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Thai Student Executive Function: A Confirmatory Factor Analysis (CFA)

Phramaha Wachiravit Kamphinit[1], Pariyaporn Tungkunanan[2], Paitoon Pimdee[3*], Boonchan Sisan[4]

[1,2,3,4] *King Mongkut's Institute of Technology Ladkrabang (KMITL), School of Industrial Education and Technology, Bangkok, 10520, Thailand*

[1] wachiravit.ka@gmail.com
https://orcid.org/0000-0003-3590-0810
[2] pariyaporn.tu@kmitl.ac.th
https://orcid.org/0000-0002-4143-0010
[3*] paitoon.pi@kmitl.ac.th
https://orcid.org/0000-0002-3724-2885
[4] boonchan.si@kmitl.ac.th
https://orcid.org/0000-0002-8095-9945

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Correspondence concerning this article should be addressed to Associate Professor Dr. Paitoon Pimdee*, King Mongkut's Institute of Technology Ladkrabang (KMITL), School of Industrial Education and Technology, 1 Chalong Krung 1 Alley, Lat Krabang, Bangkok, 10520, Thailand. *E-mail address*: paitoon.pi@kmitl.ac.th

Abstract

Developmental research suggests that *executive function* (EF) develops from age seven onward and is related to academic success. EFs are also known as *cognitive control* or *executive control* and make it possible for children to play with ideas, think before acting, take on new and unanticipated challenges, resist temptations, and stay focused. Therefore, given the importance of EF on a child's development and capabilities, the authors used multistage sampling to survey 500 primary-school educators and administrators serving under the Bangkok Metropolitan Authority's Department of Education (BMA-DOE) in the 2021 academic year. The questionnaire used a five-level opinion scale to assess each educator's opinion concerning each EF element. These included *working memory* (WM), *goal-setting* (GS), *goal-directed behaviors* (GDB), *cognitive control and flexibility* (CCF), and *systematic management planning, action, and self-assessment* (SMA). The CFA used LISREL 9.1 to examine the structural integrity of the variables concerning each student's EF abilities. Additionally, a Kaiser-Meyer-Olkin (KMO) index analysis and Bartlett's test of sphericity (BTS) suitability level of the variables were performed. The results from the analysis showed that the teachers believed that a student's GDB was most essential. Next was both CCF and SMA, judged to be equal in importance, followed by GS and WM. The implication is that Thai educators perceive a student's positive attitude and commitment toward their assignments as essential EF elements.

Keywords: Cognitive control, goal-directed behaviors, goal setting, Thailand, working memory

Introduction

The 21st century represents challenging times for humanity due to it being a time of rapid technological, economic, environmental, health, and political change (Kanawapee et al., 2022; Meltzer, 2018). As such, related negative factors such as Internet abuse and addiction (Pimdee & Leekitchwatana, 2022), food shortages, natural disasters, and terrorism weigh heavily not only on the adult populations, but the children they affect as well (Shonkoff et al., 2011).

In mid-2022, as the world is crawling out from the ravages of the global COVID-19 pandemic, it is once again vividly reminded of the carnage of war with the vivid and horrific daily social media images coming from the Russian-Ukrainian War. Although most things are not new, what is the same is the long-lasting effect on the youth they influence. Therefore, all aspects of human development are required to enhance the quality of intelligence, which includes an individual's behavior and work and life skills (Widowati et al., 2021a; Widowati et al., 2021b).

One factor which has been studied at length is *executive function* (EF) (also known as *cognitive control* and *executive control*), which is a high-level function of the brain that helps control emotions, thoughts, and actions (Chalanun, 2022). In simple terms, EF's primary purpose is behavioral inhibition and adaptation to rules (Meltzer, 2018).

Having first appeared in research from Lezak (1982), the term 'executive function' was used to describe the connections between a human's frontal lobe, EF, and problem-solving. The author concluded that problem-solving depended on functions contained in a human's frontal lobe. These EFs included planning and organization, anticipation and etting realistic expectations while understanding the consequences, execution and flexibility, and self-monitoring/emotional control/error recognition (García-Madruga et al., 2016).

In children, EF can help acquire teamwork, decision-making, problem-solving, and adapting to their current situation and surroundings. Best et al. (2011) has also suggested that EF starts developing at age seven and is related to academic achievement. In adults, EF skills are vital because it reflects systematic managerial thinking and rational, creative, flexible, and analytical thinking. Therefore, EF is based on human development in each area at all ages (Ahmed et al., 2019; Ginns et al., 2021; Menon & D'Esposito, 2022; Zelazo, 2020).

