International Journal of Innovative Research and Scientific Studies, 8(2) 2025, pages: 2268-2277

IJIRSS
International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

The role of STEM education in reducing educational inequalities: A case study in the Northern Mountainous Provinces of Vietnam

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Abstract

This study investigates the role of STEM education in reducing educational inequalities in the northern mountainous provinces of Vietnam. The study's primary goal is to determine how and to what degree STEM education may improve student learning possibilities, and hence reduce educational inequalities. The study used in-depth interviews with teachers and students, in combination with mathematical statistics. The findings from the study show that teachers and students in the northern mountainous provinces of Vietnam have a positive perception of STEM education, particularly in that STEM education can reduce educational inequalities. The study also highlights some challenges such as a lack of resources, facilities, or support. To promote the effectiveness of STEM education while reducing educational inequalities, the conclusion of the study emphasizes the importance of investing in facilities, fostering teachers, strengthening online support tools (sample lectures, videos teaching STEM design and production), and more active community participation.

Keywords: Challenges, Equalities, STEM education, STEM, Vietnam.

DOI: 10.53894/ijirss.v8i2.5679
Funding: This study received no specific financial support.
History: Received: 13 February 2025 / **Revised**: 17 March 2025 / **Accepted:** 21 March 2025 / **Published:** 26 March 2025

Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.
Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Publisher: Innovative Research Publishing

1. Introduction

1.1. Background of the Issue

The successes of STEM (Science, Technology, Engineering, and Mathematics) education have become a significant driving force for worldwide education development during the last decade. STEM education is important not just for developing a highly trained workforce, but also for ensuring the sustainability and inclusiveness of social development [1]. In Vietnam, despite significant progress in enhancing education quality and providing equal learning opportunities for learners in various places [2, 3]. Many challenges remain, particularly in the northern mountainous regions.

The northern mountainous provinces of Vietnam, with their diverse, rich, and harsh geographical characteristics, face multiple infrastructure and human resource challenges [4]. Meanwhile, the demand for high-quality STEM education is

growing as a means of ensuring worker competitiveness in the digital economy. Inequality in access to high-quality education, particularly in STEM education, not only disadvantages students in these regions but also impedes the region's overall socioeconomic development [5].

Several recent studies demonstrate that, while schools in Vietnam's urban areas are becoming better equipped with contemporary labs and updated teaching programs, schools in rural and mountainous regions continue to face resource and facility constraints [6, 7]. This creates a large gap in educational opportunities between regions. In such a context, it is vital to study and investigate how STEM education might be used as a tool to reduce these inequalities.

1.2. Significance of the Study

STEM education is vital not only for developing professional skills and knowledge but also for improving and promoting educational equalities. Previous studies have shown that high-quality STEM education can help to reduce poverty and promote economic development by creating an inventive and highly educated workforce [8, 9]. However, access to quality STEM education is typically uneven in Vietnam and many developing countries, particularly between urban and rural and mountainous regions.

This study focuses on the mountainous northern provinces of Vietnam, where resource and facility constraints are common. The study aims to clarify the ability of STEM education to reduce educational inequalities by assessing not only the current situation and challenges in these regions but also the potential and opportunities for changing the situation [1, 10, 11]. In particular, in the context of the Industry 4.0 framework, ensuring that students in mountainous regions have access to high-quality STEM education is not just a matter of educational equality but also a critical aspect for the country's long-term and inclusive development [12, 13].

1.3. Overview of STEM Education in Vietnam

Vietnam has made significant progress in the implementation of STEM education in recent years. The fundamental goal, according to the Ministry of Education and Training of Vietnam (MOET), is to train human resources with deep skills and knowledge in the field of STEM education, in order to satisfy the growing needs of the knowledge economy and digitization [14, 15]. However, allocating resources and providing access to quality education remains a difficulty, particularly in rural and mountainous regions.

