of Mathematics, Science and Technology Education, 2023, 19(12), em2376
ISSN:1305-8223 (online)
OPEN ACCESS Research Paper https://doi.org/10.29333/ejmste/13894

Factors affecting the effectiveness of math teachers' integrated teaching in Vietnam high schools

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Received 14 March 2023 ▪ Accepted 15 August 2023

Abstract

The teachers' effectiveness in teaching is considered an important factor in determining the quality of high schools. Therefore, it is necessary to study the factors affecting the effectiveness of math teaching, especially the integrated teaching competence of math teachers in high schools. The main objective of this study is to determine the factors affecting the integrated teaching effectiveness of high school math teachers. Simultaneously, it proposes some appropriate solutions to help teachers have the opportunity to develop integrated teaching competence, contributing to improving the teaching efficiency of math to meet the current educational innovation requirements in Vietnam. SPSS software was used to analyze and process data from a survey of 118 math teachers at 31 high schools in Vietnam. The results of six analyzed variables show that there are three variables affecting teachers' effectiveness of integrated teaching, including teacher's perception of integrated teaching; policy on salary, bonus, and material remuneration for teachers; and student characteristics. In addition, the study also shows that teachers with a master's degree have higher integrated teaching effectiveness than teachers with bachelor's degree. The results also reveal that seniority and gender have almost no influence on the integrated teaching effectiveness of teachers. However, there is a statistically significant difference in the effectiveness of integrated teaching in grade 12 math teachers compared to grade 10 and grade 11. The new findings of this study have implications for high schools, teacher training institutions, pedagogical schools, and policymakers to improve the effectiveness of integrated teaching.

Keywords: Vietnam high schools, affecting factors, math teaching, integrated teaching

INTRODUCTION

Mathematics is the foundational knowledge of science and technology, which is decisive for the socio-economic development of each country. Besides economic benefits, it also prepares for the younger generation to meet the skill demands of the modern workplace and raises the overall competence level of the labor force. It is very important to teach and learn mathematics in high school, as it is considered a measure of the development of any country (Gabina et al., 2021).

Vietnam is fundamentally and comprehensively renovating the general education system to meet the requirements of society's human resources in which the teaching effectiveness of teachers is considered one of the leading factors determining education quality. 2018 general education program (Ministry of Education and Training, 2018) has indicated that, from an integrated point of view in high schools, mathematics education contributes to the formation and development of mathematical qualities and competencies for students; creates a connection between mathematics and practice and between mathematics and other educational subjects and activities. Therefore, research into factors affecting the effectiveness of integrated teaching of math teachers is necessary to promptly minimize negative influences.

There have been many studies on different factors affecting the effectiveness of teachers' integrated teaching. Some focus on teachers themselves, including teacher age (Li & Walsh, 2011), seniority (Bussey et al., 2000; Gueldenzoph et al., 1999), teaching style (Cooper,

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Contribution to the literature

- This study explores the main factors affecting the effectiveness of integrated teaching in high school math in Vietnam.
- This study explores the perception of integrated teaching; student characteristics; and policy on salary, bonus, and material remuneration for teachers.
- This study provides teachers, researchers, school administrators, policymakers, high schools, and teacher training institutions with the factors affecting the effectiveness of integrated teaching so they have specific strategies and solutions to improve the effectiveness of teaching high school math in Vietnam.

2001; Gueldenzoph et al., 1999), self-efficacy (Albion, 2001; Stone & Henry, 2003), self-confidence (Bingimlas, 2009), anxiety, and fear of changes (Bussey et al., 2000). Other external factors refer to infrastructure, learner learning, and administrative aspects such as accessibility and the availability of facilities and equipment (Li & Walsh, 2011). Besides, some studies have shown factors in a general way, such as teacher's perception; infrastructure; salary, bonus, and allowance; course objectives and contents; attitudes and learning abilities of students affecting teaching effectiveness, and integrated teaching competence of teachers (Nguyen, 2012; Nguyen et al., 2016; Tran et al., 2020). Hamad et al. (2022), Tashtoush et al. (2022), and Wardat et al. (2022a) study the perception of math teachers for trends of international mathematics and science study (TIMSS) or STEM programs in schools in the United Arab Emirates. The primary significance of the studies is to enable governments and school policymakers to understand the components of teacher quality that may affect math teaching and learning in the classroom. The immediate concern is that more attention should be paid to training and professional development for teachers. However, the above studies have not had the conditions to clarify the factors affecting the effectiveness of integrated teaching in high school math in order to provide specific solutions and bring about high efficiency when teaching mathematics in high schools. The factors affecting the above effectiveness of integrated teaching helped the research team identify some variables in this study.

Therefore, this study aims at identifying the main factors affecting integrated teaching in high school math and proposing some solutions that are expected to help high school math teachers, researchers, school administrators, and policymakers understand the factors affecting the effectiveness of education so that they have specific strategies and solutions to improve the effectiveness of integrated teaching in high schools.

