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Big Five Personality Traits as Predictors of Systems Thinking Ability of Upper Secondary School Students

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ABSTRACT

Developing system thinking skills among secondary school students has been set as an educational goal for years. The emerging properties of a system have recently been influenced by the characteristics of each student. Thus, this study examines the Big Five personality traits as predictors of Malaysian school students' systems thinking. Quantitative data was obtained using a standardized questionnaire with established scales (the Goldberg' International Personality Item Pool and the Systems Thinking Scale) from 196 upper secondary school students. The results indicate that personality traits affect secondary students' system thinking, and almost thirty percent of the variation in the Malaysian system thinking skill can be elucidated by its sub-domains. Although agreeableness has superior impacts on systems thinking, extraversion seems to have less importance on their systems thinking. The results also reveal the negative association between extraversion and neuroticism and systems thinking. We conclude that certain personality traits can improve systems thinking and promote students' ability to solve complex problems. The implications of these findings for the enhancement of systems thinking among school students are discussed.

Keywords: Malaysia, personality traits, systems thinking, secondary school students

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INTRODUCTION

In reaction to the COVID-19 pandemic, 107 countries have implemented national school closures. Over 862 million children and young people were impacted, which is almost half of the global students' population. The Malaysian government

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announced that all schools would close indefinitely on 18 March 2020 amid fears of the COVID-19. Therefore, it interrupted the academic year of students committed to learning (World Bank, 2020). This pandemic brought the risk of the viral infection and an increase in depressive and anxiety symptoms, insomnia, anger, fear, and incidents of dropping out of school among Malaysian students and students from the rest of the world (Cao et al., 2020). Thus, the COVID-19 threat is convincing for a new argument with regard to the use of systems thinking since the challenges we face have no borders and are all interlinked, often in invisible ways. System thinking skills in secondary schools can assist students in learning during the COVID-19 crisis. System thinking skills for students provide decision-making skills for future problems that can help them incorporate lessons from the COVID-19 crisis to better prepare for systematic challenges that have yet to come. This is precisely what systems thinking would like to achieve: exploring the relationships between different parts and how they interact. In the educational domain, systems thinking and seeing society as a whole is more vital now than ever before.

Education is a crucial tool to prepare students to live and thrive in the 21st century (O'Sullivan & Dallas, 2017). Society needs individuals with the ability to face challenging socio-economic situations and solve the current COVID-19 crisis. One of these primary skills is systems thinking, which is a form of higher-order thinking (Wang & Wang, 2011). It is defined as the skill of recognizing separate elements in the complex system of society and their interconnection and their functions that enable individuals to act and also predict the future (Arnold & Wade, 2017). According to educational scholars, the lack of systems thinking among students can affect their future decision making. Thus, schools can cultivate systems thinking among students (Behl & Ferreira, 2014). Systems thinking is also described as a type of higher-order thinking in vogue among many educational systems. Educational systems worldwide are trying to adopt systems thinking to help their students identify, understand, predict the behavior, and adapt the systems to reach individual goals and even to create new knowledge to survive in the competitive and challenging modern society (Palmberg et al., 2017). According to the above information, there are four principles of systems thinking: identifying the systems, understanding the systems, predicting the behavior of the systems, and devising the modifications to systems to produce the desired effect (Arnold & Wade, 2015).

On the one hand, there is a viewpoint that individuals need to be born with higher-order thinking skills (Hitchins, 2003). On the other hand, due to the developing nature of humans and the influence of learning in this process, scholars believe that systems thinking cannot be developed naturally because human development helps individuals to handle instant and direct surface features of challenges gradually since individuals learn from past experiences

and their cognitive abilities are limited (Sabouripour et al., 2017). Furthermore, David and Reich (2005) concluded that it could be born with system thinking, and at the same time, it needed to be taught. Thus, system thinking can be correlated with people's character traits (Arnold & Wade, 2017).

As suggested by Parks-Leduc et al. (2015), traits of personality can be defined as the set of psychological traits and a way of acting, thinking, or behaving within the individuals that are organized and can influence his or her interactions with, or adaptation to, the intrapsychic, physical, and social environment. Thus, personality traits can shape a person's reaction and adaptation to the psychological, biological, and social environments, which are part of systems thinking (Smith et al., 2019).