This is important in developing goal-directed behaviors to achieve desired results, whether about work, health, or living with others. Additionally, EF has been referred to as an umbrella term in which an individual's planning, working memory, inhibition, and mental flexibility are discussed (Chan et al., 2008). Moreover, EF skills are vital in classroom learning and goal-directed problem solving (Zelazo et al., 2017).

As self-regulation is a core element in adaptive human behavior, EFs such as task-switching, WM, and behavioral inhibitions can serve as elements in self-regulation (Hoffmann et al., 2012). Research has also pointed out that EF training holds significant promise in improving poor self-regulation in problem populations.

Other research has noted the importance of EFs in complex learning (Schwaighofer et al., 2017) and its potential to moderate the instructional approaches' effectiveness. EF's negative effect on classroom effectiveness has come from multiple studies showing the connections between ADHD and EF (Antshel et al., 2014). This has been described in Barkley's theory of EF and ADHD, in which the author states that EFs represent classes of self-directed actions or behavior that individuals use for self-regulation purposes (changing our future). However, EF is also stated to play a role in forgiveness and gratitude (Bono & McCullough, 2006).

Further studies have shown that a child's developing brain as well as their early experiences can lead to building a foundation for skilled workforces, responsible communities, and thriving economies (Center on the Developing Child at Harvard University, 2017). However, relationship development (parents, peers, and teachers), especially from ages three to five, will dramatically affect EF skills (Diamond, 2013; Lertladaluck et al., 2020). Therefore, EFs

make it possible for children to think before acting, play with ideas, and take on new and unknown challenges, resist temptations, and stay focused (Diamond, 2013).

However, throughout adolescence and early adulthood, EF skills are being influenced. Critical factors in EF development are how much support is given, a role model for good EF skills, how engagement takes place in practicing EF skills, and finally, is there a trustworthy role model guiding and protecting the individual. Without these positive EF influences, the result can be a society of 'act-now-think-later' citizens (Shonkoff et al., 2011).

In a Spanish study on inter-relationships between academic performance and EF in children, the researchers determined that prior research determining that EF had a more significant influence on math achievement was substantiated. The team also identified the EF components as *cognitive flexibility, inhibition, working memory,* and *planning*, with *working memory* having the greatest presence in the evaluated six to 12 year-olds.

In a study concerning Thai pre-service teacher EF, the author chose to analyze six EF components. These were *action, activation, effort, focus, emotion,* and *memory* (Manowaluilou, 2021). The study revealed that EF development is vital in student retention in education programs. Moreover, as expected, good student-teacher EF skills contributed many positive aspects to student learning. However, poor student-teacher EF was noted as challenging and expensive to reverse.

In another study from mainland China, the researchers reported how 997 children from grades 3-5 were affected by Theory of Mind (ToM) and two EF skills (Duh et al., 2016). Specifically, they evaluated *conflict inhibition* and *working memory* and concluded that both uniquely predicted ToM performance.

In another EF study from Japan, the researchers evaluated EF *social and nonsocial rewards* in children aged five to six years old. From their review of the literature and their results, they concluded how much reward effects EF performance in young children was inconclusive (Lertladaluck et al., 2020).

Finally, the core components of EF are familiar to many researchers, but other elements and their place in EF processes is unfamiliar to others. In studies from Thailand, we often see the terms *cognitive flexibility, attention control, goal setting*, and *information processing* as core EF elements. In another study from Korea, the researchers used the same four criteria (Kanga & Kimb, 2019). In an earlier, often cited paper from Anderson (2002), the author also used these four executive domains but referred to their outcome as '*executive control*'. The author also notes that *attention control* is the earliest EF element to appear and does so at a very early age and develops quickly early on. Additionally, nine sub-skills to EF have also been identified. These include *working memory, inhibitory control, cognitive flexibility, focus/attention, emotional control, self-monitoring, initiating, planning and organizing,* and *goal* (Chalanun, 2022).

Therefore, from this overview of *executive function*, the authors identified five main elements for review and inclusion in the study. These are detailed in the following Literature Review.

Literature Review

Working Memory (WM)

The definition of Working Memory (WM) is memory that temporarily stores and manipulates information to process and retrieve that information for use in situations where and when it is needed (Baddeley et al., 2011; Diamond, 2013). The capacity for WM can vary significantly, with 2 – 6 'chunks' acting as a collection of concepts with strong associations (Cowan, 2001). Moreover, WM capacity has been reported as essential for complex learning tasks (Sweller, 2011).