This study focuses on answering the following two main questions:

1. *What factors affect the effectiveness of integrated teaching in high school math?*
2. *What should be done to improve the effectiveness of integrated teaching in high school math in Vietnam?*

In the next part, the theoretical and conceptual framework section will present the basis for defining core concepts. The literature review section introduces a number of factors affecting the effectiveness of integrated teaching that have been mentioned by previous studies, thereby giving points that need further research to make new contributions. Next, the data collection and processing will be presented. The research results will show the factors affecting the effectiveness of integrated teaching of high school math teachers. Then, we discuss the relevance of the results of this study with the previous results and suggest measures to contribute to improving the effectiveness of integrated teaching. Finally, the conclusion section points out some of the main results and limitations of the study or data and makes recommendations for related parties to consider and use the research findings.

THEORETICAL & CONCEPTUAL FRAMEWORK & LITERATURE REVIEW

This section is mainly based on the study of previous documents that introduce the understanding of integrated teaching, the approach to integrated teaching in math in Vietnam, concept of effective teaching. In particular, this section clarifies new research points after reviewing previous research results on factors affecting teaching effectiveness.

Concept of Integrated Teaching

In general, integration in teaching has been mentioned quite early, and there have been many different approaches so far. According to Fogarty (1991), there are integrated forms: connected, nested, sequenced, shared, webbed, threaded, integrated, and immersed. D'Hainaut (1988) introduced the integrated forms: intra-subject, multi-disciplinary, interdisciplinary, and trans-disciplinary. Each integrated form is considered the basis for determining teaching goals, contents, forms, and methods, thereby increasing teaching effectiveness.

According to Roegiers (1996),

> Integrated pedagogy contributes to the formation of students with clear competencies, anticipating what is needed to serve future learning processes or to integrate into working life.

According to the Ministry of Education and Training of Vietnam (2014), in integrated teaching, knowledge, skills, and attitudes are integrated into the same content associated with practical situations and professional activities to form and develop learners' competencies, create links between subjects and knowledge, and help students develop creative thinking and activeness in learning.

Concept of Integrated Teaching in High School Math in Vietnam

Currently, teachers are encouraged to update their teaching methods as part of educational reform in Vietnam (Hoang et al., 2020). In 2018, the Ministry of Education and Training issued a new general education program, allowing schools and teachers to design a curriculum based on the national general education program (Ministry of Education and Training, 2018). Hence, Vietnamese math teachers have more conditions to implement new and updated teaching methods like integrated teaching.

Math in Vietnamese high schools is ***a field of study*** that includes subjects or knowledge systems such as *arithmetic, algebra, geometry, trigonometry, calculus, statistics, probability, combinatorics, etc*. Therefore, selecting and arranging topics or knowledge systems to teach in a reasonable way (from the first grade of elementary school to the last grade of high school) can be considered an integration of curriculum *under internal integration*. On the other hand, math is a tool subject in high schools as a lot of mathematical knowledge is used in teaching and learning other subjects, such as biology, chemistry, geography, physics, …, and application in practice, labor, and production. Therefore, this subject has many opportunities for *interdisciplinary, transdisciplinary integration*. Especially, math gives many opportunities to practice thinking (logical thinking, creative thinking …); once interested and passionate, in-depth research can be *integrated by and through learning* (Pham et al., 2018).

Integrated teaching in math is a teacher's activity to help students acquire knowledge based on exploiting the relationships between mathematical contents, mathematics, and other subjects and practice (Le, 2014). Hence, mathematical knowledge is meant for practice and other subjects.

Accordingly, we think that ***integrated teaching in high school math*** *means that teachers understand each integrated method to choose, design, and organize integrated topics (or integrated lessons) for high school students.*

Effective Teaching of Math

Effective teaching is the most important goal in school education (Seah, 2007). Therefore, research on the effectiveness of math teachers has received much attention in many different aspects (Maduabum, 2009).

Studies have shown that there are many attributes of an effective math teacher, and many of them are related to learners. According to the Australian Association of Mathematics Teachers, "effective schools are only effective when they have effective teachers." However, the term efficiency has been used in various ways. According to Stanford (2001), the teacher's effectiveness is the degree to which the desired effect is achieved on students. In terms of math teaching, a method is considered effective if it produces desired results and promotes students' understanding. According to Posamentier and Stepelman (1999), effective math teachers have their own wide range of teaching strategies. It is important for a teacher to determine the best strategy for a lesson, and it needs teachers' creativity in the classroom to teach most effectively. Posamentier and Stepelman (1999) suggest that effective math teachers help develop students' positive attitudes by understanding students' emotions and appreciating their contributions, realizing success by engaging students in learning, and by making mathematics interesting and engaging. Seah (2007) speculates that effective teaching and learning can be the result of interactions between teachers and their students, between students themselves, and between the classroom and its environment. In short, effective teaching reflects effective learning.