In recent years, the number of schools and educational programs focusing on STEM education has increased in Vietnam. To encourage student interest and participation in this area, initiatives such as the “Academy of Child Sciences” and the “STEM Education Development Program” have been launched [3, 11]. Nonetheless, according to studies, despite such gains, the discrepancy in educational quality and facilities between urban and mountainous schools remains significant [16, 17]. Mountainous region schools frequently lack the facilities and teaching equipment required to conduct an effective STEM education program.

Moreover, another significant challenge is the training and development of teachers with STEM expertise [3]. The number of high-quality teachers with STEM expertise is limited, affecting students’ education and learning quality [2, 18]. Furthermore, the link between STEM education and industrial practice is still underdeveloped; therefore, knowledge application in practice remains limited.

The investigation of how STEM education can be enhanced and made more popular among students in mountainous regions is an essential requirement in the current setting to ensure the building of an equitable and comprehensive education system in Vietnam.

1.4. The study’s objectives

In the context where STEM education is becoming an important area of global education policy and especially in Vietnam, this study aims to learn about the role and impact of STEM education in reducing educational inequalities in the Northern mountainous provinces. In particular, the study is focused upon assessing the current situation in STEM education in these regions, including a review of facilities, educational resources, teaching methods, and student access to high-quality education. At the same time, the study also aims to analyze the influence of STEM education on boosting learning opportunities and skills development, as well as preparing students for their future careers.

In addition, the study also focuses on identifying the main challenges and opportunities in stem education implementation and access from the perspectives of both teachers and students. An important component of this effort is to provide ideas and solutions to increase the quality and accessibility of STEM education based on the findings of this study. As a result, the it intends not only to provide a comprehensive view of STEM education in Vietnam's northern mountainous provinces, but also to contribute to the education policy-making process, in order to ensure sustainable and comprehensive development for all regions of the country.

2. Methodology

2.1. The Study’s Subjects

The study was carried out with teachers, administrators and students in the northern mountainous area of Vietnam from September 12, 2023 to December 10, 2023. This region includes 14 provinces: Ha Giang, Tuyen Quang, Cao Bang, Lang Son, Lao Cai, Yen Bai, Thai Nguyen, Bac Kan, Phu Tho, Bac Giang, Hoa Binh, Son La, Lai Chau, Dien Bien (Figure 1).

Figure 1.
Location of the northern mountainous region – Vietnam

In each province, we randomly selected a primary school, a secondary school and a high school to conduct the study. We invited all the teachers and administrators with experience in teaching STEM education at those schools to participate in the interview. We interviewed 392 teachers and administrators, and we received 321 votes (Table 1). Table 1 shows that, except from a significant discrepancy in the gender ratio of survey participants (the female gender ratio accounts for 63.6%), the remaining characteristics are reasonably realistic. The high proportion of female teachers is also typical because it is one of the fundamental characteristics of choosing a pedagogical profession in Vietnam. Women have traditionally constituted the majority of pedagogical universities, accounting for an average of 86.1% [19]. The percentage of teachers with fewer than 5 years of experience is low (7.5%), owing in part to a reduction in staffing in recent years in Vietnam (reducing the recruitment of new teachers) Prime Minister [20] as well as the fact that new teachers who have not been assigned to teach under STEM education did not take part in the survey.

Table 1.
Survey participants.

Study sample (n=321)	Gender		Teaching seniority			Qualification	
	Male	Female	Less than 5 years	Between 5-10 years	Over 10 years	Bachelor	Master
Quantity (People)	117	204	24	57	240	252	69
Percentage (%)	36.4	63.6	7.5	17.8	74.8	78.5	21.5

10 teachers with great experience in stem education and 10 students with good academic achievement who attended STEM education programs from 42 schools were randomly chosen for in-depth interviews (tables 2, 3). The questionnaire was distributed via the Google Forms platform. Responding online is not difficult for research respondents since they are used to working online, particularly after the Covid-19 epidemic in Vietnam [21]. The majority of in-depth interviews were conducted online via Google Meet or Zoom Meeting. However, there are still two phone interviews with our students (due to student interview tool limitations). Each in-depth interview lasts from 10 to 20 minutes.