Various studies have reviewed how working memory affects EFs. In one such study in which older adolescents from 14–18 were studied, it was determined that socioeconomic status was a significant predictor of each student's WM (Theodoraki et al., 2020). In another study on

WM, the authors identified EFs that were stated as having a relationship with WM and higher-level cognition (García-Madruga et al., 2016). WM training was also reported as being essential in reading comprehension achievement from the experiments. Garon et al. (2008) focused on three EF elements in their research, including WM, response inhibition, and shifting. Their determination of these three EF elements indicated significant age-related improvements during the ages 3-5 years old.

De Jong (2006) also determined the vital role of verbal WM in reading, including a strong connection between visual-spatial WM and reading skills. The author also found that verbal WM was a strong predictor of reading comprehension and decoding.

Goal Setting (GS)

Meltzer (2018) has written that as we move through the 21st century with its ever-increasing dependence on technological expertise, success in life depends more and more on the mastery of EF processes such as GS. Within the adult workforce, GS can be thought of as a hill on which managers' climb for success, while *skill* is a worker function. When planning and GS are combined, they become critical processes in learners' understanding of task objectives, their ability to effectively organize their time, and understand which resources are needed to complete a task. Planning and GS are integral components of self-regulated learning (SRL) intervention success (Ridgley et al., 2020; Rutherford et al., 2018). Finally, student GS increases their commitment and motivation at attaining their goals.

Goal-Directed Behaviors (GDB)

According to Meltzer (2018), EF entails numerous complex cognitive processes that serve ongoing GDB. This is consistent with Pluck et al. (2020), who added that EFs underpin intelligent GDB and achievement in non-routine activities. The study also suggested that response inhibition may be a cognitive skill that contributes to real-life success.

Cognitive Control and Flexibility (CCF)

In a study by Gabrys et al. (2018), the authors developed a CCF questionnaire to evaluate these elements and their effect on EF. Their stated importance in studying CCF was its essential role in a person's capability to adapt to continuously changing environments. Also interesting to note from the multiple studies was their conclusion that flexibility reduction frequently leads to higher levels of depression symptoms.

In another study by Mayer et al. (2019), the researchers examined how computer games could improve young adults' cognitive skills. This included EF skills such as quickly and efficiently shifting attention from one task to another. Interestingly, the authors found that commercial entertainment games did little to promote EF skills. However, brain training games such as *Lumosity* appear to improve EF shifting skills (Bainbridge & Mayer, 2018).

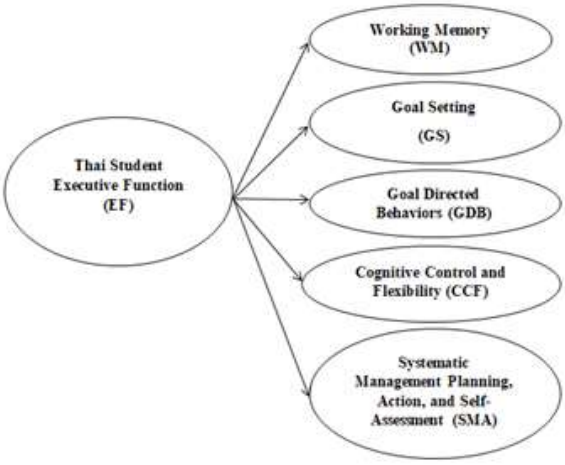
Systematic Management Planning, Action, and Self-Assessment (SMA)

Various EF researchers have noted planning and action skills. A strong indicator of a child's cognitive development is their ability to create an action plan in which priorities and goals are set (Center on the Developing Child at Harvard University, 2017). This is consistent with a study from Thailand, in which Ariyadamrongkwan et al. (2019) concluded that *systematic management planning*, *action*, and *self-assessment* are the abilities to create feasible operational procedures such as creating a mind map and putting it into practice. Planning skills can also be simple tasks such as writing down a recipe or making a travel packing list. Good SMA skills are also noted for the individual's ability to work alone.

From the above overview, the study's conceptual model is presented in Figure 1.

Figure 1

Conceptual CFA EF Student Model



Research problem

Since 1982 the idea of executive function has grown significantly as a core idea in how children aged seven and onward use their brain's frontal lobe capabilities to play with ideas, think before acting, resist temptations, stay focused, and takes on new and unanticipated. What is less clear and more controversial is how EF plays a role in their academic success, with some studies suggesting that EF is more relevant to a teacher's ability to control and manage their classroom. There are also numerous studies on what EF aspects play a role in creativity and, consequently, a learner's critical thinking and higher-order thinking skills (HOTS). However, the results are less than clear and accepted.