Overview of Factors Affecting the Effectiveness of Integrated Teaching in High School Math

According to research by Cady et al. (2006) and Tatto et al. (2018), depending on the difficulty of a taught content, a novice teacher makes decisions based on his/her own knowledge and experience. This decision-making capacity is somewhat low in the early years of teaching and increases over the years as teachers become more confident in their job (Munby et al., 2001). This means that seniority and personal experience can affect the effectiveness of integrated teaching in high school math.

Larson (2002) finds that effective math teachers have something in common, whether they orient towards 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. Besides, they also point out a number of other factors affecting effective math teaching, such as conditions for schools; conditions to support teachers; professional development experience of teachers; teachers' knowledge, beliefs, and understanding; and what teachers do in the classroom.

Ismail et al. (2015) argue that gender, level, field of educational research, teaching years, number,

frequency, and nature of professional development that teachers have undertaken, teaching context and activities, practices, and strategies are also factors that influence the effectiveness of math teaching. In particular, some teachers say that the factors that they believe in affecting the effectiveness of math teaching and learning are "professional development of teachers, teaching and learning time, availability of teaching aids, computers, etc."

Wardat et al. (2022a) conducted a study to reveal that the school environment and the perception of math teachers may influence their classroom practice through survey results from 522 math teachers in schools in Abu Dhabi for the 2020-2021 school year. Especially there is a statistically significant difference in opinion regarding student readiness in TIMSS.

Chu et al. (2015) emphasize that teacher quality is important in improving student achievement. Teachers with a master's degree can provide a high-quality learning experience for their students. Teachers who lack qualifications do not meet the minimum requirements needed to provide high-quality instruction to students. Hanushek (2011) thus finds that students make three-fold improvements when taught by high-quality teachers.

The studies of Hamad et al. (2022), Tashtoush et al. (2022), and Wardat et al. (2022a, 2022b) are about the perception of math teachers through TIMSS, STEM programs in schools in the United Arab Emirates. The primary significance of the studies is to enable governments and school policymakers to understand the components of teacher quality that may affect math teaching and learning in the classroom.

From the above studies, we assume that age, seniority, awareness, environment, school facilities, student characteristics, professional knowledge, qualifications, teaching experience, knowledge objectives, subject contents, and policy of salary, bonus, and material remuneration, are factors that may affect the effectiveness of integrated teaching of high school math teachers. Consequently, we put forward the following research hypotheses:

H1. The perception of integrated teaching of high school math teachers affects their integrated teaching effectiveness.

H2. Objectives and contents of high school math have an impact on the integrated teaching effectiveness of high school math teachers.

H3. Student characteristics affect the integrated teaching effectiveness of high school math teachers.

H4. The policy of salary, bonus, and material remuneration for high school math teachers affects their integrated teaching effectiveness.

Table 1. Characteristics of survey sample (n=118)

Characteristics of survey samples		Quantity	Percent%
Gender	Male	40	33.9
	Female	78	66.1
Teaching grade	Grade 10	42	35.6
	Grade 11	34	28.8
	Grade 12	42	35.6
Qualification	Bachelor	69	58.5
	Master	49	41.5
Seniority	Less than 3 years	15	12.7
	From 3 to 5 years	16	13.6
	From 5 to 10 years	38	32.2
	Over 10 years	49	41.5

H5. Teaching facilities and equipment in schools have an influence on the integrated teaching effectiveness of high school math teachers.

H6. Working environment affects the integrated teaching effectiveness of high school math teachers.

RESEARCH METHOD AND DATA

SPSS stands for statistical package for the social sciences. Its first version, released in 1968 after being developed by Nie et al. (1970), provides in-depth statistical analysis of data. Hence, it is a very popular program for social scientists to use for data analysis (Singh, 2015).

This study aims at finding the main factors affecting the effectiveness of integrated teaching of high school math, thereby making suggestions to improve the integrated teaching of high school math teachers in Vietnam. Thus, a quantitative study design was used. Then, data was analyzed by SPSS 26.0 software. On that basis, some measures are proposed to adjust the factors affecting effectiveness of integrated teaching of high school math. Hereinafter, survey sample, methods, tools, and analysis of results will be described.

Survey Samples

Table 1 shows the characteristics of the survey sample: of the 118 teachers currently teaching at 31 high schools answering the questionnaire, most of them are female teachers (66.1%) and male teachers are about 33.9%; 35.6% are teaching grade 10 math; 28.8% of grade 11 math; and 35.6% of grade 12 math. Professional qualifications: bachelor is 58.5%, and master is 41.5%. In terms of seniority: under three years is 12.7%; from three to five years is 13.6%; from five to 10 years is 32.2%; over 10 years is 41.5%.

Survey Method

The data was collected from May 20, 2022, to November 29, 2022. Since the participants lived in different regions of Vietnam, an online survey was an appropriate data collection method (Wright, 2006).