Table 2.
Information about teachers participating in in-depth interviews.

Study sample (n=10)	Gender		Teaching seniority			Qualification	
	Male	Female	Less than 5 years	Between 5-10 years	Over 10 years	Bachelor	Master
Quantity (people)	3	7	1	3	6	4	6
Percentage (%)	30	70	10	30	60	40	60

Table 3.
Information about students participating in in-depth interviews

Study sample (n=10)	Gender		Student's education level		
	Male	Female	Primary school	Secondary school	High school
Quantity (people)	5	5	3	4	3
Percentage (%)	50	50	30	40	30

2.2. Measurement Method

This study used quantitative research in conjunction with qualitative research - a strategy often employed in general research and the primary method in educational science research. This study employed a 17-question questionnaire (Table 4). The questionnaire's content was designed using published studies on equality in general education instruction and the research team's experience in Vietnam. The questionnaire (quantitative) is consists of 2 parts. Part 1 contains 3 questions (personal information of teachers and administrators including full name, gender, teaching seniority and education level). Part 2 consists of 12 questions, divided into 3 groups. Each question in this part is rated on the 5-point Likert scale, from level 1 "strongly disagree" to level 5 "strongly agree". Question 17 is an open-ended question.

The collected data was processed using IBM SPSS Statistics 20.0. Following data cleaning and screening, the study focused on statistics such as survey participant quantity, gender, educational level, teaching seniority, average value, median and standard deviation under several analytical directions.

Table 4.
The questionnaire's main contents.

PART I: General Information	
Full name (optional): ……	
Question 1: Gender: Male/ Female/Others	
Question 2: Teaching seniority: 0-5 years/ 6-10 years/over 10 years	
Question 3: Qualification: Bachelor/ Master/ Doctorate	
PART II. Questions on Teaching & Learning by Stem Education in General Schools	
A. Understanding of STEM education (Rating from 1 - Strongly Disagree to 5 - Strongly Agree)	
Question 4:	I have a clear understanding of the meaning and goals of STEM education.
Question 5:	I believe that STEM education is essential for a student's future.
Question 6:	STEM education is key to skills development in the 21st century.
Question 7:	I am interested in studying or teaching STEM subjects.
B. STEM education resources and support (Rating from 1 - Strongly Disagree to 5 - Strongly Agree)	
Question 8:	My school does not have sufficient resources and facilities for STEM teaching and learning.
Question 9:	The school and community do not provide sufficient support for STEM education.
Question 10:	Teachers at my school are not well trained and supported to teach STEM subjects.
Question 11:	Parents and the community do not understand and support students' STEM learning.
C. Learning outcomes and educational inequalities (Rating from 1 - Strongly Disagree to 5 - Strongly Agree)	
Question 12:	Students have good academic results in STEM subjects.
Question 13:	STEM education helps students develop critical and creative thinking skills.
Question 14:	I feel there is inequality in access to STEM education between urban and mountainous regions.
Question 15:	STEM education has the potential to reduce educational inequalities in mountainous regions.
Question 16: Do you have any other comments or suggestions about STEM education in the northern mountainous regions of Vietnam?	

3. Results and Discussion

Table 5 displays the statistical results describing the mean value of the observed variables. The preliminary statistics reveal that the scale is functioning properly. The correlation between the observed variables were also tested to determine the reliability of the data acquired using the Cronbach's Alpha reliability factor. If any of the observed variables have a Cronbach's Alpha coefficient of less than 0.6 or a Corrected Item-Total Correlation of less than 0.3, they were disqualified. The Cronbach's Alpha coefficient in the study has a value of 0.791 (Table 6), which shows that the scale is functioning properly [22].

Table 5.
Statistics describing the mean value of observed variables.