Objectives of the Research

1. Qualitative research methods are used to synthesize the literature and assess which elements play the most vital role in Thai youth EF processes as judged by their teachers and administrators.

2. From the factors selected, the research team used confirmatory factor analysis to judge the variables selected and develop items for their assessment.

3. An assessment is undertaken to determine the EF model's appropriateness from the framework developed.

4. Lastly, the research team will evaluate and rank the main variables and their aspects.

Materials and Methods

The investigation into how Thai student EF is affected by *working memory* (WM), *goal-setting* (GS), *goal-directed behaviors* (GDB), *cognitive control and flexibility* (CCF), and *systematic management planning, action, and self-assessment* (SMA) involved a qualitative and quantitative mixed-methods approach including a systematic review of the EF literature to investigate which factors affect student EF processes.

Ethics Clearance

Prior to the meeting with academic experts concerning the questionnaire's design, the authors met with our university's Human Ethics Committee to obtain approval for the study. After approval was granted, each participant in the pilot-survey group and main study group were given an informed consent form indicating their participation's anonymity and ability to opt out if

they wished to do so (Pimdee, 2020).

Population and Sample

The study's population was teachers and administrators in six BMA-DOE areas during the 2021 academic year (Hankla et al., 2021). These areas included 437 schools, 437 school principals, and 3,319 teachers (Table 1).

According to Tabachnick and Fidell (2013), adequate sample size is crucial when designing a study. Moreover, according to Brown (2015), the sample size influences the statistical power and precision of a CFA model parameter estimate and is a good tool to test the proposed model.

Therefore, the study's sample size was determined after a review of the theory and related numerous educational studies using CFAs and SEMs (structural equation models). The authors noted that Krejcie and Morgan (1970) developed a table for sample size collection from their analysis, which depicted sample size requirement leveling off just above 380 participants. Furthermore, other scholars have suggested that in multi-site surveys, *multistage random sampling* (MRS) should be used (Crawford, 1990; Kanyacome et al., 2012).

Research Instrument

The research instrument was a questionnaire on students' executive functions (EF) components. The instrument contained two major sections. They were:

Part 1 of the multiple-choice questionnaire contained four items related to each individual's gender, age, educational level, and work experience.

Part 2 of the questionnaire contained five sections with 34 items related to each teacher's opinions concerning the importance of items related to their school's student executive function (EF) abilities. These sections in their respective order were *working memory* (WM) with eight items, *goal-setting* (GS) with four items, *goal-directed behaviors* (GDB) with seven items, *cognitive control and flexibility* (CCF) with eight items, and *systematic management planning, action, and self-assessment* (SMA) with seven items.

Table 1

BMA-DOE Teacher Sampling Process

BMA-DOE Regions	Population and sample		
	Districts	Population (Teachers)	Sample (Teachers)
Central Bangkok	9	991	90
Southern Bangkok	10	1,575	100
Northern Bangkok	7	2,322	70
Eastern Bangkok	9	4,452	90
Northwest Bangkok	8	1,859	80
Southwest Bangkok	7	3,026	70
Totals	50	14,225	500

Additionally, a five-level opinion scale was developed for each educator's opinion. The scale and its interpretation were as follows: '5' indicated total agreement and had a range of 4.51 - 5.00, '4' indicated mostly agree and had a range of 3.51 - 4.50, '3' indicated uncertainly and had a

range of 2.51 - 3.50, '2' indicated somewhat disagree and had a range of 1.51 - 2.50, and finally, '1' indicated total disagreement with the item statement and had a range of 1.00 - 1.50.

Questionnaire Expert Validation/Pilot-Test

Prior to the questionnaire use in the pilot survey and distribution to the BMA-DOE teachers and administrators, five academic experts who had obtained a Ph.D. and had five or more years of teaching experience were asked to comment on each questionnaire item's *content validity*. This included comprehension, clarity, accuracy, free of item construction problems, and potentially offensive or biased items study's teachers (Hankla et al., 2021).

After adjustments were made, the final version containing 34 items was delivered to a local group of 30 local school teachers and administrators for their input and opinion concerning the survey items (Binheem et al., 2021; Perneger et al., 2015). It should also be noted that these individuals did not participate in the final survey, nor were their questionnaires used in it. As is standard procedure, Cronbach's α was calculated to determine item reliability (Tavakol & Dennick, 2011). The survey items had an average value of $\alpha = 0.98$ for each of the study's five EF components, significantly higher than the suggested lower cutoff value α of ≥ 0.70 (George & Mallery, 2010).

