Impact of factors influencing the STEM career-oriented subjects choice of Vietnamese high school students

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Article Info

ABSTRACT

Studying subjects in school had a relationship with students' future career choices. However, science, technology, engineering and mathematics fields (STEM) careers are often considered to be less accessible by many children. The purpose of this study is to investigate the factors influencing the STEM career-oriented subjects' choice of Vietnamese high school students. The survey was conducted with 1768 students in grade 10th (at the age of 16) in several high schools in 4 provinces represented for different geography regions of Vietnam by questionnaire combined with direct investigation using contact and interview methods with students. The results indicated that gender and students' academic achievement in science studies were measured as factors to consistently and positively associate with students' subjects choice toward STEM career orientation, accounting for other factors. The implications of this study in education are that teachers and educators should organize learning and teaching activities appropriate to male and female students in order to improve their academic achievement and their self-efficacy in science subjects. Hence, these supporting measures may foster students' selection of STEM-related subjects to study and enhance students' aspirations towards STEM careers.
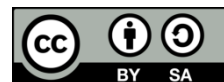
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1. INTRODUCTION

The high school period is the time that later forms young people's impressions of science and influences their future career decisions [1]. The improvement of students' interest and approaches to science disciplines and the leading students into science fields was important [2]. There is a noted disinterest among school students in pursuing science studies and careers in science-related fields [3]. A widespread concern exists regarding the diminishing interest of high school students in pursuing science, technology, engineering and mathematics fields (STEM) related careers [4]. Many children perceive science-related careers as being difficult to attain [5]. School STEM subjects play a crucial role in shaping career decisions by preparing students for the challenges of future employment [6]. Career assessments provide young individuals with a chance to reflect on themselves, learn about their interests and values, understand the influences that have shaped them, and integrate different aspects of their life and identity, thereby empowering them to make career choices that align with their personal identity [7]. Therefore, choosing and learning science-related subjects (such as biology, chemistry, and physics) at the high school provides the necessary groundwork for students intending to pursue university-level science studies and, ultimately, careers in STEM.

The focus on career-oriented education has grown in popularity in recent times [8]. According to the expectancy-value theory, an individual's achievement-related choices, perseverance, and performance are

influenced by their motivational drivers and personal beliefs [9]. For this study, the expectancy-value theory suggests that a student's belief in their ability to succeed in a career (expectancy) and how much they value that career (subjective value) combine to shape their career motivation (expectation) [10]. Additionally, factors like gender, race, and socioeconomic status influence these career expectations by affecting how students perceive their own skills and values [11].

Students' STEM career aspirations may be influenced by numerous factors, including their family circumstances, their educational experiences, and their own views [12]. Previous research has demonstrated that children with parents in science-related careers are more likely to develop science-related aspirations, complete science-related degrees, and enter science-related professions [13]. Moreover, gender, school type, mother and father education level and family income were the factors influencing Turkish high school students' career choices in science and technology [14]. Emotional closeness plays a vital role in the effectiveness of vocational role learning [15]. Parents establish the foundational framework for career aspirations through their behaviors, attitudes, and support. Aspirations for science-related careers are dependent on individual attributes, capabilities, interests, and attitudes but are also impacted by parents and family members and broader societal influences, including gender stereotypes [16].

Regarding the impact of objective contextual factors on self-efficacy and career choice, results of previous researches indicated that math interest, and science self- efficacy were the most important predictors of STEM career aspirations [17]. Understanding college requirements and self-efficacy in math and science were more positively related to major choice. Participation in career experience activities and learning environments has also been shown to significantly influence an individual's level of educational aspirations in a field [18]. To maintain aspirations in STEM-related career, it is important that students develop strong self-efficacy in STEM subjects and that they remain engaged and interested throughout the secondary school years [19].

Prior studies indicate that having an interest in a subject is typically a necessary factor for effective academic learning [20]. Initiatives designed to make STEM careers more appealing should include both male and female participants. By providing classes that boost student motivation, the perceived intrinsic worth of math and science is elevated, and students are more inclined to choose a STEM career path [21]. Studies indicate that students' interest in their academic subjects strongly influences their career certainty, and this influence is channeled through their aspiration to apply that interest in their future careers [22]. In reality, in order to increase the number of students with career orientation in specialized fields such as science and technology, teachers need to improve students' attitudes, such as awareness of science and technology applications and the work of explaining practical phenomena in subjects and the work of professions and applying various teaching methods to inspire or attract students. Children's perspectives, including their science self-efficacy, their interest in the subject, and their view of the utility of science-related pursuits, are connected to their career ambitions and academic selections [23]. A motivational pattern characterized by confidence in success, a positive view of science's interest, importance, and usefulness, and a belief that studying science was not difficult, correlated with the highest science performance and career goals [24].