Questions	Valid	Missing	Mean	Median	Mode	Std. Deviation	Minimum	Maximum
Q4	321	0	4.0623	4	4	0.86377	1	5
Q5	321	0	3.9190	4	4	0.80213	1	5
Q6	321	0	4.0405	4	4	0.78755	1	5
Q7	321	0	4.1589	4	4	0.74770	2	5
Q8	321	0	3.9813	4	4	0.72000	2	5
Q9	321	0	4.0374	4	4	0.70168	2	5
Q10	321	0	4.1059	4	4	0.74246	2	5
Q11	321	0	4.0062	4	4	0.92193	1	5
Q12	321	0	4.0000	4	4	0.91515	1	5
Q13	321	0	3.8692	4	4	0.93959	1	5
Q14	321	0	4.0249	4	4	0.84373	1	5
Q15	321	0	4.0249	4	4	0.86205	1	5

Table 6.
Results of evaluation of Cronbach's Alpha coefficient and Item-Total Statistics

Reliability Statistics		
Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
0.791	0.789	12

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Q4	44.1682	25.653	0.377	0.439	0.782
Q5	44.3115	26.003	0.373	0.380	0.782
Q6	44.1900	25.792	0.411	0.347	0.779
Q7	44.0717	26.023	0.408	0.352	0.779
Q8	44.2492	26.444	0.369	0.326	0.782
Q9	44.1931	26.738	0.340	0.343	0.785
Q10	44.1246	26.666	0.323	0.175	0.786
Q11	44.2243	26.012	0.301	0.190	0.791
Q12	44.2305	23.790	0.568	0.668	0.762
Q13	44.3614	23.675	0.562	0.615	0.762
Q14	44.2056	24.226	0.573	0.663	0.762
Q15	44.2056	24.101	0.573	0.661	0.762

3.1. Results from quantitative analysis (survey)

Attention was paid to the mean value, the standard deviation of the data acquired, and the consensus rate in each group of questions. A content is considered to be agreed by the respondents when at least 75% of the respondents give it a strongly agree (i.e. 5 on a 5-point Likert scale) or an agree (i.e. 4 on a 5-point Likert scale) [2].

3.2. For the group of questions on "Understanding of STEM education"

The study's findings (Table 7) reveal that the majority of participants have a clear and correct understanding of the aim of STEM education, with a mean value of 4.0623 and a consensus rate of 78.2%. This is consistent with prior study that stated that a thorough understanding of stem is required for the efficient implementation of these educational programs [14, 23]. Despite the positive perception, the lower mean value in the question about the importance of STEM education for a student's future (a mean value of 3.9190 and a consensus rate of 76.0%) demonstrates that there is still skepticism about the impact of STEM education on students' professional futures, which is reflected in the study of Long, et al. [17] and Le, et al. [18] concerning the perspective of teachers or in the study of Thi To Khuyen, et al. [15]concerning the perspective of teachers to successfully implement STEM education in their classrooms [15].

Table 7.
Results of the group of questions on "Understanding of STEM education"

Questions	Mean	Std. Deviation	High consensus	
			Quantity	Quantity
Q4	4.0623	0.86377	251	78.2
Q5	3.9190	0.80213	244	76.0
Q6	4.0405	0.78755	266	82.9
Q7	4.1589	0.74770	261	81.3

Notably, the question about the role of STEM education in skills development in the 21st century obtained high consensus rate (82.9%), with a mean value of 4.0405, showing a clear understanding of the role of stem education in the context of modern education. This reflects the importance of equipping students with the necessary skills to adapt in the digital world, as highlighted in the studies of Linh and Phuong [14]. Moreover, the high interest in learning and teaching STEM subjects (a mean value of 4.1589 and a consensus rate of 81.3%) not only reflects a positive attitude but is also an important factor in motivating students to receive and continue learning in this field.

The study's findings reveal that the community of teachers and education administrators has a good understanding and enthusiasm for stem education. This provides an excellent foundation for the implementation of initiatives and programs to improve the quality and effectiveness of stem education, particularly in the northern mountainous regions of Vietnam.

