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UTILIZING THE STEM-CIS INSTRUMENT TO EVALUATE THE REALITY OF STEM CAREER INTERESTS OF 10TH AND 11TH-GRADE STUDENTS OF SOME HIGH SCHOOLS IN HO CHI MINH CITY, VIETNAM

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ABSTRACT

One of the major priorities of many nations worldwide is to train STEM human resources to fulfill the demands of the 21st century. Given the potential scarcity of Vietnam's STEM workforce, it is vital to ascertain students' present STEM career interests to assist them immediately in making a STEM career decision. Therefore, the research used the STEM Career Interest Survey (STEM-CIS) instrument to describe the overall picture of STEM career interest through six social cognitive career theory (SCCT) aspects. The results processed using R software with the sample of 909 students of 10th and 11th grade studying the 2018 general education curriculum at five high schools in Ho Chi Minh City (Vietnam) show the relatively high average values of SCCT aspects in STEM careers of participants, in which the technology field is the highest, the engineering field is the lowest, and the interest between STEM fields correlates with each other. Furthermore, gender differences in STEM-CIS for each field and SCCT aspects are statistically significant, while grade levels are not. These findings will contribute to orienting the implementation of relevant educational activities in general or STEM educational activities in particular at high schools to promote STEM career pathways for Vietnamese students.

SỬ DỤNG CÔNG CỤ STEM-CIS ĐÁNH GIÁ THỰC TRẠNG HỨNG THÚ NGHỀ NGHIỆP CỦA HỌC SINH LỚP 10 VÀ 11 TẠI MỘT SỐ TRƯỜNG TRUNG HỌC PHỔ THÔNG TẠI THÀNH PHỐ HỒ CHÍ MINH, VIỆT NAM

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TỪ KHÓA

Định hướng nghề nghiệp STEM
Lý thuyết nhận thức xã hội về nghề nghiệp
Chương trình giáo dục phổ thông 2018
Học sinh trung học phổ thông
Giáo dục STEM

TÓM TẮT

Đào tạo nguồn nhân lực STEM đáp ứng nhu cầu của thế kỉ XXI là một trong những chính sách ưu tiên hàng đầu của đông đảo các quốc gia trên thế giới. Trong bối cảnh Việt Nam đối mặt với nguy cơ thiếu hụt nguồn nhân lực STEM trong tương lai, việc điều tra thực trạng hứng thú nghề nghiệp STEM của học sinh để kịp thời định hướng lựa chọn theo đuổi nghề nghiệp STEM là điều cần thiết. Do đó, bài báo sử dụng công cụ STEM Career Interest Survey (STEM-CIS) để mô tả bức tranh tổng quan liên quan đến hứng thú nghề nghiệp STEM thông qua 6 khía cạnh của lý thuyết nhận thức xã hội về nghề nghiệp (social cognitive career theory). Kết quả xử lí bằng phần mềm R với mẫu 909 học sinh lớp 10 và 11 đang theo học chương trình giáo dục phổ thông 2018 tại 5 trường trung học phổ thông trên địa bàn thành phố Hồ Chí Minh tại Việt Nam cho thấy giá trị trung bình chung các khía cạnh lý thuyết nhận thức xã hội về nghề nghiệp STEM của học sinh ở mức khá, trong đó lĩnh vực Công nghệ là cao nhất, Kĩ thuật là thấp nhất, và hứng thú giữa các lĩnh vực STEM có mối tương quan với nhau. Thêm vào đó, hứng thú nghề nghiệp STEM và các khía cạnh lý thuyết nhận thức xã hội về nghề nghiệp có sự khác biệt mang ý nghĩa thống kê giữa giới tính, nhưng không với khối lớp. Những kết quả trên sẽ góp phần định hướng triển khai các hoạt động giáo dục nói chung hay các hoạt động giáo dục STEM nói riêng phù hợp tại nhà trường THPT trong việc cải thiện định hướng lựa chọn nghề nghiệp STEM của học sinh.

