Evaluation Studies in Social Sciences (ESSS)
*eISSN 0128-0473 Vol 4(2)/ 2023 (19-29)*
*https://ejournal.upsi.edu.my/index.php/ESSS/index*
*DOI: https://doi.org/10.37134/esss.vol4.2.3.2023*

# TRENDS OF STEM AND CONNECTION OF COGNITIVES FOR CAREER INTEREST

Rashidin Idris[1,2], Suppiah Nachiappan[1]

[1]Faculty of Human Development, Universiti Pendidikan Sultan Idris, Tanjong Malim, Perak, Malaysia
[2]Department of Language and General Studies, Centre for Foundation and General Studies, Universiti Selangor, Bestari Jaya, Selangor, Malaysia

E-mail*: crashidin7@gmail.com

*Received*: 1 June 2023; *Accepted*: 22 November 2023; *Published*: 20 December 2023

## ABSTRACT

The Malaysian government must prioritise STEM education in schools, especially given recent statistics indicating a very low percentage of student involvement in the STEM field. STEM education is critical to a country's progress and development, so the Malaysia Education Blueprint (2013-2025) was launched to ensure that the country has skilled labour resources in the fields of science, technology, technical, and vocational education. The purpose of this study is to delve into the complicated role of the cognitive factor in STEM education, shedding light on its importance in learning and information processing, as well as its impact on students' academic performance. Despite extensive research into cognitive factors in STEM education, there is still a significant gap in understanding how cognition specifically shapes students' interest in STEM fields and careers, particularly in the Malaysian context. The present research seeks to fill this gap by delving into the nuanced relationship between cognition and STEM interest, presenting a cognitive conceptual framework emphasising the multifaceted nature of cognitive processes influencing STEM career interest. This research will benefit researchers studying STEM education trends and their relationship with cognitive abilities, as well as government agencies involved in STEM empowerment in schools.

**Keywords**: *Trends, Connection, STEM Education, Career Interest, Cognitives*

## INTRODUCTION

The trend of involvement in the field of STEM education, especially in Malaysia, still shows a trend that is not encouraging, not to mention that the target ratio to reach 60 percent is still so difficult to realize (Ministry of Education Malaysia, 2022). The level of student participation in STEM classes in schools is becoming increasingly important, and the declining trend in STEM participation clearly shows that the issue is critical in today's educational world (Idris et al., 2023a). STEM education is so important because the mastery of this field is necessary for the development of the country in the step towards becoming a developed country (Academy of Science Malaysia, 2017). According to Amelia and Lilia (2019), STEM in the context of learning and facilitation encompasses three major aspects: the field of learning (at

Evaluation Studies in Social Sciences (ESSS)
eISSN 0128-0473 Vol 4(2)/ 2023 (19-29)
https://ejournal.upsi.edu.my/index.php/ESSS/index
DOI: https://doi.org/10.37134/esss.vol4.2.3.2023

the secondary and tertiary levels), the subject package (based on a combination of specific STEM subjects), and the teaching method approach (application of knowledge, skills, and values for problem solving). Aside from that, Bryan et al. (2015) defined integrated STEM as teaching and learning science content and practice that includes elements of science and mathematics, as well as the integration of engineering practice and engineering design through relevant technology. In general, most countries promote STEM because of the importance of this field to a country's development in order to avoid falling behind developing countries, even though parents may struggle to understand the various pedagogic and curriculum requirements, as well as business entities that must invest in order to plan the scope jobs for the future in order to be more competitive. The end result of this effort is, of course, for the students themselves (Breiner et al., 2012).

The Ministry of Science, Innovation, and Technology intends to hire 500,000 market workers with diploma and degree qualifications in science and technology (Academy of Science Malaysia, 2020). This is exacerbated by all of the policies and policies put in place to help this idea become a reality. Among the new policies is the National Science, Technology, and Innovation Policy (DSTIN), which will take effect in 2021-2030. The strategy aims to improve the country's ability in the fields of science, technology, and innovation in order to empower the economy (STIE) and allow it to develop more quickly (Ministry of Science, Technology and Innovation, 2022). The goal and purpose of implementing such policies and policies is to ensure that Malaysia can compete in the development sector as well as the advancement of science and technology that occurs in tandem with the Industrial Revolution 4.0. In fact, in today's world, a focus on progress, including the Internet of Things (IoT), Artificial Intelligence (AI), Big Data, and Block Chain (Blockchain), is critical.

