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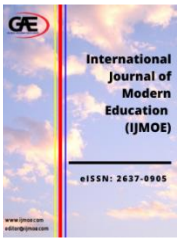

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EXPLORING AND DEVELOPING MATHEMATICS-RELATED CAREER CHOICE SURVEY FOR SECONDARY SCHOOL STUDENTS: A PRELIMINARY STUDY

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Abstract:

STEM disciplines are crucial for human development and offer low unemployment rates and strong economic prospects. Despite this, many countries struggle with a shortage of STEM graduates, prompting questions about why more students don't pursue STEM majors. The study aims to assess the reliability and validity of the mathematics-related career choice survey for secondary school students. A cross-sectional analysis was carried out with 252 participants using the self-administered survey containing 27 items. Descriptive statistics, Cronbach's alpha, and exploratory factor analysis were utilized to evaluate the questionnaires. The exploratory factor analysis revealed that Bartlett's Test of Sphericity was significant (Chi-Square = 3749.578, $p < 0.000$) and the Kaiser-Meyer-Olkin (KMO) measure was 0.872. This analysis identified six factors from the 27 items, with one item removed for not meeting the minimum factor loading requirement of 0.5, leaving 26 items. Cronbach's alpha values for each factor exceeded the 0.7 threshold, confirming the internal validity of the instrument. The survey is thus a valuable resource for students and educators, offering essential insights that enhance classroom teaching methods, educational planning, and workforce readiness in mathematics.

Keywords:

Learning Environment, Mathematics-Related Career, Mathematics Identity

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Introduction

The importance of Science, Technology, Engineering, and Mathematics (STEM) disciplines has been highlighted by organizations such as United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Bank Group (WBG), and the Organization for Economic Cooperation and Development (OECD). These fields are considered crucial for human development, enhanced competitiveness, and a country's economic prosperity (*UNESCO*, 2016). STEM is associated with low unemployment rates and strong economic prospects. Despite these positive aspects, many countries struggle with an insufficient supply of STEM graduates. Consequently, there is significant interest in reversing the current enrollment trends in STEM fields, prompting the question of why more students do not pursue STEM studies. This issue has been extensively explored in the literature from various perspectives.

Enhancing mathematics education is an important component of this effort because it equips students with critical skills like logical thinking and problem-solving and prepares them for various careers (Iwuanyanwu, 2020). Mathematics is academically significant as a foundational step toward pursuing a STEM major, providing the necessary knowledge to understand complex systems and technologies. As a mandatory subject in most schools, it is crucial for students aiming for a STEM career. Currently, over 37,000 students are enrolled in science, mathematics, and computing programs at higher education institutions nationwide (MOHE, 2022). However, this number represents a small fraction of all STEM degrees awarded, with the majority in engineering, manufacturing, and construction (MOHE, 2022).

Besides that, the level of STEM interest among Malaysian secondary school students has been unstable, with the low participation of upper secondary students in the STEM stream from 2017 to 2022, which went from 45.2 per cent to 40.94 per cent (New Straits Times, 2023). This highlights the need for additional interventions and strategies to effectively cultivate and sustain students' enthusiasm for STEM subjects and careers. Addressing these issues requires a critical examination of students' experiences with mathematics and how these experiences influence their career decisions, including both their in-class and out-of-class experiences before choosing higher education and careers.

Studying and identifying the factors influencing career choices among students is important because a shortage of skilled workers in STEM fields will impact the country's economic development in the future (Blustein et al., 2022). Additionally, identifying the factors that influence mathematics-related career choices can clarify how students learn mathematics subject content and provide guidance for teachers in planning intervention programs (Abe & Chikoko, 2020; Wieselmann et al., 2020). Career choices are influenced by factors such as background, environment, and individual internal factors (Lent et al., 2000). This study aims to develop a questionnaire to measure mathematics-related career choices and the factors affecting those choices among Form Four students in secondary schools. At this stage, students are building their interests and identifying their academic strengths, which will subsequently influence their desired career paths. Therefore, implementing appropriate interventions at the secondary school level, before students make decisions about choosing fields of study related to their career interests, is considered helpful and timely (Bottia et al., 2018).