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1. Introduction

The fourth industrial revolution's background has posed the education sector with the task of preparing high-quality human resources in STEM fields (science, technology, engineering, and mathematics) as a premise for scientific and technological development, enhancing economic competitiveness, and meeting the increasing demand for integration of each country and nation [1]. In line with the global trend, Vietnam has implemented various policies, strategies, and orientations to encourage students to pursue STEM careers. These include Directive No. 16/CT-TTg on strengthening the capacity to access the fourth industrial revolution [2], Vocational education project and student stream orientation in general education for the period 2018 – 2025 [3], The 2018 general education curriculum [4], The experiential and vocational activities curriculum [5], Official letter 3089/BGDĐT-GDTrH on the implementation of STEM education in secondary education [6], The scientific seminar "Training high-quality human resources in the fields of science, technology, engineering, and mathematics (STEM), implementing strategic breakthroughs in human resource development according to the 13th National Party Congress Resolution" [7], etc. However, only 28.7% of Vietnamese students choose to study STEM in 2021, according to the Ministry of Education and Training's report summarizing enrollment and training for the 2021–2022 academic year [8]. This is much less than those of other countries in the region and in Europe, such as Germany (39%), Singapore (46%), Malaysia (50%), Korea (35%), Finland (36%), etc.

According to the social cognitive career theory (SCCT), career interest plays a crucial role in individuals' career choice decisions [9], [10]. This theory has been widely accepted and applied by researchers in studies related to STEM career choice [11] - [15]. Therefore, investigating and clarifying the state of students' STEM career interests is essential for timely guiding students to choose STEM careers, and improving the shortage of STEM human resources in Vietnam. Based on the SCCT model, Kier et al. (2014) developed the STEM Career Interest Survey (STEM-CIS) to provide a valuable tool for assessing students' STEM career interests and related factors [13]. Specifically, it is a four-scale instrument for science, technology, engineering, and mathematics, including 44 Likert questions with five levels, focusing on examining six SCCT aspects: self-efficacy, outcome expectation, interest, personal goal, contextual support, and personal input. Among these, self-efficacy and outcome expectation directly influence the interest aspect. Additionally, contextual support and personal input are factors affecting personal goals, which in turn are directly related to career interests [9], [10]. STEM-CIS is a reliable tool used by researchers worldwide at various grade levels. It can be flexibly used in whole or in part for various purposes, such as assessing the state of students' STEM career interests [16] - [19]; evaluating the suitability of STEM-CIS in different countries [20] - [22]; assessing the impact of STEM programs and activities on STEM career interest and related SCCT components [23] - [26]; using individual SCCT components in the instrument for other research models [27], [28]; etc.

In Vietnamese education, the 2018 general education curriculum emphasizes that the high school level is where career guidance education needs to be focused [4]. Therefore, the state of STEM career interests of grade 10 and 11 students studying under the 2018 program will be even more valuable scientific data, contributing to the evaluation, adjustment, and orientation of the implementation of the general education program. Within the scope of grade 10 and 11 students in some high schools in Ho Chi Minh City, the article uses the STEM-CIS instrument to focus on answering the following research questions:

(1) What is the state of students' STEM career interests and SCCT aspects?

(2) Is there a correlation of interest between the science, technology, engineering, and mathematics fields?

(3) Are there any differences in STEM career interest and SCCT aspects regarding gender and grade level?

2. Methods

2.1. Measurement

In this study, the STEM-CIS instrument was translated into Vietnamese and evaluated on a 10-level Likert scale (in which level 1 is completely disagree and level 10 is completely agree) [13]. The study converted from the Likert 5 scale to the Likert 10 scale to expand the scope of assessment, increase the distinction between levels, and allow more accurate data collection from participants. Then, a sample of 31 students at a school in Ho Chi Minh City was interviewed to ensure that the statements in the questionnaire were clear and accurately reflected the study's objectives. After making necessary adjustments, the final scale achieved a Cronbach's Alpha of 0.872 for the 44 items of STEM-CIS. Furthermore, the item-total correlation ranged from 0.402 to 0.753, with no observed variables having a correlation of less than 0.3. Thus, this instrument is suitable for surveying the current state of STEM career interests of students.