Nevertheless, given the latest trend, 72.1 percent of Malaysian Assessment Certificate (SPM) graduates for 2021 did not continue their studies at the university or college level (Department of Statistics Malaysia, 2022). It is unquestionably difficult to prepare and produce graduates who are proficient in the field of STEM at the professional level. As a result, the country loses manpower resources, which is detrimental to the country's productivity development. Simultaneously, students' cognitive skills towards STEM career interests must be strengthened, as previous research has shown that cognitive skills contribute to students' inclination towards STEM fields.

Witkin et al. (2002) stated that cognitive is a person's ability and ability based on experience gained from learning and teaching in everyday life. Cognitive is also the development of the mind and how a person processes information obtained from different sources (Butler & Scurlock, 2013). Other than that, Chen et al. (2019) stated that cognitive affects learning performance and student satisfaction especially in the classroom.

Evaluation Studies in Social Sciences (ESSS)
eISSN 0128-0473 Vol 4(2)/ 2023 (19-29)
https://ejournal.upsi.edu.my/index.php/ESSS/index
DOI: https://doi.org/10.37134/esss.vol4.2.3.2023

## TRENDS OF STEM EDUCATION INTEREST

### *Background Study of STEM Education in Malaysia*

Every year the involvement and participation in the STEM field in schools is becoming more and more worrying when the trend still shows that the ratio of 60 percent student participation in the science field has not been reached. The 60:40 ratio target for science and literature was first introduced in the early 1970s (Academy of Science Malaysia, 2017). Next, various policies and policies were also introduced to empower the field of science and technology with the launch of the National Science, Technology, and Innovation Policy (DSTIN) in line with the idea of Malaysia stepping forward as a developed country in Vision 2020 (W2020).

The Malaysian Ministry of Education established the Malaysian Education Blueprint 2013-2025, which outlines strategic plans and initiatives for the country. The approach to empowering science and technology through STEM education is empowered in schools by this policy. The Malaysia Education Blueprint (2013-2025) began to strengthen the approach to attracting students' interest in STEM. In fact, the 2013-2025 plan emphasises the involvement of educators and school administrators, as well as parents, and includes implementation for schools located outside of the city. The gender gap is also an implementation goal in the 2013-2025 plan, with the goal of eliminating significant gaps in STEM field participation among students (Ministry of Education Malaysia, 2013).

In addition, taking into account the needs of the Industrial Revolution 4.0, jobs that focus on the fields of Science, Technology, Engineering, and Mathematics (STEM) are widely seen as future job prospects (Black et al., 2021). This is exacerbated by the Ministry of Science, Innovation, and Technology's introduction of the National Science, Technology, and Innovation Policy (DSTIN) 2021-2030 to empower the advancement of science and technology towards the development of the national economy (Ministry of Science, Technology and Innovation, 2022).

Table 1
*Waves of Phase 1 to Phase 3 of Malaysia Education Blueprint (2013-2025)*

| Wave | Focus |
|---|---|
| Wave 1 (2013-2015<br><br>Strengthen the foundation | In wave 1 the focus is to increase students' interest through a new learning approach and strengthen the curriculum that emphasizes higher order thinking skills (KBAT).<br><br>Hone the teacher's teaching skills.<br><br>Enable teachers and school leaders to have high performance. |
| Wave 2 (2016-2020)<br><br>Building the foundation of wave 1 | Formulating a new primary and secondary school curriculum (KSSM and revision of the KSSR curriculum). |