There are various categories of personality traits introduced by researchers. However, the Big Five personality model (i.e., openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism) is an inclusive and a robust model of personality based on the general agreement derived from many years of observation by psychologists (Abdullah et al., 2016). Research has shown that systems thinking is frequently associated with cognitive personality traits (Arnold & Wade, 2017).

According to Ozer and Benet-Martinez (2006), personality has predictive relations to essential life outcomes at the individual, interpersonal, and social levels. At the interpersonal level, personality traits can shape the quality of the social relationship. Paunonen and Ashton (2013) stated that these traits could act as predictors. For instance, Peters (2014) found that the openness to new experiences, agreeableness, and conscientiousness of personality traits could be used to predict individuals' systems thinking.

Complex Adaptive Systems Theory (CAST) mentions that various elements in the agents' systems are dependent on each other. They can learn via experiences and adapt to the environment (agent ↔ environment) and changes in the environment (Preise et al., 2018). Based on the CAST, a system comprises diverse agents that interact to adapt to the environment. The interaction between these elements can cause changes in an entire system (Onik et al., 2017). Agents in complex adaptive systems can also be represented by persons who are by nature, heterogeneous, and have diverse traits, aptitudes, and preferences (Rammel et al., 2007). Since diverse personality traits affect systems thinking, these traits allow them to readily recognize and understand other agents' interconnections, which may comprise other people, concepts, companies, or the surroundings that are multi-level in structure (Behl & Ferreira, 2014). Thus, personality traits can also affect systems thinking on how they see and understand the agents' connections, constituting a more complex environment (Davidz & Nightingale, 2008).

As theorized by CAST, systems are defined as the collection of agents with the freedom to act in unpredictable ways,

and the actions are interconnected, which can cause change to one agent's actions and the conditions of the other agent (Sammut-Bonnici, 2015). Instead of thinking positively and linearly, CAST emphasizes the importance of thinking in a complex and non-linear manner (Onik et al., 2017). There are three main elements of CAST that are suggested by several scholars. They are the diversity of agents, interactions, and environments representing the space in which the agents reside in or are connected with. The CAST elements have their attribute, behavior, and rules, which determine how they interact.

As it is, there are still many inconsistencies about the relationships between Big Five personality traits in fostering systems thinking, especially among young people. Lacking the mentioned skills also means that the students have yet to master systems thinking. Systems thinking enables students to understand complex systems. It also enables them to understand how the systems' elements interact and how to adapt and act to improve the systems based on their knowledge. Schooling is the time and place where the students will get the opportunity to develop their skills that can be used in the future. Thus, the lack of skill causes students to have trouble knowing and identifying where or when the right time and situation to apply their knowledge is. This is because systems thinking can help students to fully understand the disciplinary core ideas that will help them to develop a logical and well-organized view of the world (Verhoeff et al., 2018). Thus, to promote and encourage systems thinking among students, the first step that needs to be taken into account is understanding how people think and see (Burnell, 2016). Going forward, this study is conducted to examine the relationship between individuals' personality traits and the systems thinking among upper secondary school students and identify which dimensions of personality trait will predict the students' systems thinking.

The Rationale for the Current Study

According to the Malaysia Education Blueprint (2013), the lower and upper secondary schools are fundamental education levels that ensure that students can obtain the thinking skills. The plans are stated in several educational policies to ensure that the development of higher-order thinking skills among students from primary to tertiary education levels can be achieved (Ahrari et al., 2016). To achieve this, The Malaysia Education Blueprint (2013) mentioned the increasing number of higher-order thinking skill's questions in examinations and the National Education Policy (NEP), Secondary School Standard Curriculum (KSSM), as well as Primary School Standard Curriculum (KSSR). Besides, the Ministry of Education Malaysia (2017) also mentioned implementing higher-order thinking skills activities and assessments in the classroom and the syllabus.