In the Vietnamese general education curriculum 2018 [25], at the high school level, in addition to compulsory subjects, there are elective subjects. Allowing students to choose subjects according to their interests and strengths is an important content that demonstrates the progressive spirit of the curriculum. Accordingly, in addition to the compulsory subjects and educational activities, 10th grade students can choose 4 subjects out of 9 elective subjects (geography, economic and legal education, physics, chemistry, biology, technology, informatics, music, and fine arts). The emergence of new careers in the future also requires the alternating of knowledge, such as natural knowledge. This direction of change will create choices and opportunities for students to meet the STEM career orientation needs. Students will choose subjects according to their interests and in accordance with the knowledge requirements for diverse career orientations in society. In the school year 2022-2023, the general education curriculum 2018 has been implemented for grade 10 and rolled out in the following years for grades 11 and 12. However, students entering grade 10 have many confusions and difficulties in selecting a group of subjects to study during three years of high school. Exploring the factors that affect students' choice of STEM career-oriented subjects in order to propose measures to effectively support students in implementing the general education program plays an important role.

This study investigates the impact of factors related to the choice of STEM career-oriented subjects among Vietnamese high school students. While previous studies have investigated the influence of a number of factors on students' career orientation related to STEM careers, they have not clearly mentioned the factors that determine the choice of STEM subjects to study and implications for teaching practices to improve the effectiveness of STEM-oriented careers for high school students. Therefore, this study focuses on some research questions: i) what are effectively factors influencing high school students' STEM career-oriented subject choice? and ii) how to propose applications for teachers and educators in organizing orientation to support students in choosing STEM career-oriented subjects?

2. METHOD

2.1. Research instrument

The survey instrument included questions referenced from previous research [26]–[29] and adjusted to suit the research context. Next, we tested the question set with students to evaluate the appropriateness of each question. After pre-testing, the questionnaire was edited to ensure ease of understanding and sufficient reliability needed for use in this study. The observed variables of the scale used for the official survey are the 4-point Likert scale. In particular, the level of agreement on statements related to science-related subject choice, academic achievement, is from i) "strongly disagree", ii) "disagree", iii) "agree", and iv) "strongly agree". Some examples of items/factors in the questionnaires were indicated in Table 1.

Table 1. Some examples of items/factors in the questionnaires

Item/factor	Example item
Students' STEM subject choice	"I choose to study biology at high school."
Students' academic achievement	"The final score at the end of the 2023-2024 school year for my biology subject is 8.0-8.5 (maximum is 10)."
Mother's profession	"My mother's current main occupation is an employee."
Father's profession	"My father's current main occupation is an employee."
Mother's professional qualifications	"My mother's education is from a university graduate or higher."
Father's professional qualifications	"My father's education is from a university graduate or higher".

2.2. Data collection

The survey was conducted with 1768 students in grade 10th (at the age of 16) in several high schools in 4 provinces represented for different geography regions of Vietnam, including Hanoi, Hoa Binh (in the northern), Ninh Thuan (in the central) and Kien Giang province (in the southern). Survey by questionnaire combined with direct investigation using contact and interview methods with students in the school year 2024-2025. The formal analysis of this study was based on 1768 questionnaires.

2.3. Data analysis

Data acquisition was achieved via a survey, and the resulting information was processed using correlational and regression statistical methods. Reliability of the scales for the model's factors and dependent variables will be determined through Cronbach's Alpha and total variable correlation coefficients. Before the main study, the questionnaire was pilot-tested for reliability using Cronbach's Alpha with participants not included in the final data. The scale is considered reliable if it meets the criteria of a Cronbach's Alpha of 0.6 or higher and a total variable correlation of 0.3 or higher. We determined that successful exploratory factor analysis (EFA) required a Kaiser-Meyer-Olkin (KMO) coefficient of 0.5 or higher, a Bartlett's test with a p-value below 0.05, explained variance exceeding 50%, eigenvalues of at least 1, and the application of the multiplicative loading factor. We conducted linear and logistic regression analyses to investigate the correlations between the variables. Additionally, the regression analysis was interpreted by examining the R-squared value, specifically its percentage, which indicates the strength of the relationship. Correlations between variable pairs were analyzed using linear regression, and logistic regression was utilized to assess the factors impacting students' science subject performance. The data were processed and analyzed through the SPSS software.