Evaluation Studies in Social Sciences (ESSS)
eISSN 0128-0473 Vol 4(2)/ 2023 (19-29)
https://ejournal.upsi.edu.my/index.php/ESSS/index
DOI: https://doi.org/10.37134/esss.vol4.2.3.2023

| | |
|---|---|
| | Encourage the development of learning communities between schools.<br><br>Improve existing science equipment and facilities in schools to ensure that students are in the best possible environment for effective STEM teaching and learning.<br><br>Extension of STEM awareness program to primary school students and parents.<br><br>Reduction of disparities up to 50% for urban and rural students.<br><br>Reduction of socioeconomic achievement gap by 25% based on student gender. |
| Wave 3 (2021-2025)<br><br>Inspire to the next level | In order to develop future action plans, introduce new initiatives and programmes based on the successes of the first and second waves.<br><br>Maintain or improve the 50% socioeconomic gap between urban and rural students, as well as student gender. |

***Trends of STEM Interest***

According to the Malaysian Ministry of Education's Annual Report, the percentage of students studying STEM is 47.18 percent, with 20.51 percent studying Pure Science subjects and the remaining 26.67 percent studying Technical Education and Vocational Training (TVET) subjects (Ministry of Education Malaysia, 2022). In 2019, student involvement in the STEM field was only 43.47 percent, which is the lowest figure since 2012 until 2022 (Ministry of Education Malaysia, 2022). However, according to the Malaysian Ministry of Education's annual report for 2022, student involvement in STEM subjects is the lowest, at 40.95 percent, with only 152,568 students participating. Figure 1 depicts the trend of student participation in STEM at school.

Evaluation Studies in Social Sciences (ESSS)
*eISSN 0128-0473 Vol 4(2)/ 2023 (19-29)*
*https://ejournal.upsi.edu.my/index.php/ESSS/index*
*DOI: https://doi.org/10.37134/esss.vol4.2.3.2023*