However, despite all these efforts by the Malaysian government, systems thinking is still lacking among Malaysian

school students. For example, Malaysian students' ranking in Trends in International Mathematics and Science Study (TIMSS) had dropped from 1999 to 2007 (Chien & Lajium, 2016). Besides, Malaysian students ranked at the bottom third of all participating countries in the year 2009 and 2012 Program for International Student Assessment (PISA) (Provasnik et al., 2016). The latest PISA results in 2018 showed that Malaysian students ranked below the OECD average in three fields, including reading, mathematics, and sciences (OECD, 2019). It can be interpreted that Malaysian students could not correct and recognize the familiar scientific events and could not identify whether or not the conclusion of simple cases is valid in complex situations such as exams. Thus, Malaysian students are still struggling with higher-order thinking skills. Raved and Yarden (2014) also found similar trends from students in different countries. Other studies show that a majority of Malaysian students still lack in some areas of systems thinking (e.g., Jerome et al., 2017), and it is opposite to the aim of the Malaysian education system, which is to produce students that can apply their knowledge and skills to solve problems, make decisions, be innovative, and creative. Lack of systems thinking skills does not necessarily mean that the students cannot perform well in academics. Nevertheless, it can affect the students' credibility while they are at their workplace. Thus, Malaysia's educational system emphasizes the importance of systems thinking skills to be developed early among students as soon as they start school.

LITERATURE REVIEW

Other than the importance of systems thinking in complex systems, there is a growing trend in personality psychological research dedicated to understanding how personality traits can affect and address complex system issues. Many previous studies have applied the theory of system thinking, system dynamics, and the role of system thinking in solving a complex problem in areas of the system, system approach, and comparisons of different system thinking approaches used mainly in education settings (Lawrence et al., 2019). Furthermore, Assaraf and Orion (2005) investigated the impact of high school students' systemic abilities on earth system education. Lavi and Dori (2019) showed the correlation between systems thinking on the learning tools, educational process, and thinking paradigm. In elementary and secondary education, Smolova (2019) stressed the need for a systematic approach. Dachner and Polin (2016) conducted a "management by goal" systematic approach to help companies reached a good quality decision-making process.

Currently, the emerging properties of a system have recently been influenced by personalities. Researchers studying the relations between personality and system thinking have developed and examined a wide variety of personality constructs reflecting different theoretical orientations. According to a recent study by Wright (2017), empirical factor approaches to the study of personality traits have shown that five factors account for much of the

variation in personality characteristics. These constructs reflect the continuums on the aspects of introversion-extraversion, emotional stability or neuroticism, openness to experience, agreeableness, and conscientiousness. The introversion-extraversion factor relates to individuals' sociability and introspectiveness, consisting of reserved-outgoing, quiet-talkative, and impulsivity-deliberateness (Fadda & Scalas, 2016). Neuroticism refers to emotional life, specifying opposites such as stable-labile, calm-worrying, even-temperamental, self-satisfied, and hardy-vulnerable opposites (Tackett & Lahey, 2017). Openness to experience refers to words such as inventive, original, and curious, as opposed to down-to-earth, traditional, incurious, and preferred routine (Schwaba et al., 2018). Agreeableness encompasses elements such as dubious-confident, flaky-generous, and anxious-good nature (Zufferey et al., 2019). Conscientiousness involves traits such as hard-working, well-structured, ambitious, and punctual versus their opposites, which are lazy, disorganized, aimless, and procrastinating (Lewis et al., 2018). While there may be some dispute about these five main factors' perception, there is ample evidence to support their stability and intensity for us to employ this conceptual taxonomy in presenting the literature on the relationships between personality characteristics and system thinking abilities.

Nagahi et al. (2020) stated that engineering managers were responsible for functioning in complex systems, often operating in a parallel environment where several tasks overlapped. System skills preferences and individual system engineering managers' personality traits are also critical to solving these complex systems. Hossain et al. (2020) stated the significance of the team members' personality characteristics in the system thinking ability. Buffinton et al. (2002) suggested that the team members' personality characteristics had a possible role to play in the problem-solving styles and interpersonal dynamics and teamwork in the management project.