Data Collection

Prior to the survey's commencement, the director of the BMA-DOE was contacted and informed of the forthcoming survey. At this point, the BMA-DOE assistance was sought to notify the targeted group within the six districts of the upcoming survey and encourage them to participate. Social media and e-mail contact information were also obtained from which each randomly sampled individual was sent a message concerning the survey and its location on Google Forms. Due to the importance of the EF survey by the BMA-DOE administration and their encouragement to participate, there was a 100% response rate for the 500 targeted participants.

Data Analysis

Descriptive statistics were used to assess each teacher's opinion concerning the importance of EF to their students. This study included the mean and standard deviation (SD), which was analyzed using *SPSS for Windows Version 21*. Moreover, a confirmatory factor analysis (CFA) using *LISREL 9.1* was used to examine the structural integrity of the variables concerning each student's EF abilities (Marsh et al., 2020). The goodness-of-fit (GoF) validity check of the model then made use of standard accepted criteria and discriminant validity (DV) (Henseler et al., 2014).

Research Findings

Respondents Characteristics (n=500)

It was found that a significant number of the surveyed teachers and administrators in the BMA-DOE areas were female (78.00%) (Hankla et al., 2021), with 29.20% being 46 years old or older. It also seems that 'young teachers' are rare within the BMA-DOE as only 0.60% were under 25.

There was a near-even distribution between individuals holding a bachelor's degree (51.40%) and a master's degree (47.20%). Finally, the work experience responses indicated that a slight majority of 24% had 5-10 years of experience; this was closely followed by 21.20% with 11-15 years of experience, 20.80% with 21 or more years' educational experience, and 19.40% with less than five years of experience. Statistically interesting, within this homogenous group and their experiences, those that reported 16-20 years of experience were only 14.60%.

Student EF Quantitative Method Analysis Overview

According to Diamond (2013) and others (Lehto et al., 2003, Miyake et al., 2000), there is an overall consensus that there are three core EFs. These include *WM* and *CCF* and *inhibition*. Higher-order EFs are built from these, planning, reasoning, and problem-solving (SMA) (Collins & Koechlin, 2012, Lunt et al. 2012). Therefore, Table 3 presents a representative overview of scholar input and the academic community's

perceived value of the study over time using Google Scholar citations concerning student EF processes.

The CFA's Goodness of Fit (GoF)

A CFA is commonly used to assess a model's fit with multiple GoF criteria and output values to determine fitness. In contrast, Cronbach's coefficient is used to calculate and check internal consistency. Therefore, the study's GoF used items suggested by Hooper et al. (2008), who wrote that convergent validity (CV) analysis should include the GFI, CFI, RMSEA, and the chi-square/chi-square/df statistic. Schumacker and Lomax (2010) have added that GFI, AGFI, NFI, and CFI values should be ≥ 0.90. Also, the value for Chi-square (χ^2) is recommended as $p \geq 0.05$ and the relative Chi-square (χ^2/pdf) ≤ 2.00 (Tabachnick & Fidell, 2007). Hu and Bentler (1999) also suggest that values for RMSEA, RMR, and SRMR be ≤ 0.05.

Also, when testing for CFA reliability and internal consistency, Netemeyer et al. (2003) state that composite reliability (CR) should be ≥ 0.80. Fornell et al. (1996) have also reported that valid and reliable loading factors and variable AVE (average variance extracted) values should be ≥ 0.5. This is consistent with Hooper et al. (2008), who also suggested that R^2 values should be ≥ 0.20, factor loadings ≥ 0.5, and composite/construct reliability (CR) should be ≥ 0.7.

Therefore, all items were consistent with both the model and its supporting theory criteria. The Chi-Square value = 455.82 was statistically significant at the 0.01 level for all variables. The p-value was 0.08663, which satisfies the specified criterion *of* $p \leq 0.01$. The relative Chi-square (χ^2/pdf) = 1.09, the GFI = 0.95, AGFI = 0.93, CFI = 1.00, RMSEA = 0.01, SRMR = 0.034, and the latent variable average for Cronbach's α = 0.98.

Structural Validity Testing

According to Makowski (2018), CFAs are used to bridge between factor analysis and structural equation modeling (SEM). An initial step is the dataset testing to determine the suitability of the factors for analysis. Two commonly accepted methods that IBM's® *SPSS*® supports for Windows Version 2x programs are *Bartlett's Test of Sphericity* (BTS) and the *Kaiser, Meyer, Olkin (KMO) Measure of Sampling Adequacy* (MSA). The KMO test measures data suitability, while the BTS is concerned with testing the hypothesis that a study's correlation matrix is an identity matrix, which indicates that the variables are unrelated.