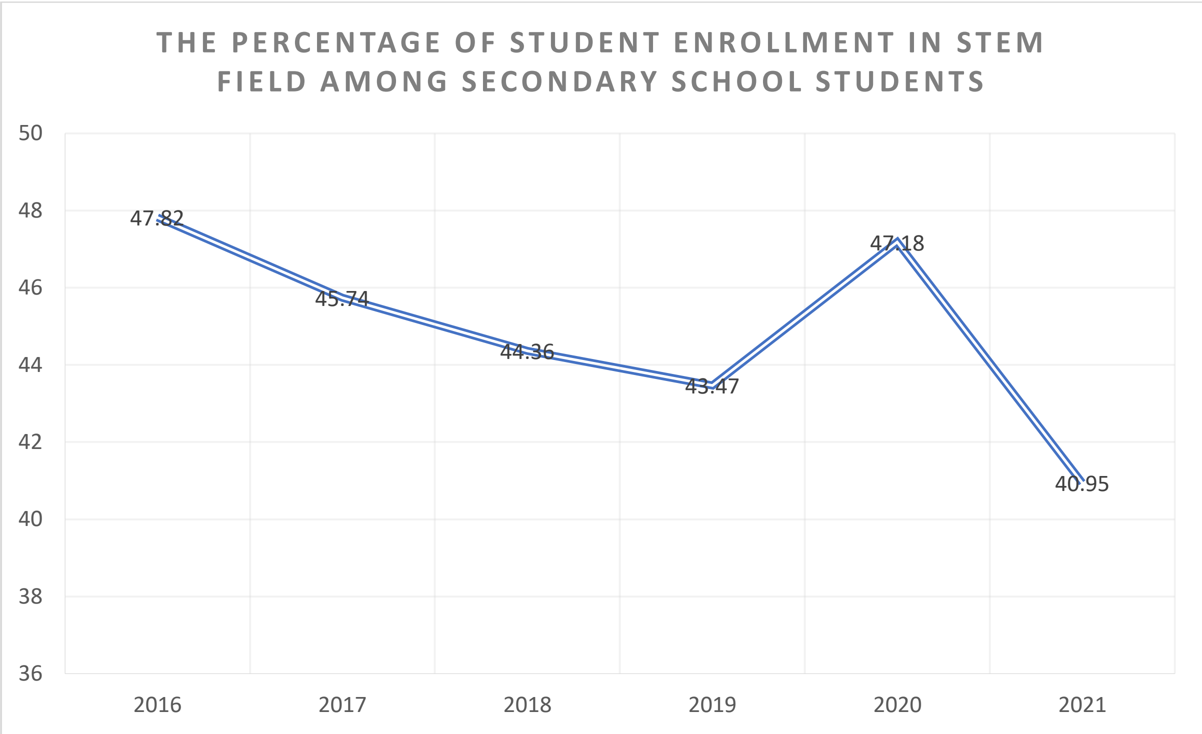


*Figure 1.* Percentage of Student Involvement in STEM in Malaysia

Figure 1 shows that in 2016 the involvement in STEM education was 47.82 percent, while 2017 recorded 45.74 percent. Between the years 2018 and 2019, respectively, they recorded values of 44.36 percent and 43.47 percent. The year 2020 recorded a student participation value in STEM of only 47.18 percent of the targeted 60 percent. The year 2021 is the lowest year of student involvement in STEM for the six-year period between 2016 and 2021 when only record student involvement in STEM 40.95 percent which includes 152 568 students in secondary school (Ministry of Education Malaysia, 2022).

### *Research of STEM Interest*

Research findings to identify factors and measures to promote STEM interest have been widely conducted at the primary, secondary, and university levels. This is because STEM participation and involvement is essential for a country to thrive in line with the development of the Industrial Revolution 4.0. Shahali et al. (2016) conducted a study to determine the effects or implications of STEM career interest on Malaysian high school students. According to the study's findings, there is a significant increase in the mean score for interest in STEM subjects and careers after participating in the STEM career intervention programme at school.

In the study by Mahmud et al. (2022), personality traits can predict interest in STEM, particularly in the career field. Respondents with a social, investigative, and realistic personality are more likely to pursue STEM careers in high school. Tekbiyik et al. (2022)

Evaluation Studies in Social Sciences (ESSS)
eISSN 0128-0473 Vol 4(2)/ 2023 (19-29)
https://ejournal.upsi.edu.my/index.php/ESSS/index
DOI: https://doi.org/10.37134/esss.vol4.2.3.2023

investigated the effects or implications of a robotics camp on STEM students' career interest. The study's findings indicate that when students are exposed to integrated learning in the classroom, their interest in STEM fields increases. In accordance with the findings of Syukri and Ernawati's (2020) study, the Problem Based Learning (PBL) learning approach also increases students' interest in STEM education at school. This can be demonstrated when experimental studies on the study sample show an improvement in academic performance in STEM.

In conclusion, previous research indicates that a variety of factors influence students' interest in STEM fields at school. In fact, raising awareness and cultivating interest in STEM fields or careers can begin in secondary school (Kier et al., 2014; Idris et al., 2023b).

## CONNECTIONS OF COGNITIVE ON STEM

### *Cognitive Factor of Learning*

The development of cognition refers to how the mind develops and how an individual receives and processes information from various sources in learning and teaching (Butler and Scurlock, 2013). Furthermore, cognitive abilities include the process of gathering information in a person's mind, such as perception, learning, storing information, language, and thinking processes (Riegler & Riegler, 2012; Gilhooly et al., 2014). As defined by Messick (1984), cognitive is also a type of personal characteristic that processes and organises information and experience based on personal preferences.

Interestingly enough, cognitive affects an individual student's learning style at school or university due to the constant cognitive nature of a person's learning style, which is always changing (Pithers, 2002; Friedman & Schustack, 2011). With the advancement of science and technology, innovative technology education frequently overlooks the fact that students with varying levels of achievement require system design and learning strategies that differ from the current situation they are in (Huang & Chiu, 2015).

Moreover, Witkin et al. (2002) define cognitive as a common and preferred approach by an individual to organise and communicate information. Individuals consistently use the same approach, and their preferred information processing mode differs from one another (Witkin et al., 1977). Previous research has discovered cognitive effects on learning and discovered that different cognitive have different priorities (Chang et al., 2015), which contributes to the atmosphere of today's educational approach that integrates STEM in school education.