Another study also highlighted the intellectual abilities and personality traits of Japanese systems engineers associated with their performance (Nagahi et al., 2020). Specifically, individuals' personality types are positively associated with systems thinking practices among members of professional organizations and graduate-level students (Linder & Frakes, 2011). The findings of previous studies (e.g., Balkis & Isiker, 2005) also indicated a significant relationship between the personalities of university students and the various styles of thinking. In a similar study, Dragoni et al. (2011) showed a positive association between managers' cognitive ability (comparable to personality traits) and their critical thinking and strategic thinking. Davidz and Nightingale (2008) showed that undergraduate students' personality types positively affected their metacognitive strategies usage. They also found that there was an association between personality traits and the development of systemic thinking.

In another study, Randle and Stroink (2018) carried out a pilot study examining the association between system thinking and various personality traits, including the big five. This study results indicated that system thinking capability was only significantly associated with the openness to experience and agreeableness. If this hypothesis is right, it may be feasible to enhance the system thinking by employing means similar to those useful for increasing the functioning of fluid intelligence. The results of this study also showed that openness to experience was associated positively with four cognitive and reasoning skills: crystallized intelligence, verbal episodic memory, fluid intelligence, and speed of processing.

Furthermore, Mumford et al. (2000) suggested that an individual's personality traits might impact his/her leadership ability in dealing with complex system problems. To refine the systems thinking paradigm and explore its relationship with knowledge, personality, and cognitive complexity, Randle and Stroink (2018) also explored systems thinking and its connection with older psychological mechanisms. Results showed that thinking systems, while linked to verbal intelligence, openness to experience, and complexity of attribution, made specific contributions to the imagination and, to some degree, to how people construct complex social problems. Therefore, the proposed research aims to further explore the role of personality in the development of systems thinking in the Malaysian context (see in Figure 1). The present investigation aims to test the following hypotheses:

***H*$_1$**. There is an association between extraversion and systems thinking skills.

***H*$_2$**. There is an association between neuroticism and systems thinking skills.

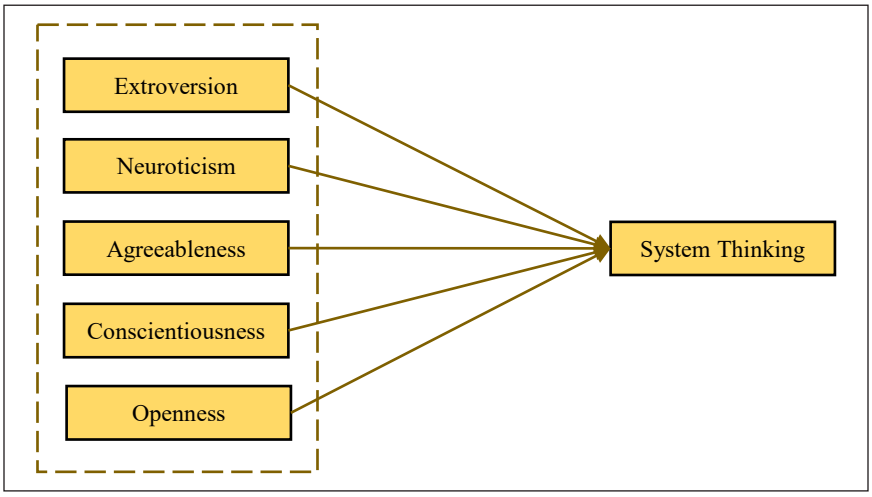

Figure 1. Theoretical framework

H_3. There is an association between agreeableness and systems thinking skills.

H_4. There is an association between conscientiousness and systems thinking skills.

H_5. There is an association between openness to experience and systems thinking skills.

H_6. There is a difference in systems thinking skills based on different personality types.

METHODS

Participants and Procedure

A total of 196 upper secondary school students from fully residential science schools in the Federal Territory of Kuala Lumpur were involved in this study via an online questionnaire distributed through email. Based on the boarding school (SBP) list, (Males: n = 88, 44.9%, and Females: n = 108, 55.1% and aged 15 to 16 years old).