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Literature Review

Several theories and models can be used as a basis for identifying the factors influencing career choices. Among them are the Social Cognitive Career Theory (SCCT) and Expectancy-Value Theory (EVT). SCCT is based on Bandura (1986) social cognitive theory and Hackett dan Betz (1981) career self-efficacy model. SCCT suggests that three personal factors—self-efficacy, outcome expectations, and interests—operate together and interact with environmental factors to shape an individual's career goals and actions (Lent et al., 1994). This theory has been used in several past studies (Jones et al., 2019; Mau et al., 2021; Smith, 2022) to investigate the factors influencing STEM career choices.

The fundamental assumption of Expectancy-Value Theory (EVT) by Eccles (1983) is that individual choices and motivations to exhibit certain behaviors arise from two components: expectations of success and value beliefs. This comprehensive theory enables researchers to consider individual factors like abilities, gender, race or ethnicity, past experiences, and cultural aspects such as family demographics and social systems. It also includes variables like social beliefs, social roles, emotional responses and memories, identity and self-concept. Moreover, these factors influence individuals' subjective task values, utility values, and perceived costs when making achievement-related decisions, such as career choices. This model has been widely used and validated in studies across various disciplines and contexts (Aeschlimann et al., 2016; Watt et al., 2017; Wegemer & Eccles, 2019).

Besides that, this study also builds on the mathematics identity framework established by Cribbs et al. (2015) which itself is based on prior research on science and physics identity by Carlone & Johnson (2007) and Hazari et al. (2010). Carlone & Johnson (2007) conducted a qualitative study on identity development among women of color in science-related fields, proposing a model of science identity with recognition, competence, and performance as key elements. Their findings highlighted the importance of these elements and the impact of gender, ethnicity, and race on experiences and career paths. Hazari et al. (2010) expanded this model by adding a fourth component, interest, in their quantitative study on students' physics identity. They surveyed college students and confirmed the theoretical framework's validity, showing that physics identity strongly predicts career choice and reveals gender differences in physics identity.

Based on these theories and models, three main factors have been considered: the learning environment, mathematical identity, and mathematics-related career choices. The following section will elaborate on the dimensions of these main factors identified through a literature review.

Learning Environment Factors

Research conducted over the past 40 years has consistently found a correlation between students' perceptions of the learning environment (Dorman, 2001) and various affective and cognitive outcomes. Based on a literature review of previous studies (Ali et al., 2023; Khine et al., 2020; Malik & Rizvi, 2018; Wild, 2015; Yerdelen & Sungur, 2019), several learning environment factors have been identified. Factors such as engagement, personal relevance, and emphasis on understanding are key predictors contributing to the classroom learning environment and student achievement (Malik & Rizvi, 2018). Additionally, collaboration among students and the science laboratory environment have been found to influence non-cognitive outcomes such as epistemological beliefs, self-efficacy, and anxiety (Ali et al., 2023;

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Khine et al., 2020; Yerdelen & Sungur, 2019). Wild (2015) considered factors such as personal relevance, uncertainty, critical voice, shared control, and student negotiation, finding that students' perceptions of the learning environment affect career expectations in science.