2.2. Sampling and participants

From October to November 2023, 988 high school students from five different high schools in Ho Chi Minh City, Vietnam, participated in the study. These students were randomly selected using a convenience sampling method. Data cleaning was conducted to eliminate instances in which students selected only one level for every Likert scale question or did not respond to any of the questions. After data cleaning, the final sample comprised 909 students with 43.9% male, 56.1% female (statistics by gender) or 48.5% in grade 11, and 51.5% in grade 10 (statistics by grade level).

2.3. Data analysis

After performing the descriptive statistics, we discovered that each component's mean (M) and median (Med) values were nearly equal. The research investigation included parametric testing with R software. The average value of component trends was observed using descriptive statistics methods, and the influence of SCCT components on students' career trends was interpreted using Pearson correlation analysis. The t-test approach was used to look for variations in grade levels and gender in STEM career interest and SCCT features.

3. Results and discussions

3.1. STEM-CIS results in each STEM field

Analysis results show that the average STEM-CIS in each student's STEM field ranges from 6.72 to 7.55 (Figure 1). Specifically, the highest average level of career interest is in the technology field, and the lowest is in the engineering field. This result is similar to the studies with learners in Indonesia [18], [19], [29]. However, when compared with students in Turkey and Kazakhstan, although engineering is still the least interesting field for students, technology is ranked behind science and mathematics [16], [30]. Therefore, it is necessary to pay attention to integrating career education into STEM activities, especially those related to engineering, to promptly improve students' state in Vietnam and other countries in general.

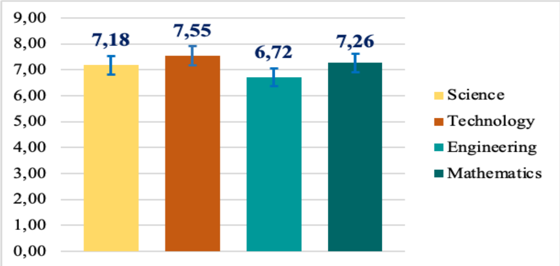

Figure 1. *General career interest in each STEM field*

3.2. Current status of each aspect of Social cognitive career theory

First, the average score of SCCT values in the STEM fields decreases in the order of outcome expectation, personal goal, self-efficacy, interest, personal input, and contextual support (Table 1). This coincides with the research results on both middle school students and pedagogical students in Indonesia [18], [19], [29]. Besides, compared with high school students in Turkey, the results are only consistent with the two lowest values: personal input and contextual support. In contrast, the highest value belongs to self-efficacy [30]. Overall, this is a good result because the three aspects with the highest average scores are: outcome expectation, personal goal, and self-efficacy, which are all factors directly related to students' STEM career interests [9], [10]. However, Table 1 also shows that the scores of contextual support and personal input are quite low. This reflects the fact that students do not have many opportunities to interact with individuals in the STEM field or have ideal career role models inside or outside the family. In addition, the average value of each SCCT aspect in the technology field is the highest (except for personal goal), and vice versa for engineering. Furthermore, although the average score of all SCCT aspects of mathematics ($M_{Mathematics} = 7.26$) is greater than that of science ($M_{Science} = 7.18$) (Figure 1), the scores of some aspects of science are still higher. Each aspect of SCCT in science, technology, engineering, and mathematics will be clarified below.