Table 2. Reliability & characteristics of the scales

Scales	Cronbach's alpha reliability	n	AS	SD
(1) Perception of integrated teaching	0.920	8	2.380	0.490
(2) Course objectives & contents	0.801	4	3.797	0.638
(3) Characteristics of students	0.974	4	3.284	0.650
(4) Salary, bonus, & remuneration policies for teachers	0.625	8	3.571	0.350
(5) Infrastructure	0.850	4	3.131	0.419
(6) Working environment	0.830	6	4.040	0.456

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

We did an online survey and sent questionnaires via Google Form to some math teacher forums, and some high schools in Vietnam. We received 118 valid responses from math teachers of 31 high schools. General information about the respondents is presented in **Table 1**. Other information collected for research purposes is presented in the following parts.

Survey Content and Tools

Part one aims to collect demographic information, such as gender (male/female); working place; actual teaching classes; qualification; working seniority. Part two aims to discover factors affecting teaching effectiveness using the 4- or 5-level Likert scale, which depends on the question's purpose. The main factors affecting the effectiveness of integrated teaching in high school math were surveyed, including

(1) high school math teachers' perception of integrated teaching,

(2) learning objectives and contents of integration-oriented high school math,

(3) characteristics of students,

(4) policies and remuneration for math teachers,

(5) teaching facilities and equipment in high schools, and

(6) working environment.

To ensure the reliability and validity of the survey tool, we have drafted, tested, and adjusted it after testing (this stage is not detailed here). To ensure the receipt of objective and multi-dimensional information, we ask high school math teachers to self-assess the factors affecting the effectiveness of integrated teaching in math through the following aspects: capable of making integrated teaching plans; capable of designing lessons in the direction of internal integration; capable of designing lessons in the direction of interdisciplinary integration; capable of choosing and using integrated teaching methods; capable of checking and evaluating student results in the integrated direction; capable of exploiting and using information effectively; capable of solving problems and linking theory with practice. The questions require teachers to rate on a Likert scale, from 1="*strongly disagree*" to 5="*strongly agree*". The reliability of the scale on influencing factors (Cronbach's alpha coefficient) is 0.954.

Six factors that affect the effectiveness of integrated teaching are considered (**Table 2**).

The analysis results show that the reliability of Cronbach's alpha reaches the highest level (mostly from 0.801 to 0.974), which proves that six scales are suitable to conduct data analysis. Internal consistency is evaluated on *Cronbach's alpha* coefficient. A structure with a high coefficient value implies that the items in the structure have the same scope and significance (Cronbach, 1971). The coefficient should be at least 0.7 in the early stages and values of 0.8 or 0.9 for more advanced stages of research. Values from 0.61 to 0.7 are acceptable (Taber, 2017). Values below 0.6 indicate a lack of confidence (Nunnally & Bernstein, 1994).

Data Analysis

After receiving survey data, it was cleaned and analyzed using SPSS 26.0 software, an independent sample test, and one-way ANOVA. Analysis results were based on average scores of quantitative variables, frequency, and percentages of qualitative variables. Then, correlation and linear regression analysis was carried out to examine the relationship and influence of the variables "high school math teachers' perception of integrated teaching", "learning objectives and contents of integration-oriented high school math", "characteristics of students", "salary, bonus, and remuneration policies for math teachers", "teaching facilities and equipment in high schools", "working environment," and "integrated teaching competence of high school math teachers". The coefficient β was calculated at the significance level of <0.05.

RESEARCH RESULTS

This section presents the analysis results of the factors affecting the effectiveness of integrated teaching of high school math teachers.

Factors Affecting Integrated Teaching Effectiveness of High School Math Teachers

Self-assessment results on the integrated teaching effectiveness of high school math teachers

Data analysis results in the results of self-assessment of integrated teaching effectiveness of high school math teachers shown in **Table 3**.

Table 3. High school math teachers self-assess integrated teaching effectiveness

Characteristics of survey samples		Integrated teaching effectiveness	
		Average scores	p-values
Gender[a]	Male	3.14	0.176
	Female	2.96	
Teaching grades[b]	Grade 10	3.00	**0.011**
	Grade 11	2.90	
	Grade 12	3.31	
Qualification[a]	Bachelor	2.97	**0.041**
	Master	3.23	
Seniority[b]	Less than 3 years	3.05	0.454
	From 3 to 5 years	2.94	
	From 5 to 10 years	3.01	
	Over 10 years	3.19	

Note. [a]: Using t-test; [b]: Using one way ANOVA; & p-value in bold indicates a statistically significant difference

Table 4. Correlation between self-assessment of integrated teaching effectiveness of high school math teachers & affecting factors[a] (n=18)

Factors	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Effectiveness of integrated teaching	1						
(2) Perception of integrated teaching	0.637**	1					
(3) Course objectives and contents	-0.067	0.077	1				
(4) Characteristics of students	0.250**	0.183*	-0.181*	1			
(5) Salary, bonus, and remuneration policies for teachers	0.384**	0.246**	0.313**	-0.022	1		
(6) Infrastructure	-0.037	0.112	0.148	-0.017	0.226*	1	
(7)Working environment	0.100	0.079	0.192*	0.181	0.324**	0.327**	1

Note. (**): Level of significance p<0.01; (*): Level of significance p<0.05; & [a]: Spearman's correlation coefficient

From the results of **Table 3**, it can be seen that the integrated teaching effectiveness of grade 12 teachers (average score: 3.31) has higher integrated teaching effectiveness than the other two grades (grade 10 teachers: 3.0; grade 11 teachers: 2.9). Teachers with a master's degree (3.23) have higher integrated teaching effectiveness than teachers with a bachelor's degree (2.9). In particular, the bold p-value in **Table 3** demonstrates the statistically significant difference between the factors affecting the integration effectiveness of high school math teachers. Besides, it shows that the gender and seniority of teachers do not affect the effectiveness of integrated teaching in high school math.