3.3. For The Group of Questions on "Stem Education Resources and Support"

The study's findings (Table 8) show an unfavorable depiction of the existing state of resources and support in stem teaching and learning.

Table 8.
Results of the group of questions on "Stem education resources and support"

Questions	Mean	Std. Deviation	High consensus	
			Quantity	Percentage (%)
Q8	3.9813	0.72000	255	79.4
Q9	4.0374	0.70168	264	82.2
Q10	4.1059	0.74246	264	82.2
Q11	4.0062	0.92193	252	78.5

Specifically, a mean value of 3.9813 and a consensus rate of 79.4% for the question on the lack of resources and facilities for STEM education reveal that the majority of teachers and administrators believe their schools are inadequately equipped to facilitate stem education. This is consistent with the study of Nadelson and Seifert [12] and Thanh, et al. [13] highlighting the lack of resources as one of the major barriers to the implementation of STEM programs.

At the same time, the survey results also reflect the lack of support from the school and the community, with a mean value of 4.0374 and a high consensus rate of 82.2%. This demonstrates a lack of connection and commitment among schools and communities to support stem education, which should be prioritized in educational development policy and strategy, as Thi To Khuyen, et al. [15] and Linh and Phuong [14].

Furthermore, another major concern was reflected by the question of teachers not being well trained and supported to teach stem subjects, with a a mean value of 4.1059 and a consensus rate of 82.2%. This reflects the urgent need to strengthen professional ability and provide better support to teachers in this area, as Thuy, et al. [3] or Holmlund, et al. [24] highlighted [3, 24].

Finally, the answers for the question on community and family support, with a mean value of 4.0062 and a consensus rate of 78.5%, suggested that community and family reception and support for STEM education is still restricted. This suggests that further efforts are needed to raise public knowledge and engagement in STEM education, which is critical to the program's development and success. In Vietnam, exams place a lot of strain on both parents and students. Parents want their children to get high scores to "show off" to others as well as help their children get into good schools. Therefore, they want their children to learn more, do more difficult exercises instead of participating in group activities as well as STEM lessons. However, this has also improved in recent years [2, 25].

3.4. For the Group of Questions on "Learning Outcomes and Educational Inequalities"

The study's findings (Table 9) provide crucial information about educational inequalities in the northern mountainous provinces. The majority of teachers and educational administrators are aware that students perform well in STEM subjects, with a mean value of 4.0000 and a consensus rate of 80.7%. This demonstrates not only trust in the existing quality of STEM education, but also a positive appreciation of these subjects' potential to improve academic achievement, as indicated in their study [11, 12].

Table 9.
Results of the group of questions on "Learning outcomes and educational inequalities"

Question	Mean	Std. Deviation	High consensus	
			Quantity	Percentage (%)
Q12	4.0000	0.91515	259	80.7
Q13	3.8692	0.93959	248	77.3
Q14	4.0249	0.84373	267	83.2
Q15	4.0249	0.86205	264	82.2

In terms of skills development, the results show a clear awareness of the role of STEM education in the development of critical and creative thinking skills, with a mean value of 3.8692 and a consensus rate of 77.3%. This consensus rate, however, is lower than for other questions, reflecting uncertainty about the extent to which STEM education actually

impacts these skills. This is consistent with the findings by Nadelson and Seifert [12] and Thanh, et al. [13] emphasizing the need to integrate STEM education effectively to maximize its potential [12, 13].

The most notable point in this group of questions is the recognition of inequalities in access to STEM education between mountainous and urban regions. With a mean value of 4.0249 and a consensus rate of 83.2%, it is apparent that this inequality is widely recognized. This demonstrates a thorough knowledge of the unique constraints that mountainous regions confront in accessing and using STEM education, as addressed by Dinh and Nguyen [9] and Thanh [6] in their study [6, 9].

Finally, there is widespread consensus on the potential of STEM education to reduce educational inequalities in mountainous regions (a mean value of 4.0249, a consensus rate of 82.2%). This not only emphasizes the critical importance of STEM education in ensuring equitable educational opportunities, but it also serves as a call to action to increase resources and support for stem education in these regions.