Table 1. *Descriptive statistics of each aspect of Social cognitive career theory*

	Science		**Technology**		**Engineering**		**Mathematics**		**STEM**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
SE	7.20	1.765	7.81	1.672	7.05	1.801	7.45	1.777	7.38	1.247
PG	7.50	1.939	7.61	1.780	6.76	1.877	7.82	1.763	7.42	1.323
OE	7.74	1.812	8.38	1.507	7.33	1.668	7.74	1.812	7.77	1.288
INT	7.00	2.077	7.28	1.846	6.61	1.938	6.92	2.192	6.95	1.510
CS	6.68	2.086	6.90	2.105	6.10	2.357	6.55	2.221	6.56	1.667
PI	6.93	2.532	7.12	2.364	6.18	2.754	6.96	2.488	6.80	1.794

3.2.1. Self-efficacy

The average value of self-efficacy in STEM fields ranges from 7.05 to 7.81 (in which $M_{Technology} > M_{Mathematics} > M_{Science} > M_{Engineering}$). It can be said that students have a certain confidence in STEM subjects and activities. Although in Vietnam, Technology at the high school level is not a compulsory subject, students still feel confident when using technology in activities and when learning how to use new technology applications. However, students need more self-confidence when participating in and completing engineering-related activities. This is also the general situation in other countries [18], [19], [29], [30].

3.2.2. Personal goal

The average value of personal goals in STEM fields ranges from 6.76 to 7.82 (in which $M_{Mathematics} > M_{Technology} > M_{Science} > M_{Engineering}$). This result shows that students have certain plans to use STEM-related knowledge and skills in their future careers. From there, motivate yourself to study hard in STEM subjects and participate in STEM activities inside and outside of school. However, it is possible that many students do not clearly understand the nature of technical professions [31], so engineering is still the field with the lowest personal goal compared to other fields.

3.2.3. Outcome expectation

The outcome expectation is the only aspect expectation of SCCT with an average value greater than 8, specifically ranging from 7.33 to 8.38 (in which $M_{Technology} > M_{Science} = M_{Mathematics} > M_{Engineering}$). This shows that students realize the future STEM career prospects and will receive support from their families and relatives when pursuing these careers. Students tend to think that using technology will be very useful for their future careers and have better career prospects than in other fields. This result also partly reflects the current context with the rapid development of technology, typically artistic intelligence is a field that many educational researchers are interested in integrating into their professional future students [32].

3.2.4. Interest

The average value of interest in STEM fields ranges from 6.61 to 7.28 (in which $M_{Technology}$ > $M_{Science}$ > $M_{Mathematics}$ > $M_{Engineering}$). This data shows that students' interest in engineering-related activities or engineering-related careers is quite low. This is not just a problem for Vietnam but also for other countries such as Indonesia [18], [19], [29], Turkey [30], Kazakhstan [33], etc. Therefore, countries can work together to find appropriate solutions to improve this situation.

3.2.5. Contextual support

The average value of contextual support in all areas is the lowest compared to the remaining aspects of SCCT ranging from 6.10 to 6.90 (in which $M_{Technology}$ > $M_{Science}$ > $M_{Mathematics}$ > $M_{Engineering}$). This reflects that there are still many students who do not have role models in STEM careers in general, or most worryingly, careers related to engineering. Specifically, students' families have few members pursuing STEM careers, and at the same time, students do not have the opportunity to interact with professionals in this field. To overcome this situation, schools and educational units need to implement career counseling programs with the participation of people working in STEM fields to inspire students [13].

3.2.6. Personal input

The average value of personal input, varying between 6.18 and 7.12, is relatively low compared to the other SCCT aspects (in which $M_{Technology}$ > $M_{Mathematics}$ > $M_{Science}$ > $M_{Engineering}$). This data reflects that students feel uncomfortable talking and sharing with people working in the STEM field. This can be explained by the fact that students do not have many opportunities to interact and participate in activities with them, or a small number of students may encounter psychological difficulties and be uncomfortable when sharing. Therefore, schools need to come up with appropriate solutions to overcome this situation promptly.