The novelty of our research method lies in the unique combination of descriptive, interview, correlational, and regressional survey research. While previous research has explored survey research, none have integrated them in the way we propose. Specifically, we are developing the questionnaire and analyzing the correlative relationship and regression, which allows us to predict the impact of factors on STEM-related subject choice of students. This approach enables us to identify clearly the factors that determine the choice of STEM subjects among 10th-grade students in Vietnam with quantifiable improvement.

3. RESULTS AND DISCUSSION

3.1. Analyzing the correlation between factors affecting the choice of subjects of 10th grade students

The results of correlation analysis of the impact of factors on student subject choice was indicated in Table 2. We found that there was a close correlation between the students' academic achievement in subjects and subject choice of students which was illustrated through the pearson correlation coefficient of 0.105, sig<0.01. Prior research demonstrated a positive relationship between career development, academic motivation, and self-efficacy, with improvements in career development leading to enhanced academic self-efficacy [30]. Student characteristics were linked to career expectations in STEM, science and engineering, health services, and information and communication technology (ICT) categorie [31]. Students'

subjective assessment of their performance in math, physics, and chemistry was a stronger predictor of their interest in those subjects than their measured academic results [32].

However, in this research we also investigated that gender, parents' desired level of education, parents' qualifications, and parents' occupation had no relationship with the choice of subjects' students' studies. Our study suggested that students with different family backgrounds and parents with different occupations may still tend to choose STEM subjects and desire STEM careers in the future. The alignment of career views between adolescents and their parents partially explains how academic fit influences career exploration. Finding was suggested that academic fit directly encourages students to explore careers and also fosters parent-adolescent career agreement, which further promotes career exploration [33]. Furthermore, according to the interview results of students in our case study, parents rarely share career-related work with their children, so students are less influenced by their parents in the process of choosing related subjects regarding career orientation.

Table 2. Correlation summary

Factor	Pearson correlation	Students' STEM-related subject choice	Gender	Students' academic achievement	Mother's profession	Father's profession	Mother's professional qualifications	Father's professional qualifications
1. Students' STEM-related subject choice	Pearson Correlation	1						
	Sig. (2-tailed)							
2. Gender	Pearson Correlation	-0.036	1					
	Sig. (2-tailed)	0.126						
3. Students' academic achievement	Pearson Correlation	0.105	-0.106	1				
	Sig. (2-tailed)	<0.001	<.001					
4. Mother's profession	Pearson Correlation	0.022	0.027	0.006	1			
	Sig. (2-tailed)	0.351	0.252	0.799				
5. Father's profession	Pearson Correlation	0.003	0.018	0.038	0.394	1		
	Sig. (2-tailed)	0.907	0.445	0.106	0.000			
6. Mother's professional qualifications	Pearson Correlation	0.008	0.055	0.293	-0.055	0.075	1	
	Sig. (2-tailed)	0.727	0.021	<0.001	0.021	0.001		
7. Father's professional qualifications	Pearson Correlation	0.014	0.041	0.276	-0.045	0.065	0.707	1
	Sig. (2-tailed)	0.551	0.086	<0.001	0.059	0.006	<0.001	

Note: Pearson's correlation coefficients are displayed, and those with a p-value less than 0.05 are shown in bold to indicate statistical significance.