Mathematics Identity

Identity is an individual attribute (Simpson & Bouhafa, 2020) formed by enjoyment and interest (Godwin et al., 2016; Hill et al., 2018), achievement grades (Stets et al., 2017), confidence in abilities(Chemers et al., 2011; Robinson et al., 2018), and recognition from others (Cribbs et al., 2015; Hill et al., 2018) in at least one field of knowledge. Additionally, identity is also constructed from competence and achievement mediated by factors such as recognition and interest (Cribbs et al., 2015; Godwin et al., 2016). In this study, mathematics identity refers to a student's self-perception regarding recognition and competence in mathematics based on their mathematics learning experiences at school. Developing mathematics identity plays a crucial role in sustained participation and engagement with mathematics (Cribbs & Utley, 2023). Mathematics identity has been found to positively correlate with student achievement (Bohrnstedt et al., 2021). Furthermore, mathematics identity is a strong predictor of career choices in various STEM fields (Cribbs et al., 2021; Cribbs et al., 2016; Godwin et al., 2016).

Mathematics-Related Career Choice

Career choice is a long-term, complex process involving many decisions made over time (Sauermann, 2005). It is influenced by various factors such as personal interests, abilities, job knowledge, educational achievements, and life context. This process shapes a unique career development path for each individual. STEM careers are defined as careers in fields such as biology, agriculture, environment, computer science, physics, mathematics, engineering, or any career requiring essential STEM skills and expertise, including healthcare (National Science Board, 2022). An individual can pursue a STEM career through various pathways, whether using or not using higher education certificates (Rosenzweig & Chen, 2023). Therefore, there are multiple pathways to enter STEM careers. Regardless of the path taken, secondary education is a critical stage for shaping students' interest in STEM careers. This study measures students' inclination to choose a career in mathematics by adapting the Your Future survey in the S-STEM and Interest in STEM Career instrument by Unfried et al. (2015).

This research enhances the mathematics identity framework by adding three factors from the mathematics learning environment, aiming to develop a more reliable tool for assessing how mathematics recognition and competence affect career choices related to mathematics.These factors, which have been under-discussed in this context, are defined as students' perceptions of their mathematics classroom learning environment. The survey includes three specific factors. Critical Voice referred to the degree to which students feel it is legitimate and beneficial to question teachers' pedagogical plans and methods (Johnson & McClure, 2004; Taylor et al., 1997). Teacher support refers to the extent to which the teacher helps, befriends, and is interested in students (Ali et al., 2023; Taylor et al., 1997). Shared control is defined as the opportunities for students to explain and justify their ideas, and to test the viability of their own and others' ideas (Johnson & McClure, 2004; Taylor et al., 1997), and finally mathematics-related career choice refers to students' inclination towards mathematics-related career.

Earlier research by Cribbs et al. (2015) found that students' beliefs about their competence and performance alone do not fully contribute to developing their mathematics identity. They highlighted the importance of interest and recognition in this process. Additionally, Cribbs et

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al. (2020) identified that specific teaching methods used by high school mathematics educators, such as increased classroom interaction, emphasis on interconnectedness in mathematics, and activities promoting conceptual understanding, can predict higher levels of students' mathematics identity. However, these findings require an updated study to clarify the classroom interactions that lead to positive mathematics identification and to prompt curriculum changes. Incorporating learning environment factors into a survey instrument will help bridge the gap in the literature regarding mathematics identity and STEM career choice, as the impact of these factors is not yet well understood. Furthermore, there are few validated instruments for measuring students' mathematics-related career choices.

Consequently, this study aims to develop and validate a survey questionnaire called Mathematics-Related Career Choice Survey. This tool can be used to identify factors that influence students' choices of mathematics-related careers. Additionally, Mathematics-Related Career Choice Survey offers a chance to enhance our understanding of the obstacles and facilitators affecting these career choices.

Methodology

This study used a cross-sectional research design, collecting data at a single point in time over a specific period (Bougie & Sekaran, 2016). An initial study was conducted to meet the primary objective. A series of questionnaires were distributed to secondary school students in Perak as a measurement tool.The questionnaire consisted of four sections. Section A covered information on demographic profiles, while section B, C, and D covered on learning environment factors, mathematics identity and mathematics-related career choice respectively. The items for learning environment factors were adapted from Wild (2015) and Aluri & Fraser (2019). While, the items for mathematics identity were adapted from Chen & Wei (2020), and the items for mathematics-related career choice were adapted from Unfried et al. (2015).