3.3. Correlations of interest across STEM fields

Table 2. *Pearson correlations of interest across STEM fields*

		Science	Technology	Engineering
Technology	Pearson Correlation	.486**		
	Sig. (2-tailed)	0.000		
Engineering	Pearson Correlation	.506**	.580**	
	Sig. (2-tailed)	0.000	0.000	
Mathematics	Pearson Correlation	.598**	.439**	.398**
	Sig. (2-tailed)	0.000	0.000	0.000

The results of Pearson correlation analysis (Table 2) show that the four fields of science, technology, engineering, and mathematics are all correlated, with $p < 0.05$. There is a strong positive correlation between science and mathematics, with $r = 0.598$, showing that students interested in science are also interested in mathematics. The correlation between technology and mathematics ($r = 0.439$) and between engineering and mathematics ($r = 0.398$) are both average positive correlations. This result is quite similar to the study of Japashov et al. (2022), in which $r = 0.54$ for science and mathematics and $r = 0.42$ for technology and engineering [16]. Another similar result is from the study of Sellami et al. (2023) which analyzed data from 1,500 students in Tunisia showing a strong science-mathematics correlation, a moderate engineering-mathematics correlation, and a moderate technology-mathematics correlation, with $r = 0.61$, $r = 0.45$, and $r = 0.40$, respectively [17]. Therefore, students' learning tasks in STEM educational activities need to be designed to be both differentiated and specialized for each field of STEM. In addition, it is necessary to ensure the systematicity and integration of these four elements together to achieve the best results in STEM career orientation for students.

3.4. The difference between STEM career interest and SCCT aspects across genders and grades

In terms of gender, research results show that there is a difference in STEM-CIS results in each STEM field and SCCT in STEM careers for males and females ($p < 0.05$). Based on the results in Table 3, it can be seen that most aspects of males are higher than those of females. Specifically, the highest gap in STEM careers is in the science field ($M_{Male} = 7.46$; $M_{Female} = 6.95$), and in the SCCT components are personal inputs ($M_{Male} = 7.01$; $M_{Female} = 6.63$). This is consistent with the research results of Japashov et al. (2022) [16], especially in the technology sector. Some possible reasons for this are that females' interest in STEM careers is still related to the ability to balance career and family, and issues related to social status in perspectives of each region and each country [34]. Faced with this situation in Vietnam, it is necessary to increase the participation of female students in the STEM field, clearly identifying the career values in the STEM field that need to guide students and the considered issues on career guidance education to help students determine their career path by their abilities, strengths, and personal interests, while also meeting the requirements of future STEM careers [35].

Table 3. *T-test on the difference between STEM career interest and SCCT aspects across gender and grade level*

	Gender	N	Mean	SD	sig	Grade	N	Mean	SD	sig
Science	Male	399	7.46	1.496	0.000	10	465	7.20	1.522	0.648
	Female	509	6.95	1.524		11	444	7.15	1.545	
Technology	Male	399	7.76	1.338	0.000	10	465	7.58	1.319	0.428
	Female	509	7.38	1.320		11	444	7.51	1.365	
Engineering	Male	399	6.91	1.383	0.000	10	465	6.76	1.413	0.359
	Female	509	6.57	1.383		11	444	6.67	1.409	
Mathematics	Male	399	7.55	1.457	0.000	10	465	7.31	1.590	0.305
	Female	509	7.03	1.537		11	444	7.21	1.449	
SE	Male	399	7.50	1.208	0.000	10	465	7.38	1.212	0.977
	Female	509	7.29	1.273		11	444	7.38	1.285	
PG	Male	399	7.65	1.240	0.012	10	465	7.46	1.331	0.436
	Female	509	7.25	1.361		11	444	7.39	1.316	
OE	Male	399	7.96	1.272	0.000	10	465	7.80	1.309	0.514
	Female	509	7.62	1.280		11	444	7.74	1.267	
INT	Male	399	7.39	1.398	0.000	10	465	7.01	1.538	0.266
	Female	509	6.61	1.508		11	444	6.90	1.479	
CS	Male	399	6.82	1.648	0.000	10	465	6.61	1.639	0.323
	Female	509	6.34	1.653		11	444	6.90	1.479	
PI	Male	399	7.01	1.748	0.001	10	465	6.87	1.749	0.196
	Female	509	6.63	1.815		11	444	6.72	1.839	