3.2. Modelling predicting STEM-related subject choice

We used linear regression analysis and logistic regression to explore the impact of factors such as gender, parents, and subject learning outcomes on students' choice of science-oriented subjects. Linear regression analysis of factors affecting students' subject choice was shown in Table 3 with R-square value=0.099, sig<0.01. The results of linear regression analysis showed that 'academic achievement' and 'gender' were factors that had a positive and consistent impact on students' subject choice. They were shown in the standardized coefficients from 0.272 and 0.142, sig<0.01. However, according to the results of linear regression analysis, the factors students' desired education level, parents' desired education level, mother's profession, mother's professional qualifications, and father's professional qualifications have no impact on students' science-related subject choice. Specially, the factor 'father's profession' had the negative association with students' subject-related choice. The results of logistic regression analysis to predict the impact of factors on student subject choice with an overall percentage of 82.3% are indicated in Table 4. The results of logistic analysis showed that students' academic achievement is the positive and consistent impact on students' choice of STEM career-oriented subjects. However, the factors of 'gender', students' desired education level, parents' desired education level, mother's profession, father's profession, mother's professional qualifications, and father's professional qualifications have no impact on students' science-related subject choice.

Our study suggested that in Vietnam, students with higher learning outcomes and self-efficacy in STEM subjects will tend to choose this subject at the high school level when they have a choice of subjects interested and career-oriented. The results of this research also indicated that there was a difference between male students and female students in choosing STEM subjects. However, gender was not a decisive factor in the choice of STEM subjects in the prediction model of students' tendency to choose STEM subjects and careers. The current study's findings on the influence of gender and academic achievement aligned with

earlier research, which showed that societal beliefs about gender roles impact students' self-perception and their likelihood of choosing STEM fields [34].

Table 3. Regression linear summary

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	Beta		
(Constant)	1.809	0.147		12.316	<0.001
1. Gender	0.245	0.039	0.142	6.208	<0.000
2. Academic achievement	0.208	0.019	0.272	11.053	<0.000
3. Students' desired education level	-0.149	0.082	-0.065	-1.813	0.070
4. Parents' desired education level	0.082	0.084	0.035	0.969	0.333
5. Mother's profession	0.003	0.035	0.002	0.095	0.924
6. Father's profession	-0.079	0.040	-0.049	-1.984	0.047
7. Mother's professional qualifications	0.039	0.031	0.041	1.264	0.206
8. Father's professional qualifications	-0.013	0.030	-0.013	-0.418	0.676

Adjusted R-square: 0.099. Dependent variable: students' science-related subject choice. Note: values that are statistically significant ($p<0.05$) are displayed in bold.

Table 4. Summary of the model predicting students' science subject choices (logistic regression)

Step	Model	B	S. E.	Wald	df	Sig.	Exp(B)
Step 1[a]	1. Gender	-0.242	0.192	1.602	1	0.206	0.785
	2. Students' academic achievement	0.293	0.107	7.438	1	0.006	1.341
	3. Students' desired education level	-0.087	0.406	0.046	1	0.830	0.916
	4. Parents' desired education level	0.247	0.420	0.346	1	0.557	1.280
	5. Mother's profession	0.052	0.170	0.092	1	0.762	1.053
	6. Father's profession	0.154	0.195	0.622	1	0.430	1.167
	7. Mother's professional qualifications	0.041	0.150	0.075	1	0.784	1.042
	8. Father's professional qualifications	-0.149	0.143	1.093	1	0.296	0.861
	Constant	0.582	0.716	0.661	1	0.416	1.789

Nagelkerke R-square: 0.025. Note: logistic modelling was used to predict students' science subject choices; exponential coefficients ('Exp.') and significance ('Sig.'; p-values) are reported. Exponential coefficients are 'odds ratios'; significant coefficients ($p<0.05$) are highlighted in bold.

Teaching science subjects that are able to respond appropriately to male and female students in a general education environment can bring special benefits. According to the results of research based on the theory of Eccles's expectancy value model aimed at academic achievement and career choice [35], [9] proposed an impact method in teaching mathematics and science, starting with improving the motivation of male and female students related to these areas. Thus, the ability to apply the knowledge of the subject in practice and the actual achievements of students in the subjects have developed and improved. Subject-related learning motivation has a clear impact on female students, while academic achievement has a positive effect on male students. Specifically, students' interest in physics is identified as a factor that has a strong impact on male students' choice of majoring in STEM fields when choosing. However, as pointed out in recent studies [36], [37], it is still a matter of debate whether physics will become a new barrier controlling students' choice of studying and working in STEM fields. According to research based on the social cognitive career theory, students' career choices are mostly affected by the STEM subjects they can take in school, their career orientation, and their ability to find STEM-related jobs, as well as the social influences they receive from family, friends, and role models [38].