Additionally, Ford and Chen (2001) stated that cognitive factors and roles in learning activities can contribute to more efficient learning and higher academic achievement. Thus, the role and cognitive factors in learning will have a significant impact on student learning performance (Chang et al., 2015). Cognitive methods can improve not only the level of student learning performance but also the learning attitude (Dunn & Dunn, 1994).

To summarise, in order to improve effectiveness, satisfaction, and learning experience, the design of the teaching system must also take into account the cognitive skills possessed by

Evaluation Studies in Social Sciences (ESSS)
eISSN 0128-0473 Vol 4(2)/ 2023 (19-29)
https://ejournal.upsi.edu.my/index.php/ESSS/index
DOI: https://doi.org/10.37134/esss.vol4.2.3.2023

students (Hsieh et al., 2011), especially now that STEM education has been introduced and is part of the syllabus in education majors (Ministry of Education Malaysia, 2016).

***Cognitive on STEM Interest Research***

A study conducted by Hu et al. (2016) discovered that the humour factor in STEM education can improve the educational experience, particularly the problem-solving approach that is always used in STEM-based subjects at school. Mefoh et al. (2017) discovered that male and female students have cognitive differences when solving problems related to problem solving at school, particularly in STEM subjects, based on the cognitive aspect. Field-independent cognition (FI) students completed more problem-solving tasks than field-dependent cognition (FD) students. Male students also outperform female students in school problem-solving tasks.

The cognitive role also helps to explore the cognitive process especially in giving a role to STEM education at school. Li and Wang (2020) reported that students with a high cognitive level who use navigation integration (navigation) have a good level of academic performance in learning based on STEM education at school. Berkowitz and Stern (2018) found that cognitive abilities contribute significantly to academic achievement especially for students taking engineering courses in STEM.

Cognitive factors are also studied to predict the interest of students who pursue STEM education in school. According to Chachashvili-Bolotin et al. (2016), positive STEM learning experiences can increase students' interest in STEM fields. Anugrah and Galih (2019) discovered an effect of improving cognitive skills among students participating in STEM-based learning in schools, particularly in Indonesia.

Cognitive ability has the potential to influence students' career choices. Donmez (2021) discovered cognitive differences in female students who participate in STEM activities outside of school hours. The study's findings indicate that implementing STEM activities outside of school contributes to students' cognitive improvement in STEM learning. After participating in the activity, 60% of students with cognitive FI changed their career path to STEM.

Setiawan et al. (2020) use cognitive as a variable to identify individuals' ability to solve problems encountered in STEM learning at school. According to the findings of their study, there is a significant difference in FI and FD students' cognitive reasoning and problem-solving abilities in STEM subjects, particularly mathematics. Recognising students' cognitive abilities can help educators tailor teaching strategies and interventions to improve educational results and pupil participation in subjects related to STEM (Idris et al., 2023c).

Evaluation Studies in Social Sciences (ESSS)
eISSN 0128-0473 Vol 4(2)/ 2023 (19-29)
https://ejournal.upsi.edu.my/index.php/ESSS/index
DOI: https://doi.org/10.37134/esss.vol4.2.3.2023