The instrument underwent testing through a pretest as part of a pilot study conducted between August 2022 to March 2023. The study population consisted of 5948 form four science stream students in Perak, with cluster sampling used to select respondents. For a pilot study, Hertzog (2008) suggests a sample size of 10% of the main study, which would be 46 respondents from the main research sample of 457. Johanson & Brooks (2010) recommend a minimum of 30 respondents for preliminary surveys or new scale constructions. However, for exploratory factor analysis (EFA), Hair et al. (2010) propose a minimum of 50 observations, preferring 100 or more. Mundfrom et al. (2005) suggest a sample size range of 55 to 200 for six factors with a variables-to-factors ratio of six or seven. To meet good and excellent criteria, sample sizes should not exceed 120 and should be 130 or above, respectively. Thus, 252 respondents were considered appropriate for the pilot study. The pilot study aimed to identify issues with the questionnaire, focusing on question clarity and respondent difficulties. As the pilot participants shared similar characteristics with the actual respondents, their data was utilized for an initial evaluation of the validity and reliability of the measurement items. The questionnaire was administered to pure science stream students using the drop-off survey method.

The study utilized two main analyses: Descriptive analysis and Exploratory Factor Analysis (EFA), employing IBM SPSS v28. Descriptive analysis summarized the data, including demographic information presented graphically as percentages. EFA followed, beginning with a normality test to assess whether the data met the normality assumption, typically defined by skewness and kurtosis values between -2 and 2 (Garson, 2012). This test helps determine if the

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data is suitable for parametric analysis. An EFA was performed to validate the items measuring the constructs, confirming their appropriateness and applicability within the research context, and to establish a unidimensional scale for each construct (Hair et al., 2010). Essentially, the EFA process sought to identify representative items for each proposed construct for use in the actual research.

In EFA, the Kaiser-Meyer-Olkin (KMO) measure, which indicates sampling adequacy, should ideally be close to 1 and exceed the recommended value of 0.6 (Bahkia et al., 2019; Hair et al., 2010; Hoque et al., 2018). Principal component analysis with varimax rotation was applied. Factor loadings and cross-loadings for each item were reviewed to confirm convergent and discriminant validity. Items with factor loadings below 0.50 or those showing significant loadings on multiple constructs were excluded from the analysis (Hair et al., 2010). Finally, a reliability test was conducted to verify the consistency of the factors, using Cronbach's Alpha, which measures internal consistency. Values above 0.7 were considered reliable, enhancing the accuracy of the assessment and evaluations (Hair et al., 2010; Muda et al., 2020; Musa et al., 2023).

Results and Discussion

Table 1 shows the respondents' profile consisted of 151 (59.9%) female and 101 (40.1%) male. 191 (75.8%) respondents were Malays, 23 (9.1%) respondents were Indians, while the Chinese and other races had the same number of 19 (7.5%) respectively. Data screening shows no missing value. Therefore, all responses were used in the analysis.

Table 1: Respondent's Profile

Background	Item	Frequency	Percentage (%)
Gender	Male	101	40.2
	Female	151	59.9
Ethnic	Malay	191	75.8
	Chinese	19	7.5
	Indian	23	9.1
	Other	19	7.5

A total of 27 MRCCS items were loaded to be analysed. These items representing six constructs: shared control, critical voice, teacher support, mathematics recognition, mathematics competence, and mathematics-related career choice. The results in Table 2 shows that the Kaiser-Meyer-Olkin (KMO) value of 0.872, with significant Bartlett's Test of Sphericity value. A KMO value exceeding the recommended threshold of 0.6, along with a significant Bartlett's test result, indicated that the data was suitable for conducting factor analysis (Bahkia et al., 2019; Hair et al., 2010; Hoque et al., 2018).