According to the Cochran sampling formula (Singh & Masuku, 2014), the total sample size required should be in the range of 143 and 215 students. Byrne (2016) reiterated that the sample size for SEM must be reasonably significant. One hundred ninety-six samples met the SEM status for this study (Hu & Bentler, 1999). Following Chatterji's (2003) suggestion for education research, the quantitative method was employed. Before the actual analysis was initiated, a pilot test was performed on 33 participants. According to Malmqvist et al. (2019), a pilot study can be defined as a small study to investigate the viability of a method intended for use in a grander scale test. A pilot study can determine the effectiveness of recruiting, randomization, retention, testing processes, experimental approaches, and innovative intervention implementation (Fraser et al., 2018). The purpose of the pilot test in this study is to determine the instrument's readability and reliability before it is distributed in the actual field. Based on the pilot study result, instrument system thinking and personal traits, including extraversion, agreeableness, neuroticism, and openness to experience, have acceptable to high internal consistency (Cronbach Alpha range between 0.6 and 0.8). This result shows that the overall questionnaire was readable, the internal consistency is accurate, and no item is ambiguous. Henceforth, for the distribution of the instrument in the actual field, a convenience sampling technique was used for this research with the information obtained from fully residential science schools in the Federal Territory of Kuala Lumpur, namely Sekolah Menengah Sains Alam Shah, Sekolah Menengah Sains Seri Puteri, and Sekolah Menengah Sains Selangor.

Research Design

This study is a quantitative approach with correlational research design (Hassan & Ghazali, 2012; Gay et al., 2012). It used a standardized questionnaire with established scales to collect data. Furthermore, it aims at producing a model that explains and predicts the relations between students' traits and system thinking skills.

Measures

Systems Thinking. It can also be defined as individuals' cognitive ability to perceive a system as a whole (Mobus, 2018), and it consists of elements, interconnections, and a function or purpose (Meadows, 2008). The Systems Thinking Scale (STS) was used to measure the systems thinking ability (Moore et al., 2018). The questionnaire consisted of 20 items and scored on a 5-point Likert scale from (1) never to (5) always. In the current paper, STS's reliability was .82, and the convergent validity (Average variance extracted: AVE) was .616 with the construct reliability (CR) of .86.

Personality Traits. Personality traits are qualities/characteristics that distinguish the character, action, and attitude of an individual. The Big Five factors of personality are assumed to represent the basic structure behind all personality traits. The Goldberg's International Personality Item Pool (IPIP) (Goldberg et al., 2006) questionnaire was used to identify respondents' personality traits. In the current paper, the reliability of the IPIP of five factors ranged from .70 to .95, and the convergent validity ranged from .52 to .54, with the CR ranging from .812 to .878.

Data Analysis

This study employed the structural equation modelling (SEM) analysis using AMOS 24.0 version software. According to Byrne (2016), applying SEM has the following advantages:

(a). Enhances the statistical estimation by considering the measurement error in the estimation process,
(b) Allows the researching of multiple correlations,
(c) Tests more complex models such as testing mediation, and offers goodness-of-fit indices for the model tested, and,
(d) Enhances identification of the instruments' validity and reliability.

The mean extracted variance (AVE) and the construct reliability (CR) were calculated as valid and reliable instrument indices. As a result, AVE and CR were performed to measure the validity and reliability of the instruments. Convergence means a set of indicators (items) that is presumed to measure a construct.

Similar standard procedures of SEM were used to explore the relationships among the studied variables (Ismail, et al., 2020). In this study, several steps were needed to conduct the SEM analysis, including (i) develop a model based on the concept and theory, (ii) develop the path diagram to the structural model, (iii) determine the input matrix and model estimation, (iv) evaluate the goodness of fit, (v) interpret and modify the model.

Data Preparation

The data had a normal distribution shown by skewness values from -.635 to -.035 and the values of Kurtosis from -.581 to 1.403. Byrne (2016) defined that if the skewness values were between -2 and +2, the values

of Kurtosis were between -3 and +3, and the data should be presumed to have multivariate normality. The use of model fit indices with chi-square/degree of freedom ratio (CMIN / DF), comparative-fit index (CFI), goodness-of-fit index (GFI), and Tucker-Lewis index (TLI) was encouraged by Kline (2016) for model fit. A rule of thumb for the fit indices is that the values imply a satisfactory fit at, or above, 0.90 (Kline, 2016). The model can also be defined as satisfactory if the approximation root means square error (RMSEA) is between 0.03 and 0.08. Good fit indices were shown in this model: CMIN / DF = 1.409, $p < 0.01$, CFI=.916, IFI=.919, TLI=.961, GFI=.869, and RMSEA=.046. (cf. Table 1).