Key opinions were acquired by asking respondents open-ended questions about the development of STEM education in the northern mountainous region, as shown in Table 10.

Table 10.
Comments or suggestions on STEM education in the northern mountainous region

No.	Content of comments	Quantity of comments
1	Strengthen facilities for the development of STEM education	120
2	Provide teachers with training courses on STEM education	85
3	Give examples of STEM lessons to schools	91
4	Give instructions for making STEM products from simple materials	72
5	Organize contests on STEM-based teaching in a more practical way	24
6	Design sample STEM lessons for teachers to learn and apply in their schools	33

These comments suggest that teachers and administrators are greatly interested in the development of STEM education, but they still need more help in order to properly apply STEM education in their classrooms.

Thus, the study's findings show that teachers and administrators all recognize the educational inequalities between the northern mountainous provinces and other central areas, and stem education will reduce this inequality.

3.5. Results From Qualitative Analysis (Interviews and Observations):

3.5.1. Interviews With Teachers

In-depth interviews with teachers in the mountainous northern regions of Vietnam provided a realistic view of the situation of stem education here. Several general responses from teachers revealed both the challenge and potential of stem education in reducing educational inequalities. Key interview questions are presented in Table 11.

Table 11.
Key interview questions for teachers

1. Can you describe how STEM subjects are taught at your school?
2. In your opinion, what are the biggest challenges in teaching STEM subjects in mountainous regions?
3. How do you think STEM education affects the development of students in mountainous regions?
4. What resources does your school have to support STEM education? Do you feel these resources are sufficient?
5. What initiatives have you implemented to improve the quality of STEM teaching?
6. What changes do you believe are required to improve stem education in mountainous regions?

Teachers point out how they frequently center their teaching on utilizing available resources and making the most of recycled materials. They discuss the lack of facilities and resources while yet attempting to provide a positive and innovative learning environment for students. This reflects an important trait in STEM education: the ability to adapt and create from difficult conditions, as highlighted in the study by Thanh, et al. [13].

The most significant problems in STEM education have been identified as a lack of facilities, educational resources, and professional support for teachers. This is consistent with Le, et al. [18] findings on the differences in educational opportunity between mountainous and urban regions [18].

However, teachers also believe that STEM education can help reduce educational inequalities. They discovered that, despite limited resources, creative use of available materials and the implementation of STEM projects in the classroom yielded great outcomes, not only in terms of improving skills but also in creating interest and passion in students. This reflects an important trend in STEM education, creativity and flexibility can compensate for resource deficiencies, as mentioned by Tran, et al. [21]

Finally, teachers indicated a need for additional investment in facilities and support to implement STEM education in schools. It is not only a demand to policymakers to act, but also an essential requirement for the long-term development of stem education in these regions.

3.5.2. Interviews with students

Responses from students in schools in Vietnam's mountainous regions provided valuable insight into their experiences and attitudes toward STEM education. Key interview questions are presented in Table 12. The students expressed their

enthusiasm and optimism for STEM subjects, as seen by their confidence and engagement in these classes in comparison to traditional educational ones.

Table 12.
Key interview questions with students.

1. How do you feel about STEM subjects at your school?
2. Do you believe you have adequate resources and support at school and from your family to succeed in STEM subjects?
3. Are you confident in the skills gained from your STEM subjects compared to your peers in the more developed regions of Vietnam?
4. What are your comments on how to improve STEM learning and teaching at your school?

Students expressed that they felt supported by the school but not by their families. They confront difficulties in terms of the facilities and technological tools required for STEM project practice and fabrication. This is a significant barrier to obtaining high-quality learning resources, as underlined by Tran, et al. [21] in their study of educational inequality in Vietnam [21].

Despite these obstacles, these students expressed a willingness to participate in more STEM activities. They expect more resources and assistance in STEM learning, including the availability of more facilities and technical tools. This demonstrates the critical need to increase the quality of stem education while also providing extra resources for students to make the most of learning opportunities in this area.