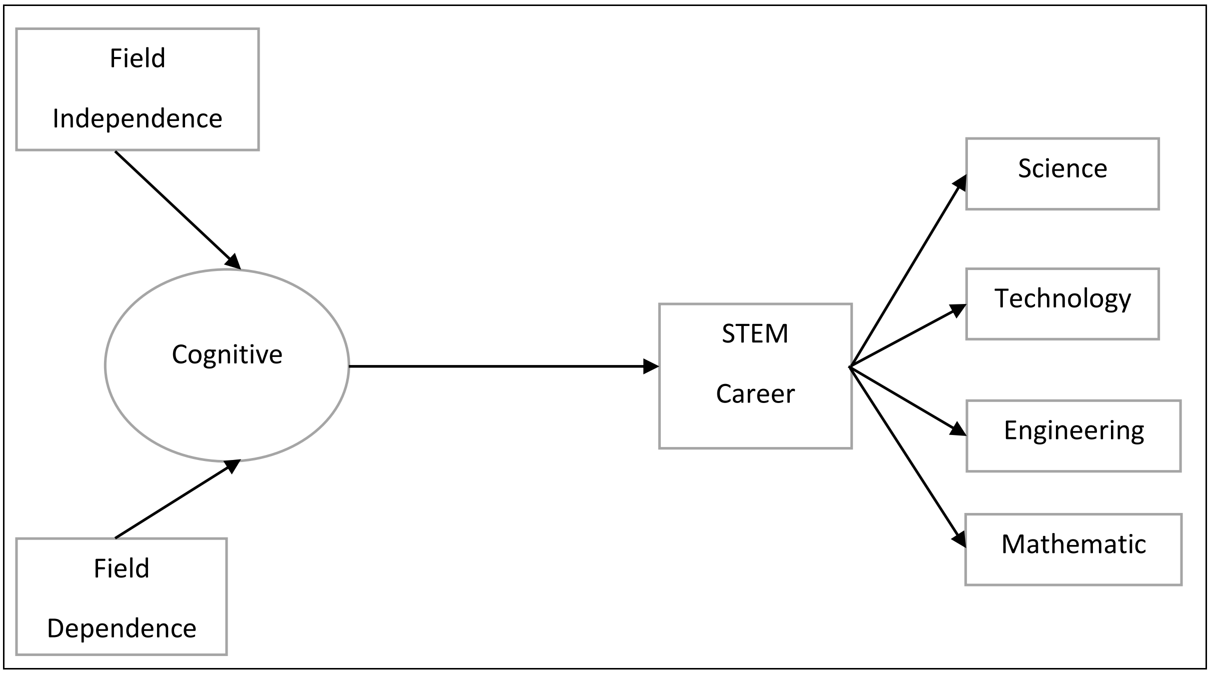


*Figure 2.* Cognitive Conceptual Framework of STEM Career Interest

## CONCLUSION AND FUTURE AGENDA

The role of cognition in learning, particularly in STEM education, is becoming increasingly important to investigate. Previous research has identified a wide range of cognitive abilities and roles in improving the elements of student understanding found in problem-solving oriented learning found in STEM learning in schools. Previous research has also demonstrated the cognitive influence to improve learning and academic levels, particularly in STEM education. Indeed, cognitive abilities play a role in increasing student interest in STEM fields. However, there has been little research to examine and identify the role of cognition on the tendency of interest in STEM fields and careers, particularly in Malaysia. Ideally, the study's findings will aid in increasing the tendency or involvement of Malaysian students in the STEM field, which currently stands at 60%.

## ACKNOWLEDGEMENT

This study not granted funding.

**Evaluation Studies in Social Sciences (ESSS)**
*eISSN 0128-0473 Vol 4(2)/ 2023 (19-29)*
*https://ejournal.upsi.edu.my/index.php/ESSS/index*
*DOI: https://doi.org/10.37134/esss.vol4.2.3.2023*

## REFERENCES

Academy of Science Malaysia. (2017). *Science outlook report. Conveging towards progressive Malaysia 2050*. Research and Policy Recommendations Documents. https://www.akademisains.gov.my/asm-publication/science-outlook-report-2017/

Academy of Science Malaysia. (2020). *10-10 Malaysian Science, Technology, Innovation and Economy (MySTIE) Framework*: Trailblazing the way for prosperity, social well-being & global competitiveness. http://www.akademisains.gov.my/10-10-mystie.

Amelia, A., & Lilia, H. (2019). The challenge of integrating STEM education in the Malaysian curriculum. *Seminar Wacana Pendidikan*, September, 1-10.

Anugrah, R. F., & Galih, D. S. (2019). Effect of STEM-based learning on the Cognitive Skills improvement. *Mimbar Sekolah Dasar*, *6*(2), 198-207. http://doi.org/10.17509/mimbar-sd.v6i2.17562.

Berkowitz, M., & Stern, E. (2018). Which cognitive abilities make the difference? Predicting academic achievements in advanced STEM studies. *Journal of Intelligence*, *6*(48), 1-24. http://doi:10.3390/jintelligence6040048.

