

Developing Student Executive Function Skills Through Teacher Learning Management

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This research investigated teacher learning management (TLM) approaches to promote student executive function (SEF) skills in higher education teacher development in Thailand. The informants were nine academic experts with 6-42 years each of TLM and SEF skill development and teaching expertise. The contents from the interviews were analyzed to summarize the essence and used in drafting an educator TLM plan to promote student executive function thinking skills. Data analysis used content analysis techniques consisting of four steps: data reduction, data formatting, conclusions, and confirmations. Results revealed that the teacher learning management methodology used in promoting SEF thinking skills consisted of five elements. These included 1) TLM definition problems, 2) setting goals for TLM, 3) determining content for TLM, 4) TLM implementation, and 5) TLM assessment. The study contributes to the literature that SEF skill education and development and teacher learning management are critical elements in a student teacher's development and a nation's future economic success and sustainability.

Keywords: executive functions, student teachers, teacher learning management, Thailand, working memory

INTRODUCTION

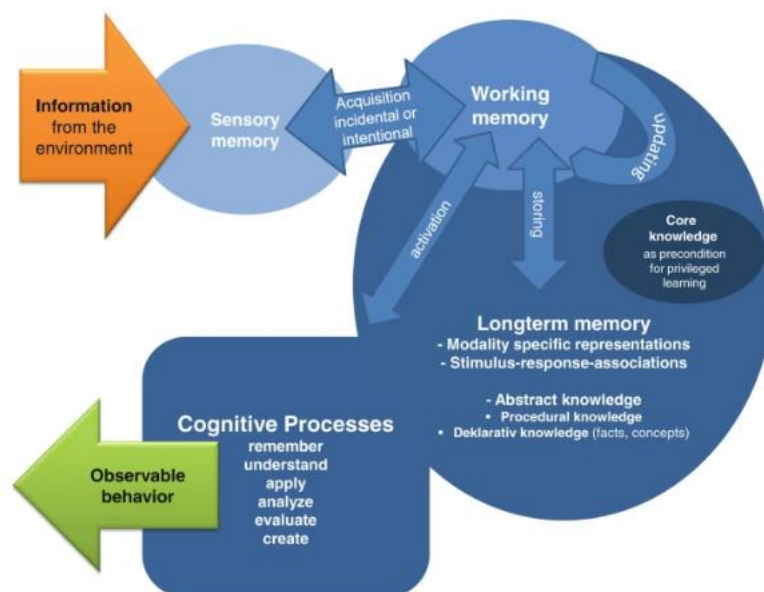
Student Executive Function (SEF)

Although numerous scholars have studied and commented on the essential nature of executive function (EF) development, only some have agreed on EF's definition and components (Doebel, 2020). However, research by Harvard (2022) has stated that EF and self-regulation skills (SRS) are the mental processes that enable planning, attention focusing, memorization, and the ability to undertake multiple tasks. Each is interrelated and critical for development and learning, and when properly developed, individuals and society will experience lifelong benefits. Rmus et al. (2021) have also added that an individual's capability to learn rewarding actions is central to goal-directed decision-making, an element of EF.

According to Stern (2017), learning involves processing knowledge representations in memory, including encoding, storage, and retrieval. Sensory memory handles large amounts of incoming information from the

senses, but only a fraction passes to working memory. Working memory maintains and manipulates information temporarily, allowing attention control and conscious processing (Nyberg & Eriksson, 2016). It is a gateway to long-term memory, storing acquired information in various modalities. Personalized learning should consider individual differences and create a conducive learning environment (Ruenphongphun et al., 2022). Teachers should also assess students' understanding throughout the learning experience to guide instruction (Sittisak et al., 2022). Information not attended to is lost from sensory memory, as sensory memory is only a buffer and is short-term unless needed elsewhere. Information processing progresses from sensory memory to short-term and long-term memory. Therefore, attention is crucial for learning and memory formation.