As a result, students' responses emphasize the importance of investing in stem education in mountainous regions, not only in terms of knowledge but also in terms of building a sufficient and supported learning environment. This not only benefits students' personal growth, but it also helps to reduce educational inequalities and improves the region's socioeconomic development.

3.6. Synthetic And Comparative Analysis

We compared target groups based on gender, seniority, and education level to further examine the viewpoints of different target groups on the research question. The results are shown in Table 13 and Figure 2.

Table 13.
Mean value of questions based on target groups

	Gender		**Educational level**		**Seniority**		
	Male	**Female**	**Bachelor**	**Master**	**1 to less than 5 years**	**From 6 to 10 years**	**Over 10 years**
Q4	3.9744	4.1127	4.0516	4.1014	4.0833	3.9474	4.0875
Q5	3.8291	3.9706	3.8968	4.0000	4.0000	3.8246	3.9333
Q6	4.0000	4.0637	4.0198	4.1159	4.2917	4.0877	4.0042
Q7	4.1709	4.1520	4.1746	4.1014	4.2083	4.0526	4.1792
Q8	4.0256	3.9559	3.9524	4.0870	4.0000	3.9649	3.9833
Q9	4.0513	4.0294	3.8826	3.8739	4.1667	4.0702	4.0167
Q10	4.0598	4.0324	4.1111	4.0870	4.0833	4.0351	4.1250
Q11	4.0513	3.9804	4.0675	3.7826	3.7500	3.9649	4.0417
Q12	4.0769	3.9559	4.0437	3.8406	4.0417	4.0175	3.9917
Q13	3.8462	3.8824	3.9246	3.9667	3.8333	3.9123	3.8625
Q14	4.0427	4.0147	4.0635	4.0841	3.9583	4.0877	4.0167
Q15	4.0684	4.1520	4.0556	4.1130	3.9167	4.0000	4.0417

Figure 2 depicts the difference in perspectives among the target groups based on gender, seniority, and educational level. However, the difference is minor and does not follow a consistent pattern across all questions. Female teachers sometimes make a lower rating than male teachers on research issues, particularly questions 8–12, although they make a higher rating in sentence 15. This demonstrates that female teachers are more confident in addressing educational inequalities through the use of STEM education. In terms of seniority, the results of the questions are not consistent. In general, the consistent pattern in this group is not evident. Teachers with a master's degree frequently have a more positive outlook than those with a bachelor's degree. They are more confident in the success of STEM education and its role in erasing educational inequalities.

This disparity may represent differences in understandings and expectations among groups, as well as the impact of factors such as teaching experience, gender, and professional knowledge on the perspective of the issues investigated.