Black, S. E., Muller, C., Spitz-Oener, A., He, Z., Hung, K., & Warren, J., R. (2021). The importance of STEM: High school knowledge, skills and occupations in an era of growing inequality, *Research Policy, 50* (7), 1-19. https://doi.org/10.1016/J.RESPOL.2021.104249.

Breiner, J. M., Harkness, S. S., Johnson, C. C., & Koehler, C. M. (2012). What is STEM? A discussion about conceptions of STEM in education and partnerships. *School Science and Mathematics*, *112*(1), 3–11.

Bryan, L. A., Moore, T. J., Johnson, C. C., & Roehrig, G. H. (2015). *Integrated STEM education*. In C. C. Johnson, E. E. Peters-Burton, & T. J. Moore (Eds.), STEM roadmap: A framework for integration. Taylor & Francis.

Butler, T., & Scurlock-Evans, L. (2013). *Personality and Individual Differences*. Pearson Education Limited.

Chachasvili-Bolotin, S., Milner-Bolotin, M., & Lissitsa, S. (2016). Examination of factors predicting secondary student interest in tertiary STEM education. *International Journal Science Education, 38*(3), 366-390. doi:10.1080/09500693.2016.1143137.

Chang, B., Chen, S. Y., & Jhan, S. N. (2015). The influences of an interactive group-based videogame: Cognitive styles vs. prior ability. *Computers & Education, 88*, 399-407.

Chen, Y. T., Liou, S., & Chen, L. F. (2019). The relationships among gender, cognitive styles, learning strategies, and learning performance in the flipped classroom. *International Journal of Human–Computer Interaction, 35*(4–5), 395–403.

Department of Statistics Malaysia (DOSM). (2022). Survey: 72.1% of Malaysians not keen on higher education after SPM, want to work as influencers or in gig economy instead. Retrieved by 12 January 2023 at https://www.dosm.gov.my/v1/uploads/files/5_Gallery/2_Media/4_Stats%40media/1

Donmez, I. (2021). Impact of out-of-school STEM activities on STEM career choices of female student. *Eurosian Journal of Educational Research, 91*, 173-204.

eISSN 0128-0473 Vol 4(2)/ 2023 (19-29)
https://ejournal.upsi.edu.my/index.php/ESSS/index
DOI: https://doi.org/10.37134/esss.vol4.2.3.2023

Dunn, R. S., & Dunn, K. J. (1994). *Teaching Young Children Through Their Individual Learning Styles.* Allyn and Bacon.

Ford, N., & Chen, S. Y. (2001). Matching/Mismatching revisited: An empirical study of learning and teaching styles. *British Journal of Educational Technology, 32*(1), 5-22.

Friedman. H. S., & Schustack. M., W. (2011). *Personality: Classic Theories and Modern Research*. Pearson.

Gilhooly, K. J., Lyddy, F., & Pollick, F. (2014). *Cognitive Psychology*. McGraw Hill Education.

Hsieh, S. W., Jang, Y. R., Hwang, G. J., & Chen, N. S. (2011). Effects of teaching and learning styles on students' reflection levels for ubiquitous learning. *Computers & Education, 57*(1), 1194-1201.

Huang, Y. M., & Chiu, P. S. (2015). The effectiveness of the meaningful learning-based evaluation for different achieving students in a ubiquitous learning context. *Computers & Education*, *87*, 243-253.

Hu, D. L., Lefton, L., & Ludovice, P. J. (2016). Humour applied to STEM education. *System Research and Behavioral Science*. Wiley Online Library. http://doi.org/10.1002/sres.2406.

Idris, R., Govindasamy, P., & Nachiappan, S. (2023a). Fueling ambitions: The dynamic interplay of personality, cognitive and self-efficacy in fostering STEM interest among Malaysian secondary school students. *International Journal of Advanced Research in Education and Society, 5*(3), 276-287. https://doi.org/10.55057/ijares.2023.5.3.27.

Idris, R., Govindasamy, P., & Nachiappan, S., Bacotang, J. (2023b). Charting the courses: STEM interest career survey among secondary school students in Malaysia. *International Journal of Academic Research in Business and Social Sciences, 13*(9), 1546-1556. http://dx.doi.org/10.6007/IJARBSS/v13-i9/17957.