For the KMO value analysis, KMO values range from 0 to 1, which indicates the element's appropriateness for further analysis. Multiple studies suggest that if the value of KMO ≥ 0.5 and with significant values (sig) or probability (p) is ≤ 0.05, then the variable meets the criteria for further factor analysis ((Hair et al., 2020; Napitupulu et al., 2017) (Table 4). For BTS values, it is suggested that if the output BTS p-value is lower than the chosen significance level, then the dataset of suitable for continued analysis (Shkeer & Awang, 2019). Also, Hair et al. (2016) have reported that KMO results can be considered acceptable when they are 0.80 – 1.00.

Table 2 *BMA-DOE Teacher and Administrator Personal Characteristics*

Questionnaire Item	**Individuals**	**%**
Gender		
Men	110	22.00
Women	390	78.00
Age		
Under 25 years old.	3	0.60
25 to 35 years old.	142	28.40

36 to 45 years old.	209	41.80
46 or over.	146	29.20
Education level		
No bachelor's degree	5	1.00
Bachelor's degree	257	51.40
Master's degree	236	47.20
Ph.D.	2	0.40
Educational experience		
Less than five years.	97	19.40
5-10 years.	120	24.00
11-15 years.	106	21.20
16-20 years.	73	14.60
21 or more years.	104	20.80

Table 3 *Student EF Processes Literature Review Overview*

Student Executive Function	Google Scholar 16,440 citations	Google Scholar 10,469 citations	(Anderson, 2002) Google Scholar 3,051 citations	(Garon et al., 2008) Google Scholar 3,045 citations	(Meltzer, 2010) Google Scholar 664 citations	(Collins & Koechlin, 2012) Google Scholar 594 citations	Google Scholar 217 citations	Google Scholar No citations
Working memory (WM)	✓	✓	✓	✓	✓	✓	✓	✓
Goal setting (GS)			✓		✓			✓
Goal-directed behaviors (GDB)	✓	✓		✓	✓	✓	✓	
Cognitive control and flexibility (CCF)	✓	✓	✓	✓	✓	✓	✓	✓
Systematic management planning, action, and self-assessment (SMA)						✓	✓	✓

CFA Assessment

Table 5 details the results of the CFA as well as the 34 items from the teacher survey concerning student EF processes. First, we note that the β values, the standardized beta coefficient or standard component weight, represent the strength comparison between the predictor and criterion (Piedmont, 2014) or the independent variable to the dependent variable (Khaled et al., 2019). The higher the absolute value of the β, the stronger the effect (Mu et al., 2020). The standard error (SE) values represent the spread of the data, with higher values representing a more significant data spread.

Table 4 *KMO and BTS Analysis of Student EF Processes*

EF Student Element	KMO	BTS χ^2	BTS df	BTS *p*
WM	0.87	1558.33	28	*p*=0.00
GS	0.78	560.59	6	*p*=0.00
GDB	0.87	1356.14	21	*p*=0.00
CCF	0.90	1665.13	28	*p*=0.00
SMA	0.87	1387.94	21	*p*=0.00

Table 5

CFA Results on the BMA-DOE Teacher Opinion Survey Concerning Student EF Processes

OVA	Questionnaire Item	β (SE)	Co D R^2	Element Score FS	Element precision)AVE, CR(
WM	*Working Memory* (WM) To what extent do you see this list of questions reflecting the importance of student WM?				
a1	Students should be able to memorize information while studying.	0.63**(0.04)	0.40	0.16	0.42, 0.85
a2	Students should be able to memorize commands while performing assigned tasks.	0.52**(0.05)	0.28	0.01	
a3	Students should be able to remember the details of the assignment being performed.	0.62**(0.04)	0.38	0.15	
a4	Students should be able to remember information to solve problems in the assignment as needed.	0.75**(0.04)	0.57	0.26	
a5	Students should be able to link old information to new information and apply it as needed.	0.77**(0.04)	0.60	0.29	
a6	Students should be able to judge the difference	0.58**(0.0	0.33	0.13	