Table 2: The KMO and Bartlett's Test Result

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.872
Bartlett's Test of Sphericity	Approx. Chi-Square	3749.578
	df	351
	Sig.	0.000

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Using eigenvalues of greater than 1.0 as a guideline for extraction, the EFA conducted on 27 items has succeeded to extract six factors, which able to explain 66.617% of the total variance (Table 3).

Table 3: The Total Variance Explained Result

Component	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.914	29.311	29.311	3.842	14.230	14.230
2	3.208	11.882	41.194	3.502	12.969	27.199
3	2.339	8.662	49.856	3.270	12.112	39.311
4	2.180	8.075	57.931	2.645	9.795	49.106
5	1.324	4.904	62.835	2.400	8.890	57.995
6	1.021	3.782	66.617	2.328	8.622	66.617

Principal Component Analysis (PCA) with Varimax rotation was used to extract items. Table 4 presents the results from the Exploratory Factor Analysis (EFA), detailing the six constructs and their respective items. One item, namely KM1 from the mathematics-related career choice construct, was problematic with loadings below 0.50 and was subsequently deleted. The remaining 26 items were found to be good and acceptable.

Table 4: Rotated Component Matrix Result

Item	Loadings					
	Mathematics Competency	Mathematics Recognition	Mathematics-related Career Choice	Shared Control	Teacher Support	Critical Voice
KOM7	0.76					
KOM3	0.71					
KOM1	0.69					
KOM6	0.67					
KOM2	0.65					
KOM8	0.61					
IKT2		0.91				
IKT4		0.89				
IKT3		0.88				
IKT1		0.75				
KM4			0.83			
KM5			0.80			
KM2			0.75			
KM6			0.72			
KM3			0.67			
KB2				0.83		
KB3				0.79		
KB1				0.68		
KB4				0.68		
SG3					0.83	

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SG2	0.83	
SG1	0.76	
SK3		0.81
SK4		0.66
SK2		0.65
SK1		0.59

As shown in Table 5, the Cronbach's alpha values for shared control, critical voice, teacher support, mathematics recognition, mathematics competency, and mathematics-related career choice were 0.807, 0.786, 0.860, 0.936, 0.839 and 0.830 respectively. Therefore, the Cronbach's alpha values met the recommended reliability coefficient threshold of 0.7 (Hair et al., 2010) for all scales.

Table 5: Reliability Assessment Result

Construct	Cronbach's Alpha	Number of Items
Shared Control	0.807	4
Critical Voice	0.786	4
Teacher Support	0.860	3
Mathematics Recognition	0.936	4
Mathematics Competency	0.839	6
Mathematics-related Career Choice	0.830	5

Conclusion

The study aimed to develop and validate the Mathematics-related Career Choice Survey to assess students' choice in mathematics-related careers. The survey included 26 items categorized under six factors: shared control, critical voice, teacher support, mathematics recognition, mathematics competency, and mathematics-related career choice. High Cronbach's alpha values indicated strong internal reliability for these factors, meeting Bartlett's test requirements (significant). The KMO scores were satisfactory (>0.6), and factor loadings exceeded 0.50. The results confirmed that the items were appropriate for the study. Multiple scale improvement and validation procedures were used to ensure the instrument's internal consistency and stability across the sample.

Future research should consider using confirmatory factor analysis (CFA) on the identified factors to improve the validity and reliability of the instrument. These factors can offer a solid foundation for developing a model of mathematics-related career choice among secondary school students. By providing mathematics educators with a reliable tool for assessing students' career choices in mathematics, this study can help enhance classroom teaching methods. Furthermore, including students' participation in out-of-school STEM activities could also provide a more comprehensive understanding of factors influencing students' inclination towards mathematics-related careers and their persistence in the field.

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DOI: 10.35631/IJMOE.623056

References

Abe, E. N., & Chikoko, V. (2020). Exploring the factors that influence the career decision of STEM students at a university in South Africa. *International Journal of STEM Education*, *7*(1), 1–14.