Factors affecting the integrated teaching effectiveness of high school math teachers

Six factors may affect the teaching effectiveness of high school math teachers, as mentioned above, none of which should be considered in isolation as their influence can become significant when other factors are mediating ones (Ifinedo et al., 2020). Therefore, it is necessary to consider the correlation relationship between the six mentioned influencing factors and teacher's integrated teaching effectiveness.

The correlation analysis result in **Table 4** shows that out of the six above-mentioned factors, *only three factors of (2), (4), (5) have an influence on high school math teachers' integrated teaching effectiveness*. *The remaining factors of (3), (6), (7) have no or little influence on the integrated teaching effectiveness of these teachers*. *The factors of (2),(4),(5)* all have a positive correlation and are very influential on *integrated teaching effectiveness* with the significance level *p<0.01 (results with **)*. To conclude influence of factors on the effectiveness of *integrated teaching of high school math teachers*, a regression analysis was conducted with the dependent variable of integrated teaching effectiveness and the independent variables of X_1=*high school math teachers' perception of integrated teaching;* X_2=*learning objectives and contents of integration-oriented high school math;* X_3=*characteristics of students;* X_4=*salary, bonus, and remuneration policies for math teachers;* X_5=*teaching facilities and equipment in high schools; and* X_6=*working environment*. The values of the factors used for the regression are the sums of the observed variables that have been tested. Regression analysis was performed by the total regression method of variables with SPSS version 26.0 software. The results of the regression model testing between the factors affecting training results are shown in **Table 5** and **Figure 1**.

The results of the regression analysis show that the adjusted $\mathbf{R^2}$ value (adjusted R square) accurately reflects the fit of the model to the whole. The adjusted $\mathbf{R^2}$ value of 0.512 (or 51.2%) means that there is a linear regression model between the integrated teaching effectiveness of high school math teachers and six factors affecting them. In particular, **Table 5** also gives us the results of the F-test to evaluate the hypothesis of the fit to the regression model. The F-test sig value is <0.05, so the multiple regression model satisfies the evaluation conditions and suitability test for research results.

Table 5. Results of the regression analysis [(b)] of the model

Independent variables[(a)]	Dependent variables [(b)]	R^2 adjusted	F	β	t	p-values
X_1	Integrated teaching	0.512	21.469**	0.562	8.242	0.000
X_2	effectiveness of teachers			-0.181	-2.578	0.011
X_3				0.121	1.749	0.083
X_4				0.340	4.628	0.000
X_5				-0.147	-2.168	0.032
X_6				-0.007	-0.100	0.921

Note. (**): Level of significance p<0.01; [(a)]: Predictive factors: X_1, X_2, X_3, X_4, X_5, & X_6; & [(b)]: Dependent variable: Y=Integrated teaching competence of high school math teachers

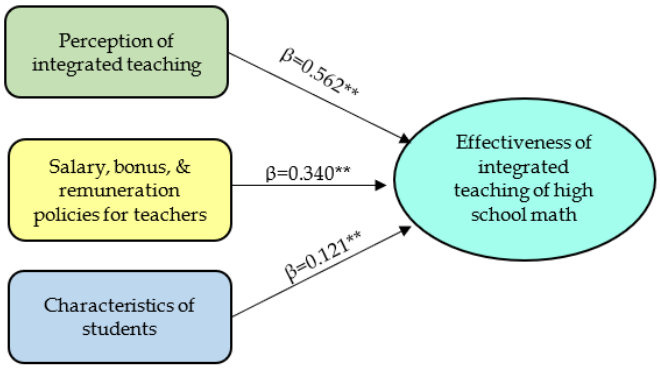

Figure 1. Result of regression analysis on the effectiveness of integrated teaching of high school math teachers (Source: Authors' own elaboration)

Variables of X_1, X_2, X_3, X_4, X_5, and X_6 all meet acceptable standards (tolerance >0.0001). The standard regression values of the independent variables in the model are statistically significant, but there are three factors of X_1, X_3, and X_4 closely affecting the model. There are three remaining factors of X_2, X_5, and X_6 almost having no effect on the regression model. Beta coefficient of *high school math teachers' perception of integrated teaching is 0.562; salary, bonus, and remuneration policies for math teachers is 0.340; and characteristics of students is 0.121.*