	between good and bad performance.	4)			
a7	Students should be able to design complex workflows that are easy to use.	0.63**(0.04)	0.40	0.11	
a8	Students should be able to handle complex workflows.	0.65**(0.04)	0.42	0.15	
GS	*Goal Setting* (GS) To what extent do you see the following list of questions reflecting student goal-driven shifts in thinking?				
b9	Students should be able to see the importance of doing their assignments.	0.63**(0.04)	0.40	0.21	0.48, 0.78
b10	Students should be able to recognize the cause of assignment-related problems.	0.76**(0.04)	0.59	0.36	
b11	Students should be able to recognize the results of their work and effort.	0.77**(0.04)	0.60	0.37	
b12	Students should be able to set new goals at school when and as needed.	0.61**(0.05)	0.37	0.19	
GDB	*Goal Directed Behaviors (GDB)* To what extent do you see the following list of questions reflecting student interest in pursuing their goals?				
c13	Students should be able to accept new things that happen without clinging to old ideas.	0.62**(0.04)	0.38	0.14	0.46, 0.85
c14	Students should learn how to focus on their assignments' success.	0.64**(0.04)	0.41	0.18	
c15	Students should have a positive attitude towards the assignment being done.	0.79**(0.04)	0.62	0.29	
c16	Students should be able to see what they are doing as an exciting challenge.	0.69**(0.04)	0.48	0.22	
c17	Students should have an ongoing commitment to their tasks and assignments.	0.75**(0.04)	0.56	0.22	
c18	Students should be able to have patience with their tasks and assignments.	0.65**(0.04)	0.42	0.07	
c19	Students should be able to think it necessary to persevere and not compromise their intentions in performing their duties even though there are difficult and unpleasant obstacles.	0.60**(0.04)	0.36	0.11	
CCF	*Cognitive control and flexibility* (CCF)				

	To what extent do you see the following list of questions reflecting a student's cognitive/intellectual control and flexibility?				
d20	Students should be able to manage action plans within the specified scope.	0.64**(0.04)	0.41	0.12	
d21	Students should be able to recognize their mistakes.	0.63**(0.04)	0.39	0.11	
d22	Students should be able to deal with problems without being emotional.	0.64**(0.04)	0.41	0.12	0.46, 0.85
d23	Students should be able to have restraint in doing anything that causes harm to their selves or others.	0.75**(0.04)	0.57	0.22	
d24	Students should be flexible in creating new options to solve problems.	0.77**(0.04)	0.60	0.21	
d25	Students should understand that there are many perspectives to solving problems.	0.77**(0.04)	0.60	0.28	
d26	Students should be able to have a backup action plan in case their original plan fails.	0.68**(0.04)	0.58	0.13	
d27	Students should learn how to come up with new ways to fix problems.	0.64**(0.04)	0.41	0.07	
SMA	*Systematic Management Planning, Action, and Self-Assessment* (SMA) To what extent do you see the following list of items reflecting your students' systematic planning, action, and self-assessment abilities?				
e28	Students should be able to outline their assignment procedures.	0.62**(0.04)	0.39	0.03	
e29	Students should be able to create helpful mind maps.	0.57**(0.04)	0.33	0.03	0.48, 0.86
e30	Students should be able to perform their assigned duties quickly.	0.78**(0.05)	0.61	0.42	
e31	Students should learn how to work independently to accomplish the task at hand.	0.52**(0.04)	0.27	0.01	
e32	Students should be able to track the results of their and their classmates' work.	0.79**(0.04)	0.63	0.20	
e33	tudents should learn how to evaluate their performance to ascertain its advantages and	0.79**(0.04)	0.63	0.34	

	disadvantages.			
e34	Students should be able to evaluate their assessment results and use them to improve their deficiencies.	0.76**(0.04)	0.57	0.22

Note. OVA – observed variable abbreviation, $^{**}p \leq 0.01$, SE = standard error, β = *standard component weight, CoD* = coefficient of determination, AVE = average variance extracted, CR = composite reliability.

Discussion

Many studies have examined the roles of EFs on youth academic achievement with no explicit support for which EF process has the most effect, if any at all (Bailey et al., 2018). However, EF processes seem to align academic achievement with classroom performance. However, increasing problems with EF can be associated with a student's decrease in their academic self-concept.

Some studies have also noted that even when there is adequate student motivation, goal-directed EFs may prevent academic success (Gollwitzer & Brandstatter, 1997; Zimmerman, 2002). Sibley et al. (2019) have also added that self-regulated learning is necessary to support one's values and suppress counterproductive motivational states.

However, from our study of 500 Thai BMA-DOE teachers' and administrators' opinions on their student EF processes, we determined the importance they placed on each of the five EF student processes (Table 6). We present the following in order of most important to least important.