Aeschlimann, B., Herzog, W., & Makarova, E. (2016). How to foster students' motivation in mathematics and science classes and promote students' STEM career choice. A study in Swiss high schools. *International Journal of Educational Research*, *79*, 31–41.

Ali, N., Khurma, O. A., Afari, E., & Khine, M. S. (2023). The influence of learning environment to students' non-cognitive outcomes: Looking through the PISA lens. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(3), em2233.

Aluri, V. L. N., & Fraser, B. J. (2019). Students' perceptions of mathematics classroom learning environments: measurement and associations with achievement. *Learning Environments Research*, *22*(3), 409–426. https://doi.org/10.1007/s10984-019-09282-1

Bahkia, A. S., Awang, Z., Afthanorhan, A., Ghazali, P. L., & Foziah, H. (2019). Exploratory factor analysis on occupational stress in context of Malaysian sewerage operations. *AIP Conference Proceedings*, *2138*(1), 50006.

Bandura, A. (1986). Social foundations of thought and action. *Englewood Cliffs, NJ*, *1986*(23–28).

Blustein, D. L., Erby, W., Meerkins, T., Soldz, I., & Ezema, G. N. (2022). A critical exploration of assumptions underlying STEM career development. *Journal of Career Development*, *49*(2), 471–487.

Bohrnstedt, G. W., Cohen, E. D., Yee, D., & Broer, M. (2021). Mathematics identity and discrepancies between self-and reflected appraisals: their relationships with grade 12 mathematics achievement using new evidence from a US national study. *Social Psychology of Education*, *24*, 763–788.

Bottia, M. C., Stearns, E., Mickelson, R. A., & Moller, S. (2018). Boosting the numbers of STEM majors? The role of high schools with a STEM program. *Science Education*, *102*(1), 85–107.

Bougie, R., & Sekaran, U. (2016). *Research Methods For Business: A Skill Building Approach* (7th Editio). Wiley.

Carlone, H. B., & Johnson, A. (2007). Understanding the Science Experiences of Successful Women of Color : Science Identity as an Analytic Lens. *Journal of Research in Science Teaching*, *44*(8), 1187–1218. https://doi.org/10.1002/tea

Chemers, M. M., Zurbriggen, E. L., Syed, M., Goza, B. K., & Bearman, S. (2011). The role of efficacy and identity in science career commitment among underrepresented minority students. *Journal of Social Issues*, *67*(3), 469–491.

Chen, S., & Wei, B. (2020). Development and Validation of an Instrument to Measure High School Students' Science Identity in Science Learning. *Research in Science Education*, 1–16.

Cribbs, J. D., Cass, C., Hazari, Z., Sadler, P. M., & Sonnert, G. (2016). Mathematics identity and student persistence in engineering. *International Journal of Engineering Education*.

Cribbs, J. D., Hazari, Z., Sonnert, G., & Sadler, P. M. (2015). Establishing an Explanatory Model for Mathematics Identity. *Child Development*, *86*(4), 1048–1062. https://doi.org/10.1111/cdev.12363

Cribbs, J. D., & Utley, J. (2023). Mathematics identity instrument development for fifth through twelfth grade students. *Mathematics Education Research Journal*, 1–23.

International Journal of Modern Education IJMOE EISSN: 2637-0905
Volume 6 Issue 23 (December 2024) PP. 814-825
DOI: 10.35631/IJMOE.623056
Cribbs, J., Hazari, Z., Sonnert, G., & Sadler, P. M. (2020). College students' mathematics-related career intentions and high school mathematics pedagogy through the lens of identity. *MEdRJ*.

Cribbs, J., Hazari, Z., Sonnert, G., & Sadler, P. M. (2021). College students' mathematics-related career intentions and high school mathematics pedagogy through the lens of identity. *Mathematics Education Research Journal*, *33*, 541–568.