The measurement model provides evidence that the selected items reconstruct an unobserved construct (Byrne, 2016). The CFA result indicated a satisfactory measurement model with high factor loadings for all of the items on the predictable factors, and the commonalities of each item are above 0.50. This denotes that all of the constructs imitate the convergent construct validity calculation. In terms of the validity analysis, all constructs display sufficient discriminant validity, while the value of the square root of AVE of each dimension was more significant than the correlation coefficients of the pairwise dimension.

RESULTS AND DISCUSSION

Structural Model

This model comprises the Big Five personality traits variables, namely extraversion, neuroticism, agreeableness, openness, conscientiousness as exogenous variables, and the system thinking that acts as the endogenous variable. As presented in Figure 2, extraversion is negatively and not significantly associated with systems thinking (β = -0.034, p = 0.776). Hence, this contrasts with Lukaszewski's (2019) work, who stated that students with the personality trait of extraversion were sociable, courageous, confident, active, socially attractive, positive emotionality-centered, and approach-oriented. Besides, the results showed that students with extraverted personality function-focused more on people or feelings than things and systems, which do not confirm previous studies (Clancy & Dollinger, 1993). Thus, this finding does not support H_1. Our findings may also be in line with Carvalho et al. (2020), suggesting that

Table 1
Goodness–of-fit measures and AVE and CR values of study instruments

Constructs	Mean	*SD*	AVE	CR	Fit index	Outcome
Extroversion	3.12	.73	.524	.812	CMIN/DF	1.409
Neuroticism	2.8	.71	.54	.878	CFI	.916
Agreeableness	3.6	.48	.526	.814	IFI	.919
Openness	3.4	.50	.522	.844	TLI	.961
Conscientiousness	3.5	.59	.534	.817	GFI	.869
System thinking skills	3.8	.43	.616	.864	RMSEA	.046

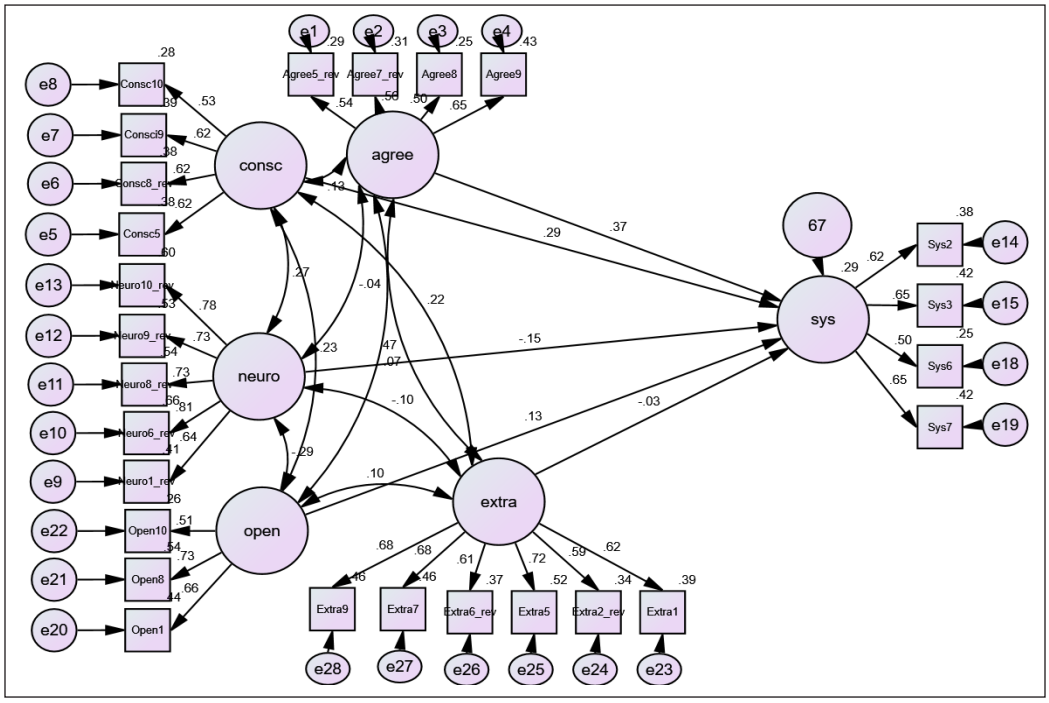

Figure 2. Structural model of the study
Note. Agreeableness (agree), openness (open), neuroticism (neuro), conscientiousness (consc), extraversion (extra), and neuroticism (sys).

extroverted functioning seems powerless in the COVID-19 traumatic situation and cannot influence students' systems thinking.