Analysis results for the regression model:

$$Y = 0.562X_1 + 0.340X_3 + 0.121X_4 \quad (1)$$

The above model explains that 51.20% of the change of Y variable is caused by independent variables, and the remaining 48.80% of the variation is caused by other variables. However, the model shows that the independent variables all positively affect the integrated teaching effectiveness of high school math teachers with 99% reliability level. The regression results show that, if the independent variables are kept the same when the assessment score of *high school math teachers' perception of integrated teaching* increases by one, the integrated teaching effectiveness of teachers increases on average by 0.562 points. Similarly, when the assessment score on *salary, bonus, and remuneration policies for math teachers* increases by one, the integrated teaching effectiveness increases by 0.340 points on average; when the score on *characteristics of students* increases by one, the integrated teaching effectiveness increases by 0.112 points on average.

From the above analysis, we can conclude that the theoretical model is compatible with the research data, and of the six factors that are variables, there are three factors affecting the results of the integrated teaching effectiveness of high school math teachers.

Figure 1 shows the importance of the components depending on the absolute value of the normalized regression coefficient. The greater the absolute value of the component, the greater the influence on integrated teaching results. Therefore, it can be affirmed that high school math teachers' integrated teaching effectiveness has the most influence from the *perception of integrated teaching* factor (β=0.562); the second is *salary, bonus, and remuneration policies for math teachers* (β=0.340); the third is *Characteristics of students* (β=0.121).

Thus, the analysis results with six independent variables and one dependent variable show that there are three independent variables that affect training results when increasing these factors, the teaching effectiveness of teacher training will increase. This means that teacher training institutions, policy agencies, and management agencies need to make efforts to improve these factors to improve the integrated teaching effectiveness of high school math teachers. Compared with research hypothesis, results are shown in **Table 6**.

Discussion

Teaching effectiveness will be better if math teachers are trained more effectively (Ismail et al., 2015) of which the most important factor is their own ability. Effective teachers always have a sense of improving their expertise, so they use methods and strategies more effectively because they have a deep knowledge of teaching content and strategies (Meskill et al., 2002; Jang & Tsai, 2012; Saltan & Arslan, 2017), and become more proficient in using new tools when teaching and learning (Smarkola, 2007). Baumert et al. (2010) argues that teachers with a degree in mathematics have a positive impact on student achievement; teachers with limited mathematical knowledge have a negative impact on pedagogy and teaching quality as well as student progress over the entire teaching career. Thus, finding of the current study is that math teachers with a master's degree have higher teaching effectiveness in integrated teaching than math teachers with a university's degree, which is consistent with the results of previous studies.

Table 6. Hypothesis inspection result after using the regression model

Hypothesis	Inspection result
H1. The perception of integrated teaching by high school math teachers affects their integrated teaching effectiveness.	Accepted
H2. Objectives and contents of high school math have an impact on the integrated teaching effectiveness of high school math teachers.	Not accepted
H3. Student characteristics affect the integrated teaching effectiveness of high school math teachers.	Accepted
H4. The policy of salary, bonus, and material remuneration for high school math teachers affects their integrated teaching effectiveness.	Accepted
H5. Teaching facilities and equipment in schools have an influence on the integrated teaching effectiveness of high school math teachers.	Not accepted
H6. Working environment affects the integrated teaching effectiveness of high school math teachers.	Not accepted

This study reveals that *student characteristics* affect the effectiveness of integrated teaching in high school math, which is also consistent with the speculation of Seah (2007) that effective teaching and learning can be the result of interaction between teachers and their students, between students themselves, and between classroom and its environment. Furthermore, it is consistent with Posamentier and Stepelman's (1999) assertion that math teachers are effective when promoting students' contributions. Students' success in math depends on their attitude toward the subject (Schenkel, 2009), which plays an important role in their academic achievement (Alibraheim, 2021). Therefore, when applying integrated teaching in high school math, teachers should support and encourage students to study, which improves their attitudes and academic achievement, thereby improving the effectiveness of subject teaching.

The research results also show that the factor of *salary, bonus, and remuneration policies for teachers* has an influence on the integrated teaching effectiveness of high school math teachers. This result is also consistent with many previous studies that these factors have a great influence on the effectiveness of integrated teaching (Hao, 2005; Nguyen, 2009; Vo Van, 2017). Therefore, schools need to have adequate policies to serve and satisfy both materially and spiritually teaching staff; attentive care and encourage working spirit for all staff and teachers (Vo Van, 2017). Accordingly, teachers will feel secure in their work and have time to invest in professional development, and plan and implement effective teaching.