Dorman, J. P. (2001). Associations between classroom environment and academic efficacy. *Learning Environments Research*, *4*, 243–257.

Eccles, J. (1983). Expectancies, values and academic behaviors. *Achievement and Achievement Motives*.

Garson, G. D. (2012). *Testing Statistical Assumptions*. Statistical Associates Publishing.

Godwin, A., Potvin, G., Hazari, Z., & Lock, R. (2016). Identity, critical agency, and engineering: An affective model for predicting engineering as a career choice. *Journal of Engineering Education*, *105*(2), 312–340.

Hackett, G., & Betz, N. E. (1981). A self-efficacy approach to the career development of women. *Journal of Vocational Behavior*, *18*(3), 326–339.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate Data Analysis: A Global Perspective* (7th editio). Pearson Education.

Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, M. (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of Research in Science Teaching*, *47*(8), 978–1003.

Hertzog, M. A. (2008). Considerations in determining sample size for pilot studies. *Research in Nursing & Health*, *31*(2), 180–191.

Hill, P. W., McQuillan, J., Spiegel, A. N., & Diamond, J. (2018). Discovery orientation, cognitive schemas, and disparities in science identity in early adolescence. *Sociological Perspectives*, *61*(1), 99–125.

Hoque, A. S. M. M., Siddiqui, B. A., Awang, Z. Bin, & Baharu, S. M. A. T. (2018). Exploratory factor analysis of Entrepreneurial orientation in the context of Bangladeshi small and medium Enterprises (SMEs). *European Journal of Management and Marketing Studies*.

Iwuanyanwu, P. N. (2020). Nature of problem-solving skills for 21st century STEM learners: What teachers need to know. *Journal of STEM Teacher Education*, *55*(1), 4.

Johanson, G. A., & Brooks, G. P. (2010). Initial scale development: sample size for pilot studies. *Educational and Psychological Measurement*, *70*(3), 394–400.

Johnson, B., & McClure, R. (2004). Validity and reliability of a shortened, revised version of the Constructivist Learning Environment Survey (CLES). *Learning Environments Research*, *7*(1), 65–80.

Jones, M. G., Childers, G., Corin, E., Chesnutt, K., & Andre, T. (2019). Free choice science learning and STEM career choice. *International Journal of Science Education, Part B: Communication and Public Engagement*, *9*(1), 29–39. https://doi.org/10.1080/21548455.2018.1534024

Khine, M. S., Fraser, B. J., & Afari, E. (2020). Structural relationships between learning environments and students' non-cognitive outcomes: Secondary analysis of PISA data. *Learning Environments Research*, *23*(3), 395–412.

Lent, R., Brown, S. D., & Hackett, G. (1994). Toward a unifying scct and academic interest, choice and performance. In *Journal of Vocational Behavior* (Vol. 45, pp. 79–122).

Lent, R. W., Brown, S. D., & Hackett, G. (2000). Contextual supports and barriers to career choice: A social cognitive analysis. *Journal of Counseling Psychology*, *47*(1), 36.

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume 6 Issue 23 (December 2024) PP. 814-825
DOI: 10.35631/IJMOE.623056

Malik, R. H., & Rizvi, A. A. (2018). Effect of Classroom Learning Environment on Students' Academic Achievement in Mathematics at Secondary Level. *Bulletin of Education and Research*, *40*(2), 207–218.

Mau, W.-C. J., Chen, S.-J., & Lin, C.-C. (2021). Social cognitive factors of science, technology, engineering, and mathematics career interests. *International Journal for Educational and Vocational Guidance*, *21*, 47–60.

MOHE. (2022). *Higher Education Statistics 2022*. https://www.mohe.gov.my/en/download/statistics/2022-3

Muda, H., Baba, Z. S., Awang, Z., Badrul, N. S., Loganathan, N., & Ali, M. H. (2020). Expert review and pretesting of behavioral supervision in higher education. *Journal of Applied Research in Higher Education*, *12*(4), 767–785.