Hence, this result could suggest that neuroticism traits can negatively predict students' systems thinking (β = -0.152, p =0.008). This finding is aligned with the idea of Barlow et al. (2014), which stated that individuals with neuroticism traits had frequent experiences of negative emotions, which were often accompanied by the perception that the world was a dangerous and threatening place, which could hamper their systems thinking. Therefore, H_2 is not supported. Moreover, we found that students with an agreeableness trait think more systematically (β =0.370, p =0.024). As systems thinking is a set of methods, models, and techniques to analyze and solve complex problems (Pan et al., 2013), students with agreeableness traits can easily handle challenging situations with a sense of conflict resolution, leading them to systems thinking. Thus, H_3 is supported. The findings also indicate that conscientiousness is a significant predictor of students' systems thinking (β =0.288, p =0.022). This confirms the findings of Hiep and Ameen (2017). They stated that conscientiousness consisted of the leadership competence of showing a clear commitment and plan to solve issues and achieve goals when managing an enterprise or a group, which can be assumed as complex systems. Leaders need to consider, analyze, and evaluate to solve complex problems, which can be

done by applying systems thinking. Thus, H_4 is supported. Our findings contrast with Carvalho et al.'s (2020) findings, which stated that conscientiousness did not lead to systems thinking in challenging situations like the COVID-19 pandemic. Our results have established that students high in this trait can think systematically in these difficult times.

Finally, students' openness to experience does not lead them to systems thinking (β =0.131, p =0.250). The results do not confirm Schretlen et al.'s (2010) findings that the trait of openness to experience is strongly correlated with divergent thinking and cognitive flexibility to deal with a task and the changing environment. Thus, H_5 is not backed by the findings of this study. Extraversion, neuroticism, agreeableness, conscientiousness, and openness variables explained 29% of the variance in systems thinking among upper secondary school students in Malaysia.

An Analysis of Crosstabs

When comparing personality traits and systems thinking, it was found that more than half of the extroverts exhibited moderate systems thinking level. The current findings showed that most respondents with average neuroticism had either moderate or high system thinking levels.

Besides, as shown in Table 2, 44.1% of students with a high level of conscientiousness had a high level of systems thinking. Moreover, the majority of students with moderate agreeableness traits have a moderate level of systems thinking. Almost 40% of students demonstrating high level of openness to personality traits also showed high systems thinking level. The overall distribution of personality traits and systems thinking is tabulated in Table 2. The chi-square was used to statistically determine whether the distribution of categorical variables between the personality traits and systems thinking skills differed significantly from one and other. The chi-square revealed no significant difference between neuroticism and system thinking skill level with a chi-square, 4.01 and a p value of >0.05.

CONCLUSION

As schools worldwide have closed and leaving more than a billion students out of school, governments have deployed various remote learning modes. Thus, students who understand that their actions (based on their personalities) take place within a broader context can anticipate a crisis more quickly. This, in turn, makes them more resilient. Systems thinking is the ability that involves the need to think about the system as a whole by knowing and understanding the elements in the system, the relationship between the elements within the system, and adapting the knowledge about the system to solve the issue or to improve the function of the system (Arnold & Wade, 2017). As systems thinking is becoming more and more commonly known as the necessary force in Malaysia's education and a significant source in one's personal life, the growth of Malaysia's public interest in cultivating students' systems thinking has a greater