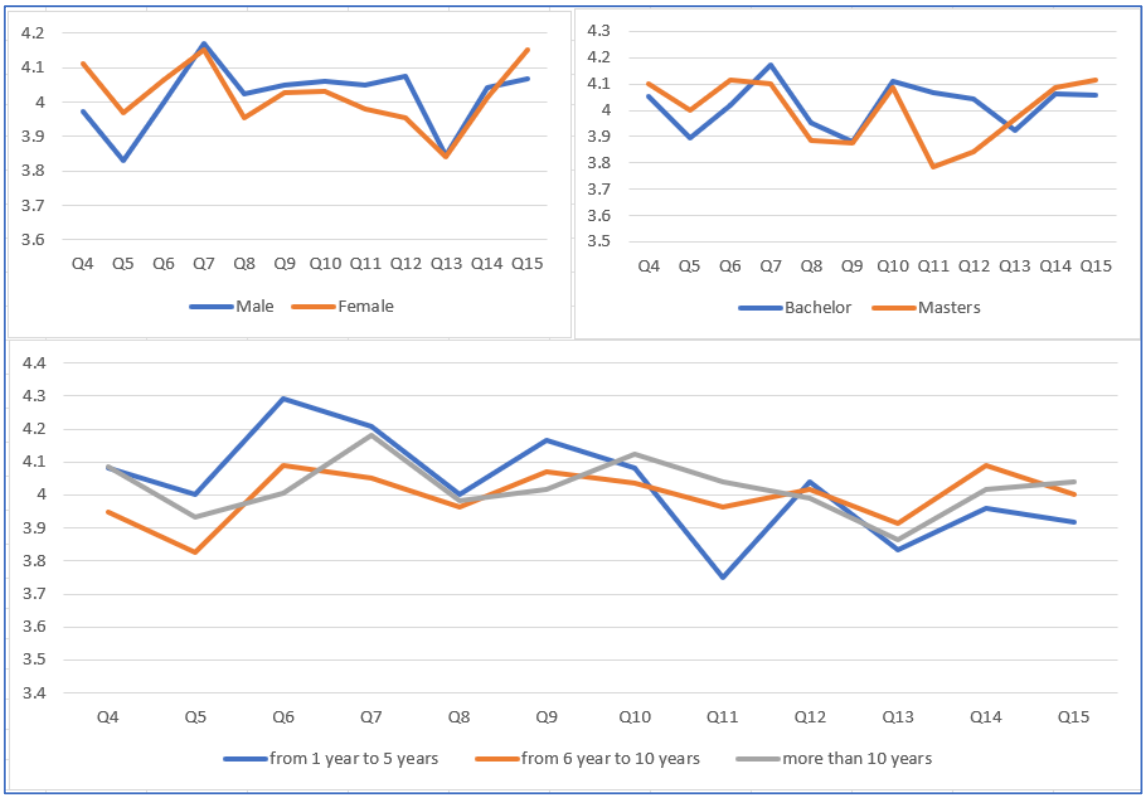

Figure 2.
Graph showing the mean value of the questions based on a) gender b) education level c) seniority

4. Conclusion

The study on the role of stem education in reducing educational inequalities in the northern mountainous provinces of Vietnam shows that there is a clear and positive knowledge of STEM education among teachers and administrators. Although STEM education is highly recognized for its 21st-century skill development and enthusiasm in learning and teaching, problems such as a lack of resources and support, as well as limited knowledge and support from parents and the community persist. The study found that access to STEM education differs across mountainous and urban areas, but the study also found that STEM education has the capacity to reduce this inequality. Teachers and students in mountainous regions expressed a wish for improved support and the provision of tools required to make the most of STEM learning opportunities.

5. Recommendations

In order to promote and improve the effectiveness of STEM education as well as reduce educational inequalities in northern mountainous provinces of Vietnam, we recommend: (1) Increasing investment in STEM education facilities and resources, including recycled technologies and materials, to enhance learning and teaching; (2) Creating and implementing continuous professional and refresher training programs for teachers, with a focus on creativity and flexibility in the use of stem teaching approaches; (3) Increasing community and parent knowledge and participation in advocating for and understanding of stem education through effective education and communication programs; (4) Encouraging collaboration among schools, local communities, and educational organizations education to share resources and experiences, creating the best learning opportunities for students; (5) Supporting and encouraging the implementation of practical and creative STEM projects in schools, with the goal of assisting students in maximizing their STEM skills and knowledge; (6) Creating and executing particular strategies to assist mountainous regions in reducing inequality and increasing access to high-quality education; (7) Strengthening the development of online support tools such as sample stem education lectures, videos to guide STEM product production, and so on, so that teachers and students in mountainous, remote, and disadvantaged areas can be more convenient in STEM teaching and learning.

6. Limitations

Because this study was conducted mostly in Vietnam's mountainous northern provinces, it has limited representation and subjectivity due to its dependence on secondary data and interviews. Furthermore, access to STEM education in this region is limited, reducing the credibility of the outcomes. To improve the study's quality, it is required to broaden its geographical coverage, reinforce quantitative data, and delve further into the investigation of factors influencing STEM education. Long-term follow-up will also aid in better understanding the influence of STEM education on reducing educational inequalities.

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