Regarding grade levels, analysis results found no difference in STEM-CIS results in each STEM field and SCCT aspects in STEM careers for grades 10 and 11 because $p > 0.05$ (Table 3). This matches the previous research by Japashov et al. (2022), in the fields of science, technology, and engineering but not mathematics [16]. However, it is contrary to the other research by Dönmez & İdin because the results show that as the age group increases, students are more interested in STEM career fields, and the age of high school students is an important age to influence and guide STEM careers [30]. In the case of Vietnam, current 10th and 11th-grade students are the first generation to follow the 2018 general education program to emphasize vocational education [4]. Therefore, the program needs time to adjust and complete to be more effective in career orientation for students in general or careers in the STEM field in particular. Specifically, Luong et al. (2022). mentioned the main difficulty when implementing vocational education is that current school plans are implemented in grade levels that do not have a clear classification of knowledge and competencies to determine a suitable career [36].

4. Conclusion

This study examined the current state of STEM-CIS elements of grade 10 and 11 students in five high schools in Ho Chi Minh City, Vietnam, using the STEM-CIS instrument. The findings indicated that there was a moderate to high range of career interest, from 6.72 to 7.55, in the four STEM fields (science, technology, engineering, and mathematics). Interests in STEM careers were correlated with science and engineering showing the largest positive association. Male students also showed greater interest in STEM careers and SCCT components than did female students. However, there was no difference in these aspects between grade levels. The results presented above will contribute to providing suggestions and orientations for high schools in implementing and developing STEM education activities to meet the goal of improving students' STEM career interests and guiding them to pursue STEM careers in the future. In future studies, we will conduct research and experiment with specific measures to improve students' STEM career interests and use the STEM-CIS instrument to evaluate their effectiveness.

REFERENCES

[1] H. H. Le, "STEM education in the 2018 general education curriculum: Orientation and implementation," *Vietnam Journal of Education*, vol. 516, no. 2, pp. 1-6, 2021.

[2] Vietnam Prime Minister, *Directive 16/CT-TTg - Strengthening capacity to access the 4.0 Revolution*, 2017.

[3] Vietnam Prime Minister, *Vocational education project and student stream orientation in general education for the period 2018 - 2025*, 2018.

[4] Vietnam Ministry of Education and Training, *2018 general education curriculum*, 2018.

[5] Vietnam Ministry of Education and Training, *Experiential activities, vocational and experiential activities curriculum*, 2018.

[6] Vietnam Ministry of Education and Training, *Official letter 3089/BGDĐT-GDTrH on the implementation of STEM education in secondary education*, 2020.

[7] Central Propaganda Committee and Vietnam National University Hanoi, *Training high-quality human resources in the fields of science, technology, engineering, and mathematics (STEM), implementing strategic breakthroughs in human resource development according to the 13th National Party Congress Resolution*, 2023.

[8] Vietnam Ministry of Education and Training, *Report summarizing enrollment and training for the 2021-2022 school year of higher education*, Hanoi, 2022.

[9] R. W. Lent, S. D. Brown, and G. Hackett, "Contextual supports and barriers to career choice: A social cognitive analysis," *Journal of Counseling Psychology - American Psychological Association Inc.*, vol. 47, no. 1, pp. 36-49, 2000, doi: 10.1037/0022-0167.47.1.36.

[10] R. W. Lent, S. D. Brown, and G. Hackett, "Toward a unifying scct and academic interest, choice and performance," *Journal of Vocational Behavior*, vol. 45, pp. 79-122, 1994, doi: 10.1006/jvbe.1994.1027.

[11] G. Nugent, B. Barker, G. Welch, N. Grandgenett, C. R. Wu, and C. Nelson, "A Model of Factors Contributing to STEM Learning and Career Orientation," *Int J Sci Educ*, vol. 37, no. 7, pp. 1067-1088, May 2015, doi: 10.1080/09500693.2015.1017863.