Table 2
Crosstabs of personality traits and level of system thinking skill

Personality traits	Systems thinking skill level						Pearson's Chi-square (χ^2)	Sig-χ^2
	Low		Moderate		High			
	N	%	N	%	N	%		
Extraversion							4.046	0.044
1.00 -2.33	0	0.00	13	18.8	20	15.7		
2.34-3.66	0	0.00	46	66.7	67	52.8		
3.67-5.00	0	0.00	10	14.5	40	31.5		
Neuroticism							4.01	.135
1.00 -2.33	0	0.00	13	18.8	41	32.3		
2.34-3.66	0	0.00	43	62.3	77	60.6		
3.67-5.00	0	0.00	13	18.8	9	7.1		
Conscientiousness							4.64	.032
1.00 -2.33	0	0.00	1	1.4	3	2.4		
2.34-3.66	0	0.00	38	55.1	68	53.5		
3.67-5.00	0	0.00	30	43.5	56	44.1		
Agreeableness							4.62	.035
1.00 -2.33	0	0.00	2	2.9	2	1.6		
2.34-3.66	0	0.00	48	69.6	55	43.3		
3.67-5.00	0	0.00	19	27.5	70	55.1		
Openness							4.6	.036
1.00 -2.33	0	0.00	1	1.4	3	2.4		
2.34-3.66	0	0.00	48	69.6	73	57.5		
3.67-5.00	0	0.00	20	29	51	40.2		

need. Malaysia Education Blueprint (2013) highlighted the importance of thinking skills by including the skill as one of the students' aspirations to survive in the 21st-century economy.

This study also reveals that different personality traits influence students' abilities in systems thinking. This is because personality traits are developed based on students' environmental, cultural, and socio-economic backgrounds. This study's findings support the fact that some aspects of an individuals' personality traits can affect the individuals' ability to think in systems thinking (Paunonen & Ashton, 2013). Schools do not have any substantial influence in promoting systems thinking to their students. Systems thinking and the extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience personality traits were analyzed using crosstabs. It indicates that most students have a high level of systems thinking and a moderate level for almost all five personality traits. As compared with previous studies, there are differences between Malaysian students with students from other countries. It may

be the culture and environment where the students lived (e.g., Schwaba et al. 2018). In general, this study's findings offer practical implications and vital recommendations for school managers and prospective studies. The findings support the notion that a sense of agreeableness and conscientiousness among the rest of the traits certainly need to be encouraged and nourished among Malaysian secondary school students.

This study also provides more understanding and additional information on improving the students' ability to think in systems thinking. The ability to think can be improved during formal teaching and learning sessions by giving students practices and knowledge to answer specific issues. Other methods can also be applied by teachers and school leaders to improve the students' systems thinking. Based on this study's additional information, one needs to identify the most critical predictor in personality traits that can significantly improve students' systems thinking. It is suggested that school leaders and educators organize activities that can promote certain personality traits that can improve systems thinking in schools or more specifically, classrooms.

According to current findings, the link between personality traits and systems thinking can provide students with immediate efficiency and improve the performance of the system by adapting the skills and personality of individuals to their future role requirements in a timely fashion. Besides, it is possible to support the enhancement of system thing skills and certain personality characteristics (e.g., conscientiousness, agreeability) through curricula across schools and determine which majors produce more students of system thinkers than others (Nagahi et al. 2020). The curriculum should be revised to design more courses that are relevant to the resolution of complex system problems to improve these skills. This study gives some implications, especially ideas to teachers on how to enhance students' ability in systems thinking by developing learning strategies by keeping in mind the individual's needs and personality traits. Agreeableness trait shows the most influence in system thinking, meanwhile extraversion and neuroticism show the opposite. Therefore, educators need to develop an intervention that is effective in altering personality factors to enhance the positive effect, particularly the intervention involved in developing systems thinking skills.

LIMITATIONS AND FUTURE STUDIES

This study cannot be generalized to all fully residential schools in the country, much less the other students from other schools, like the daily schools. The result for the level of systems thinking cannot describe the systems thinking ability for other students in Malaysia. This study was conducted at fully residential schools accommodating bright and high-achieving students from all over Malaysia. Moreover, many other factors that may be linked to systems thinking can be considered. Another limitation of this study is the use of only the Big Five personality

traits to assess upper secondary school students' personalities. There are many models and theories related to personality traits that can be found in many academic disciplines. In the present study, we selected the Big Five Personality due to its bipolar trait dimensions, which are part of the most widely used personality structure

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