Idris, R., Govindasamy, P., & Nachiappan, S., Bacotang, J. (2023c). Empowering minds: Harnessing the potential of cognitive field independence and dependence in STEM education. *International Journal of Academic Research in Business and Social Sciences. 13*(9), 1504-1514. http://dx.doi.org/10.6007/IJARBSS/v13-i9/17955.

Kier, M. W., Blanchard, M. R., Osborne, J. W., & Albert, J. L. (2014). The development of the STEM career interest survey (STEM-CIS). *Research in Science Education, 44*, 461-481.

Li, X., & Wang, W. (2020). Exploring spatial cognitive process among STEM student and its role in STEM education. A cognitive neuroscience perspective. *Science & Education, 30*, 121-145. https://doi.org/10.1007/s11191-020-00167-x.

Mahmud, M. I., Kari, D. N. P. M., & Ai, T. Y. (2022). The Relationship between career interests and STEM careers of secondary school students. *Journal of Positive School Psychology*, *6*(2), 587-595.

Mefoh, P. C., Nwoke, M. B., Chukwuorji, J. C., & Chijioke, A. O. (2017). Effect of cognitive style and gender on adolescents' problem solving ability. *Thinking Skills and Creativity*, *25*, 47–52.

Messick, S. (1984). The nature of cognitive styles: Problems and promises in educational research. *Educational Psychologist, 19*(2), 59-74.

**Evaluation Studies in Social Sciences (ESSS)**
*eISSN 0128-0473 Vol 4(2)/ 2023 (19-29)*
*https://ejournal.upsi.edu.my/index.php/ESSS/index*
*DOI: https://doi.org/10.37134/esss.vol4.2.3.2023*

Ministry of Education Malaysia. (2013). *Malaysia Education Blueprint Plan 2013-2025*. Putrajaya: Ministry of Education Malaysia.

Ministry of Education Malaysia. (2016). *Guide to the implementation of science, technology, engineering and mathematics (STEM) in teaching and learning*. Curriculum Development Division Putrajaya.

Ministry of Education Malaysia. (2022). *Annual Report of the Malaysian Education Development Plan*. Putrajaya: Ministry of Education Malaysia.

Ministry of Science, Technology and Innovation. (2022). *List of Malaysian Government Policies and Policies*. Retrieved by 14 January, 2023 at https://mastic.mosti.gov.my/sti/sti-policies/national-science-technology-and-innovation-policy.

Pithers, R. T. (2002). Cognitive learning style: A review of the field dependent field independent approach. *Journal of Education and Training, 54*, 117-132.

Riegler, R. B & Riegler. R. G. (2012). *Cognitive Psychology. Applying the Science of The Mind*. Allyn & Bacon.

Setiwan, A., Wawan, Koderi & Pratiwi, W. (2020). Game based learning in mathematics: Future teachers' viewpoint. *Journal for the Mathematics Education and Teaching Practices*, *1*(2), 87-93.

Shahali, E. H. M., Halim, L., Rasul, M. S., Osman, K., & Zulkifeli, M. A. (2016). STEM learning through engineering design: Impact on middle secondary students' interest towards STEM. *EURASIA Journal of Mathematics, Science and Technology Education*, *13*(5), 1189-1211.

Syukri, M., & Ernawati. (2020). Increasing students' interest in learning through a PBL model based on the STEM approach in learning physics. *Jurnal Pencerahan, 14*(2), 1693-7775.

Tekbiyik, A., Bulut, D. B., & Sandalci, Y. (2022). Effects of a summer robotics camp on student STEM career interest and knowledge structure. *Journal of Pedagogical Research*, *6*(2), 91-109. https://dx.doi.org/10.33902/JPR.202212606.

Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. W. (1977). Field dependent and field-independent cognitive styles and their educational implications. *Review of Educational Research*, *47*, 1-64.

Witkin, H. A., Oltman, P. K. , Raskin E., & Karp S. A. (2002). *Group Embedded Figures Test Sampler, Set Manual, Sample Figures and Scoring*. Mind Garden, Inc.