Mundfrom, D. J., Shaw, D. G., & Ke, T. L. (2005). Minimum sample size recommendations for conducting factor analyses. *International Journal of Testing*, *5*(2), 159–168.

Musa, M., Talip, R., & Awang, Z. (2023). Exploratory Factor Analysis for Technostress Among Primary School Teachers. *Malaysian Journal of Social Sciences and Humanities (MJSSH)*, *8*(2), e002117–e002117.

National Science Board. (2022). *Science and engineering indicators 2022*. https://ncses.nsf.gov/indicators

New Straits Times. (2023, October 19). Malaysia sees a surge in STEM enrollment, reaching 45.73 per cent in schools. *New Straits Times*. https://www.nst.com.my/news/nation/2023/10/968877/malaysia-sees-surge-stem-enrollment-reaching-4573-cent-schools

Robinson, K. A., Perez, T., Nuttall, A. K., Roseth, C. J., & Linnenbrink-Garcia, L. (2018). From science student to scientist: Predictors and outcomes of heterogeneous science identity trajectories in college. *Developmental Psychology*, *54*(10), 1977.

Rosenzweig, E. Q., & Chen, X.-Y. (2023). Which STEM careers are most appealing? Examining high school students' preferences and motivational beliefs for different STEM career choices. *International Journal of STEM Education*, *10*(1), 40.

Sauermann, H. (2005). Vocational choice: A decision making perspective. *Journal of Vocational Behavior*, *66*(2), 273–303.

Simpson, A., & Bouhafa, Y. (2020). Youths' and adults' identity in STEM: A systematic literature review. *Journal for STEM Education Research*, *3*, 167–194.

Smith, K. N. (2022). 'If I do science, I can get the money': a life history analysis of postsecondary students' decisions to pursue teaching careers in STEM. *Teachers and Teaching*, *28*(1), 102–117.

Stets, J. E., Brenner, P. S., Burke, P. J., & Serpe, R. T. (2017). The science identity and entering a science occupation. *Social Science Research*, *64*, 1–14.

Taylor, P. C., Fraser, B. J., & Fisher, D. L. (1997). Monitoring constructivist classroom learning environments. *International Journal of Educational Research*, *27*(4), 293–302.

UNESCO. (2016). https://unesdoc.unesco.org/ark:/48223/pf0000245656

Unfried, A., Faber, M., Stanhope, D. S., & Wiebe, E. (2015). The development and validation of a measure of student attitudes toward science, technology, engineering, and math (S-STEM). *Journal of Psychoeducational Assessment*, *33*(7), 622–639.

Watt, H. M. G., Hyde, J. S., Petersen, J., Morris, Z. A., Rozek, C. S., & Harackiewicz, J. M. (2017). Mathematics—A critical filter for STEM-related career choices? A longitudinal examination among Australian and US adolescents. *Sex Roles*, *77*(3), 254–271.

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Wegemer, C. M., & Eccles, J. S. (2019). Gendered STEM career choices: Altruistic values, beliefs, and identity. *Journal of Vocational Behavior*, *110*, 28–42.

Wieselmann, J. R., Roehrig, G. H., & Kim, J. N. (2020). Who succeeds in STEM? Elementary girls' attitudes and beliefs about self and STEM. *School Science and Mathematics*, *120*(5), 297–308.

Wild, A. (2015). Relationships between High School Chemistry Students' Perceptions of a Constructivist Learning Environment and their STEM Career Expectations. *International Journal of Science Education*, *37*(14), 2284–2305. https://doi.org/10.1080/09500693.2015.1076951

Yerdelen, S., & Sungur, S. (2019). Multilevel investigation of students' self-regulation processes in learning science: Classroom learning environment and teacher effectiveness. *International Journal of Science and Mathematics Education*, *17*, 89–110.