[12] S. L. Turner, J. R. Joeng, M. D. Sims, S. N. Dade, and M. F. Reid, "SES, Gender, and STEM Career Interests, Goals, and Actions: A Test of SCCT," *J Career Assess*, vol. 27, no. 1, pp. 134-150, Feb. 2019, doi: 10.1177/1069072717748665.

[13] M. W. Kier, M. R. Blanchard, J. W. Osborne, and J. L. Albert, "The Development of the STEM Career Interest Survey (STEM-CIS)," *Res Sci Educ*, vol. 44, no. 3, pp. 461-481, 2014, doi: 10.1007/s11165-013-9389-3.

[14] T. Luo, W. W. M. So, Z. H. Wan, and W. C. Li, "STEM stereotypes predict students' STEM career interest via self-efficacy and outcome expectations," *Int J STEM Educ*, vol. 8, no. 1, p. 36, Dec. 2021, doi: 10.1186/s40594-021-00295-y.

[15] A. L. Sellami, A. Al-Ali, A. Allouh, and S. Alhazbi, “Student Attitudes and Interests in STEM in Qatar through the Lens of the Social Cognitive Theory,” *Sustainability*, vol. 15, no. 9, pp. 1-16, May 2023, doi: 10.3390/su15097504.
[16] N. Japashov, Z. Naushabekov, S. Ongarbayev, A. Postiglione, and N. Balta, “STEM Career Interest of Kazakhstani Middle and High School Students,” *Educ Sci (Basel)*, vol. 12, no. 6, Jun. 2022, doi: 10.3390/educsci12060397.
[17] A. L. Sellami, N. A. Al-Rakeb, and E. Tok, “Secondary School Students’ Interest in STEM Careers in Qatar,” *Educ Sci (Basel)*, vol. 13, no. 4, p. 369, Apr. 2023, doi: 10.3390/educsci13040369.
[18] M. Sidiq, A. Permanasari, and R. Riandi, “The Analysis of STEM Career Interest of Students Aged 13-15 as an Overview for The Development of STEM Career Counseling,” in *Proceedings of the 3rd International Conference of Science Education in Industrial Revolution 4.0, ICONSEIR 2021, December 21st, 2021, Medan, North Sumatra, Indonesia*, EAI, Jun. 2022, doi: 10.4108/eai.21-12-2021.2317329.
[19] N. Winarno, A. Widodo, D. Rusdiana, D. Rochintaniawati, and R. M. A. Afifah, “Profile of Pre-Service Science Teachers Based on STEM Career Interest Survey,” *J Phys Conf Ser*, vol. 895, Sep. 2017, Art. no. 012170, doi: 10.1088/1742-6596/895/1/012170.
[20] W. C. J. Mau, S. J. Chen, and C. C. Lin, “Social cognitive factors of science, technology, engineering, and mathematics career interests,” *Int J Educ Vocat Guid*, vol. 21, no. 1, pp. 47-60, Apr. 2021, doi: 10.1007/s10775-020-09427-2.
[21] D. Ardianto, B. Rubini, and I. D. Pursitasari, “Assessing STEM career interest among secondary students: A Rasch model measurement analysis,” *Eurasia Journal of Mathematics, Science and Technology Education*, vol. 19, no. 1, p. em2213, Jan. 2023, doi: 10.29333/ejmste/12796.
[22] Z. K. Ünlü, İ. Dököe, and V. Ünlü, “Adaptation of the Science, Technology, Engineering, and Mathematics Career Interest Survey (STEM-CIS) into Turkish,” *Eurasian Journal of Educational Research*, vol. 16, no. 63, pp. 21-36, Apr. 2016, doi: 10.14689/ejer.2016.63.2.
[23] E. Hiğde and H. Aktamış, “The effects of STEM activities on students’ STEM career interests, motivation, science process skills, science achievement and views,” *Think Skills Creat*, vol. 43, Mar. 2022, doi: 10.1016/j.tsc.2022.101000.