Table 6

Results from the BMA-DOE Teacher Questionnaire Concerning Student EF Processes

Student Executive Function (EF)	**Comment Level**			**Rank**
	mean	SD	Interpretation	
Working memory (WM)	4.35	0.41	Mostly Agree	4
Goal setting (GS)	4.48	0.42	Mostly Agree	3
Goal-directed behaviors (GDB)	4.60	0.38	Total agreement	1
Cognitive control and flexibility (CCF)	4.49	0.40	Mostly Agree	2
Systematic management planning, action, and self-assessment (SMA)	4.49	0.40	Mostly Agree	2
Results	**4.47**	**0.34**	**Somewhat Agree**	

Goal-Directed Behaviors (GDB)

In Table 5, we find that the educators' opinions concerning GDB importance of the seven items queried revealed that most significantly was the idea that students should have a positive attitude towards the assignments being done (c15, β =0.79, SE = 0.04, $p \leq 0.01$). This was closely followed by the student's commitment to their assignments (c17, β =0.75, SE = 0.04, $p \leq 0.01$).

Cognitive Control and Flexibility (CCF)

In Table 5, we find that the educators' opinions concerning CCF importance of the eight items queried revealed that three items were ranked at near-equal importance. There were students should be able to be flexible in creating new options to solve problems (d24, β =0.77, SE = 0.04, $p \leq 0.01$), and students should be able to understand that there are many perspectives to solving problems (d25, β =0.77, SE = 0.04, $p \leq 0.01$) and students should be able to have restraint in doing anything that causes harm to their selves or others (d23, β =0.75, SE = 0.04, $p \leq 0.01$).

Systematic Management Planning, Action, and Self-assessment (SMA)

In Table 5, we find that the educators' opinions concerning SMA importance of the seven items queried revealed that four items were ranked at near-equal importance. There were students should be able to track the results of their and their classmates' work (e32, β =0.79, SE = 0.04, $p \leq 0.01$), and students should be able to evaluate their performance to ascertain its advantages and disadvantages (e33, β =0.79, SE = 0.04, $p \leq 0.01$), students should be able to perform their assigned duties quickly (e30, β =0.78, SE = 0.05, $p \leq 0.01$), and students should be able to evaluate their assessment results and use them to improve their deficiencies (e34, β =0.76, SE = 0.04, $p \leq 0.01$).

Goal Setting (GS)

In Table 5, the educators' opinions concerning the GS importance of the four items queried revealed that two items were of near-equal importance. These were students should be able to recognize the results of their work and effort (b11, β =0.77, SE = 0.04, $p \leq 0.01$), and students should be able to recognize the cause of assignment-related problems (b10, β = 0.76, SE = 0.04, $p \leq 0.01$).

Working Memory (WM)

In Table 5, we find that the educators' opinions concerning WM's importance of the eight items queried revealed that two items were of near-equal importance to the educators. These were students should be able to link old information to new information and apply it as needed (a5, β = 0.77, SE = 0.04, $p \leq 0.01$), and students should be able to remember information to solve problems in the assignment as needed (a4, β = 0.75, SE = 0.04, $p \leq 0.01$).

Conclusion

The study set out to examine five theory-supported student executive function (EF) processes using a sample of opinions from 500 BMA-DOE teachers and administrators in the 2021 academic year. From the confirmatory factor analysis (CFA), *working memory* (WM), *goal-setting* (GS), *goal-directed behaviors* (GDB), *cognitive control and flexibility* (CCF), and *systematic management planning, action, and self-assessment* (SMA) were analyzed. The results from the analysis showed that the teachers believed that a student's GDB was most important (mean = 4.60, SD = 0.38). This was followed by CCF and SMA (mean = 4.49, SD = 0.40), which were judged to be equal in importance, followed by GS (mean = 4.48, SD = 0.42), and WM (mean = 4.35, SD = 0.41). GDB's importance probably comes from its importance in preventing academic success when there are student deficits. GDB is an element of self-regulated learning which uses a cognitive process to take actions supporting one's values and suppressing counterproductive motivational states.

Limitations and Suggestions for Future Research

One limitation to the study is the wide variety of EF-related elements that emerged since the term 'executive function' in 1982. Also another limitation is produced in literature research as EF can also be classified as *executive control* and *cognitive control*. One factor which also came up in the research was gender's role in EF, but these studies are very few. Therefore, more attention should be given in future research to gender's EF role, if any. Moreover, although EF is perceived to be involved with the brain's frontal lobe

activities, what are the connections between these activities and a student's emotional quotient (EQ) or emotional intelligence? Finally, this study sample made use of 500 urban teachers. Therefore, how similar would these results be for teachers in more rural and less affluent communities?

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