The results supported the hypothesis that increasing students' academic achievement in STEM-related subjects would promote their scientific career aspiration and STEM career-oriented subject choice. STEM orientation and particularly career aspirations had received less attention than individual interest perspectives [39]. At the same time, science teachers have challenges to introduce, promote, and use careers in their teaching. In addition, stereotypes of the careers still exist, and school science fails to promote the role of women in science. Sustainable solutions to improve girls' participation in science education include providing more educational resources, encouraging female students to pursue science, and educating students, teachers, parents, and community members about the importance of girls in science [40]. Enhancing motivational factors within mathematics, physics, and chemistry classrooms through focused teaching methods can increase high school students' learning motivation and positively influence their decision to pursue STEM studies. This finding is practically significant and gives us hope, as science careers are becoming more and more vital in our society.

The empirical results reported herein should be considered some of the limitations. There were three significant limitations in this study that should be addressed in further research. Firstly, the research focused on 10th-grade high school students in regions of Vietnam, with the number of surveys in 24 schools; the survey results may be more diverse if deployed in a larger number of schools. Secondly, the study utilized

qualitative research and also used quantitative methods in two high schools within Hanoi and Hoa Binh province to clarify and analyze some of the survey results; however, the comprehensiveness of the results might be achieved more fully, in detail, and more diversely if direct interviews with students in more schools in more regions were used. Thirdly, this study found that parents had no influence on students' choice of STEM subjects and STEM career aspirations; fathers' profession was the factor that had a negative impact on students' choice of subjects; research results could be more clarify the role and moderating influence of parents on high school students' choice of STEM subjects and careers.

4.   CONCLUSION

Analysis of factors affecting high school students' STEM career-oriented subject choice in Vietnam highlighted that gender and students' academic achievement in STEM-related studies were measured as factors to clearly associate with students' subjects' choice toward STEM career orientation, accounting for other factors. However, family factors such as parents' desired level of education, parents' occupation, and measured parents' qualifications have no relationship with students' choice of STEM career-oriented subjects. Overall, these patterns of results suggested that increasing students' academic achievement in STEM-related subjects such as math, biology, physics, chemistry, etc. may then help foster students' aspirations towards STEM careers and promote them to select these subjects to study in high school in Vietnam. Particularly, learning outcomes and confidence in subjects related to science and engineering are factors that have a positive and consistent impact on students' choice of STEM career-oriented subjects.

This study's findings are applicable to educational settings in these ways: teachers and educators should organize learning and teaching activities appropriate to male and female students in order to improve their academic achievement and their self-efficacy in science subjects. Hence, supporting measured teachers and educators may foster students' selection of STEM-related subjects to study and enhance students' aspirations towards STEM careers. In this study, parents had little influence on the choice of STEM-related subjects because parents rarely shared career orientation for their children. Therefore, parents should share more with their children about the characteristics, trends, and future prospects of STEM careers to promote students' interest and love of STEM-oriented subjects and careers.

Future research should investigate deeper into the learning and teaching approaches and educational conditions that promote students' academic achievement in math and science subjects and enhance teachers' STEM-career orientation teaching to promote student's self-efficacy in the STEM field and STEM career aspirations for high school students. Moreover, further research needs to clarify how measured support for teachers and educators can motivate students to choose STEM-related subjects to study and increase students' aspirations towards STEM careers. In addition, other research could clarify the role and moderating influence of parents on high school students' choice of STEM subjects and careers.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization	I : **I**nvestigation	Vi : **Vi**sualization
M : **M**ethodology	R : **R**esources	Su : **Su**pervision
So : **So**ftware	D : **D**ata Curation	P : **P**roject administration
Va : **Va**lidation	O : Writing - **O**riginal Draft	Fu : **Fu**nding acquisition
Fo : **Fo**rmal analysis	E : Writing - Review & **E**diting	

CONFLICT OF INTEREST STATEMENT
The authors declare no conflict of interest, financial or otherwise, associated with this paper.

CONFLICT OF INTEREST STATEMENT
Authors state no conflict of interest.

INFORMED CONSENT
We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL
The research related to human use has been complied with all the relevant national regulations and institutional policies in accordance with the tenets of the Helsinki Declaration and has been approved by the Vietnam National Institute of Educational Sciences review board.

DATA AVAILABILITY
The authors confirm that the data supporting the findings of this study are available within the article.

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