This study finds that the factor of *the perception of integrated teaching of high school math teachers* has the highest influence on training results. On the one hand, perhaps, teachers are aware that integrated teaching helps to limit duplicate content in math with other subjects, saving study time while ensuring comprehensiveness of knowledge and promoting activeness, independence, and creativity in students' learning. On the other hand, math integrated teaching in high schools also creates conditions to diversify teaching forms and methods of organizing learning activities, taking advantage of social forces to participate in the educational process. Moreover, they also recognize that effective math teaching must be accompanied by teachers' extensive knowledge of the subject, their understanding of what optimizes student learning, and best practices in class. It can be said that teachers' perception plays an essential role in choosing their teaching methods (Li et al., 2019). In addition, other factors impact teachers' perception, including: their previous experience (Khlaif, 2018), confidence in teachers' competence and inquiry skills. Besides, perception is closely related to attitude, and conversely, attitude arises from beliefs and values. Hence, teachers' attitudes and beliefs significantly influence on activities and practices in the classrooms (Burke et al., 2018; Gil-Flores et al., 2017; Willis et al., 2019). In summary, the perception of high school math teachers has a consistently important influence on their integrated teaching effectiveness.

Solution

To improve the effectiveness of integrated teaching in high school math, a number of solutions will be offered. This group of measures can be beneficial to all related parties, especially those who employ or use teachers.

1. *Improving the perception of integrated teaching for high school math teachers*

Some studies show that an increasing number of researchers support the notion that better prepared teachers are more effective (Ingersoll & Strong, 2011; National Academy of Sciences, 2001), especially teaching experience, also strongly influences teachers' perceptions (Jimoyiannis & Komis, 2007). Educational change depends on what teachers do and think (Fullan, 2007). Therefore, in our opinion, teachers need to be deeply aware of the importance of teaching contents and activities in order to improve integration-oriented math teaching quality. In order to raise perception of issues related to integrated teaching for math teachers, schools need to focus on popularizing the purpose, meaning and nature of integration-oriented math teaching. It is necessary to assign people to collect documents, research and draft propaganda content on math integrated teaching for teachers. Thus, each teacher and schools need to have specific strategies to promote cognitive problems in integrated teaching of math teachers.

2. *Flexible use of methods and forms of organization, creating an active learning environment, and developing the integrated learning ability of high school students in math teaching*

Several studies show a significant relationship between academic achievement and student motivation (Zee & Koomen, 2016). Teacher support is needed to encourage positive attitudes towards math (Marchis, 2011; Sakiz et al., 2012). Therefore, teachers need to care, respect, appreciate, listen, treat fairly, encourage and have high expectations in students (Sakiz, 2007). Also, in integrated teaching, teachers should design tasks, questions, to inspire, help students focus on aspects related to mathematical knowledge (Mueller et al., 2011; National Council of Teachers of Mathematics, 2010) to propose a good learning environment to increase the effectiveness of integrated teaching in high school math.

Therefore, in our opinion, when applying integrated teaching, high school math teachers need to create excitement for students by making students aware of objectives and roles of interdisciplinary integrated learning or linking math with real life; flexible use of teaching methods and forms (organizing games, group activities, using outdoor activities, etc.); renewing concepts and ways of testing and evaluating students in the direction of developing quality and competence. Besides, for successfully integrated teaching in math, students need to be well equipped and practiced learning methods such as finding and reading documents, listening to lectures, systematizing knowledge, group learning, etc. In addition, it is necessary to build a friendly learning environment through interactions. Students have chances to discuss with their teachers and friends to improve their understanding and thinking level.

3. *Improving policies and remuneration for teachers*

Some studies show that schools need to reduce external factors, non-teaching work, such as regular announcements, meetings, administrative work, etc. It is necessary to focus on priorities for effective math teaching (Ismail et al., 2015). High schools should organize workshops to help improve teaching materials (Gabina et al., 2021); sufficient funds are needed to purchase the necessary equipment and materials for the creation of teaching materials (Gabina et al., 2021); public authorities at all levels need to ensure that math teachers are encouraged to perform professional duties, and design teaching materials (Gabina et al., 2021). These activities are also considered a good mental reward for teachers in general and math teachers in particular.

Accordingly, we think that, in order to promote the effectiveness of integrated teaching of high school math teachers, all levels and schools need to fully apply and implement all regulations on rights and obligations of teachers, particularly: ensuring correct, sufficient, and timely salary, allowances, bonuses, overtime payment, etc.; in addition, there should be a financial support policy for teachers who study master's and doctor's programs and a partial subsidy for teachers who defend their master's and doctoral theses; besides, attention should be paid to evaluation, commendation, and awarding of titles: good teachers, excellent teachers, people's teachers, medals for education career, … and to directing more closely the organization of titles from units to ensure the balance in the whole school. Finally, schools need to have welfare policies and services to meet both material and spiritual needs for teachers such as health and safety policies; gifts and bonuses on special occasions and holidays in order to show the care, thoughtfulness, and encouragement of working spirit for all teachers and staff.

4. *Improving training quality of high school math teachers to support effective integrated teaching*

Some studies show that in order to teach math effectively, teachers must have good knowledge of the subject, good pedagogical skills, especially questioning skills (Abd Salam & Shahrill, 2014; Kani et al., 2014; Omar et al., 2014). Therefore, it is necessary to create skilled teachers in most fields. This requires significant changes in teacher training, as well as new policies on recruiting and evaluating teachers. In addition, many people agree that teacher quality has a great influence on math teaching and learning results (Gabina et al., 2021). Thus, it is necessary to encourage math teachers to participate in seminars, conferences, classes to improve their knowledge and skills in using teaching materials and teaching organization, especially in integrated teaching.