[24] M. Ali, C. A. Talib, J. Surif, N. H. Ibrahim, and A. H. Abdullah, “Effect of STEM competition on STEM career interest,” in *Proceedings of the 2018 IEEE 10th International Conference on Engineering Education, ICEED 2018*, Institute of Electrical and Electronics Engineers Inc., Jul. 2018, pp. 111-116, doi: 10.1109/ICEED.2018.8626904.
[25] A. A. Ogegbo and A. Y. Aina, “Exploring young students’ attitude towards coding and its relationship with STEM career interest,” *Educ Inf Technol (Dordr)*, 2023, doi: 10.1007/s10639-023-12133-5.
[26] E. H. M. Shahali, L. Halim, M. S. Rasul, K. Osman, and M. A. Zulkifeli, “STEM learning through engineering design: Impact on middle secondary students’ interest towards STEM,” *Eurasia Journal of Mathematics, Science and Technology Education*, vol. 13, no. 5, pp. 1189-1211, May 2017, doi: 10.12973/eurasia.2017.00667a.
[27] S. C. Playton, G. M. Childers, and R. L. Hite, “Measuring STEM Career Awareness and Interest in Middle Childhood STEM Learners: Validation of the STEM Future-Career Interest Survey (STEM Future-CIS),” *Res Sci Educ*, 2023, doi: 10.1007/s11165-023-10131-8.
[28] N. Wang, A. L. Tan, X. Zhou, K. Liu, F. Zeng, and J. Xiang, “Gender differences in high school students’ interest in STEM careers: a multi-group comparison based on structural equation model,” *Int J STEM Educ*, vol. 10, no. 1, Dec. 2023, doi: 10.1186/s40594-023-00443-6.
[29] R. Watrianthos, D. Antony Kifta, H. Sahputra Batubara, S. Sukardi, and S. Syahril, “Analysis Student’s Career Based on Social Cognitive Career Theory to Develop Students’ STEM Career Interests,” *International Journal of Advanced Multidisciplinary Research and Studies*, vol. 2, no. 3, pp. 120-124, 2022.
[30] İ. Dönmez and Ş. İdin, “Determination of the STEM Career Interests of Middle School Students,” *International Journal of Progressive Education*, vol. 16, no. 4, pp. 1-12, Aug. 2020, doi: 10.29329/ijpe.2020.268.1.
[31] U. Sarı, M. Alıcı, and Ö. F. Şen, “The Effect of STEM Instruction on Attitude, Career Perception and Career Interest in a Problem-based Learning Environment and Student Opinions,” *Electronic Journal of Science Education*, vol. 22, no. 1, pp. 1-21, 2018.
[32] H. Zhang, I. Lee, S. Ali, D. DiPaola, Y. Cheng, and C. Breazeal, “Integrating Ethics and Career Futures with Technical Learning to Promote AI Literacy for Middle School Students: An Exploratory Study,” *Int J Artif Intell Educ*, vol. 33, no. 2, pp. 290-324, Jun. 2023, doi: 10.1007/s40593-022-00293-3.

[33] N. Japashov, Z. Naushabekov, S. Ongarbayev, A. Postiglione, and N. Balta, “STEM Career Interest of Kazakhstani Middle and High School Students,” *Educ Sci (Basel)*, vol. 12, no. 6, Jun. 2022, doi: 10.3390/educsci12060397.
[34] S. V. Rosser, “Breaking into the Lab: Engineering Progress for Women in Science and Technology,” *Int J Gend Sci Technol*, vol. 10, no. 2, pp. 213-232, 2018.
[35] T. B. L. Do, “Career values orientation for female students in the fields of science, technology, engineering, and math in Vietnam,” *Vietnam Journal Of Educational Sciences*, vol. 147, pp. 24-28, 2017.
[36] T. T. H. Luong, T. T. T. Mai, and H. M. N. Le, “Physics teachers’ perceptions on integrated vocational guidance in high school,” *Hanoi Pedagogical University 2 Journal of Education*, vol. 76, no. 4/2022, pp. 108-120, 2022.