Also, teachers have encountered new challenges due to the use of information technology in the 21st century school context (Albion et al., 2015). Teacher training institutions also face the challenge of renovating training and preparation for teachers to successfully integrate information technology into teaching and learning (Sang et al., 2010). Cross-country studies have shown that a significant number of teachers across countries leave their pedagogical schools with inadequate mathematical knowledge (Tatto et al., 2018). Therefore, from our viewpoint, high schools need to focus on professional training and encourage math teachers to have further studying. Teacher training institutions need to focus on preparing future teachers with necessary knowledge and skills in terms of expertise and professionalism so that they can confidently meet the professional standards of teachers. They are always active to turn career challenges into their strengths.

CONCLUSIONS

The main objective of the study is to determine the factors affecting the effectiveness of integrated teaching of high school math teachers. Besides, the research results are the premise for the authors to propose some

specific solutions to help leaders and teachers plan and strategize to improve the effectiveness of integrated teaching in math and educational quality. To explore the factors affecting the effectiveness of integrated teaching, a theoretical model was built and tested. The factors affecting the results of integrated teaching effectiveness in high school math achieve their reliability and allowable value. Of the six factors included in the variables for the survey, the results show that there are three factors affecting the integrated teaching effectiveness of high school math teachers: high school math teachers' perception of integrated teaching; salary, bonus, and remuneration policies for math teachers; student characteristics. The three remaining factors of learning objectives and contents of integration-oriented high school math, teaching facilities and equipment in high schools; working environment have almost no influence on integrated teaching competence of high school math teachers. Accordingly, it is important to draw attention to policymakers and administrators in high schools about the importance of involving math teachers in training courses and seminars to train them on how to use integrated curricula and strategies, which contribute to raising their awareness. Moreover, this is also seen as good treatment for them. In addition, student characteristics affect the effectiveness of integrated teaching, so teachers need to adjust teaching, especially teaching methods to attract students' interest and meet their learning needs.

The study also reveals that well-trained math teachers are more effective in integrated teaching than poorly trained teachers; gender and seniority do not affect the effectiveness of integrated teaching in high school math. Thus, teacher quality is one of the important determinants in the effective learning process of students, or in other words, the qualifications of teachers have been shown to be an important component in the success of students to perform well integrated teaching in math. Therefore, it is necessary to take measures to develop expertise and improve the educational level of teachers, so that they can have an effective impact on student learning. Since then, it has helped educate students to develop their quality and skills to meet educational requirements and contribute to human resources training that can adapt to the changes of the present and future society.

Limitations and Future Research

Due to limited research time, a small sample size of the online survey for 118 math teachers from 31 high schools in Vietnam was conducted, thus, it is impossible for the samples to represent all teachers in the country. In addition, the study only deals with integration in teaching high school math in general. It has not specifically classified the factors affecting the effectiveness of integrated teaching of math with other subjects. It does not mention factors beyond teachers' control (e.g., student's past performance, race, gender, socio-economic status) and it also limits any deviations from not random placement.

However, first of all, this study and the obtained results are valuable to the research team. In addition, some missing points from previous documents have been filled in. Thus, this study provides useful insight for future related studies. From the research results, we recommend that more similar studies be conducted to determine the influencing factors of other teaching methods (experiential teaching, project teaching, etc.) on the effectiveness of math teaching at different levels: elementary, secondary, and high school to take timely action to improve math achievement and students' attitudes toward math, and then help them achieve their desired learning outcomes. Furthermore, researchers can use our approach similarly in some other studies with other subjects in high school, such as biology, chemistry, physics, etc.

Finally, our study is based on a small sample, so we also recommend appropriate investment, especially in international projects to expand and study in depth with a larger number of statistics in order to be able to discover interesting theoretical points and make meaningful recommendations for the development of integrated teaching effectiveness of math teachers in particular and other teaching orientations to improve math teaching and learning quality in schools in different countries.

Author contributions: All authors have sufficiently contributed to the study and agreed with the results and conclusions.

Funding: This study was funded by the Vietnam Ministry of Education and Training under grant number B.2021-SP2-02.

Acknowledgment: The authors would like to thank Dr. Ha Le Thanh (Hanoi Pedagogical University 2, Hanoi, Vietnam) for his excellent suggestions.

Ethical statement: The authors stated that the study was conducted in accordance with ethical standards and meets the ethical standards stipulated in Decision No 1327/QĐ-ĐHSPHN2 dated October 7th, 2020, on "Regulations on management of science and technology activities at Hanoi Pedagogical University 2." The research was conducted in strict compliance with academic ethics and research ethics. Informed consents were obtained from the participants.

Declaration of interest: No conflict of interest is declared by authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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