FIGURE 1
SEF BRAIN FUNCTIONS



Source: Stern (2017)

Doebel (2020) proposed that developing SEF is better understood as using goals to activate mental content such as beliefs, values, norms, knowledge, and preferences. Ahmed et al. (2020) found that SEF's working memory is predictable and essential for academic achievement. Similarly, Cortés Pascual et al. (2019) noted that SEF skills were a good predictor of academic performance, with working memory having the highest presence compared to other EF functions such as inhibition, cognitive flexibility, and planning. This view challenges the traditional definition of executive function as a set of underlying components such as working memory, inhibitory control, and mental flexibility.

Several scholars have examined the importance of learning abilities. Chen et al. (2018) emphasized the importance of student motivation, while Enciso et al. (2017) and Changwong et al. (2018) both reported the need for critical thinking skills (CTS) development. Lawson and Farah (2017) identified several critical factors for SEF and academic achievement, including student readiness and willpower, aspiration and achievement levels, attention span, the learner's health condition, and socioeconomic status. Sánchez-Pérez et al. (2018) added that the ability to control and regulate actions and cognitions such as SEFs leads to academic success, leading to a global movement to develop SEF training programs to increase students' SEF and academic achievement. According to information processing theorists, attention is also considered essential to learning and memory formation.

Teacher Learning Management (TLM)

SEF skills must be developed in a practical environment for their improvement. Ahbabi (2019) in Abu Dhabi identified five critical strategies contributing to a school's improvement: administrators who participated and reflected on what was being implemented, the ability for schools to share a common ambitious vision, a healthy learning environment, high expectations for success, and differentiated instructional strategies.

In Thailand, the primary factors found to be most important for school management included the use of teaching resources, information communications technology (ICT) and digital media, innovation, and research, and the curriculum and teaching-learning systems (e.g., learning management systems such as Moodle) (Mongkhuntod, 2020). TLM and readiness, learner promotion policies, ICT support, learning resources, and parental support have also been identified as factors affecting student quality (Lunenburg & Ornstein, 2012).

Sermisri et al. (2022) developed a cooperative TLM model for enhancing student-teacher problem-solving skills, recommending the essential need for student-teacher planning, maintaining self-control, information literacy, critical thinking, and the application of knowledge. Sittisak et al. (2022) noted that for teachers to implement an effective online course, they need to define their objectives, select their resources, plan how they will be used, implement them, present them, and evaluate their effectiveness. These studies emphasize the importance of school management, TLM, technology, and resources in creating an effective learning environment for students.

METHODS

The study investigated teachers' learning management approaches in promoting student EF thinking skills.

Key Informants

The key informants for the study were nine experts with knowledge in learning management and EF thinking who held positions as lecturers in Faculties of Education/Teaching or as education supervisors or teacher development supervisors within the Bangkok Metropolitan Administration's (BMA) Office of Education. Each individual had a minimum of:

- 1) Experience as a teacher in learning management and SEF education.
- 2) Held at least a master's degree in education or learning management.
- 3) Had at least five years of experience in TLM and SEF education.

Research Tools

The research tool used for data collection was a semi-structured interview, whose frequent use in the social sciences allows loosely structured questions to be used in obtaining new ideas. The structure is considered the 'best of both worlds' as they tap into the strengths of structured and unstructured methods, allowing researchers to gather reliable data while also getting unexpected insights from in-depth user feedback.

Furthermore, the interview questionnaire was developed to analyze relevant concepts, documents, and previous research on the effective use of TLM in promoting student EF thinking skills. The questionnaire aimed to gather insights from experts in the field and covered various aspects of management thinking and learning management expertise. The interview questionnaire contained specific points about the experts' knowledge and experience in TLM and SEF. The experts were asked to guide topics such as identifying learning management problems, setting objectives, determining content, implementing learning management strategies, and evaluating learning management effectiveness.

Research Steps

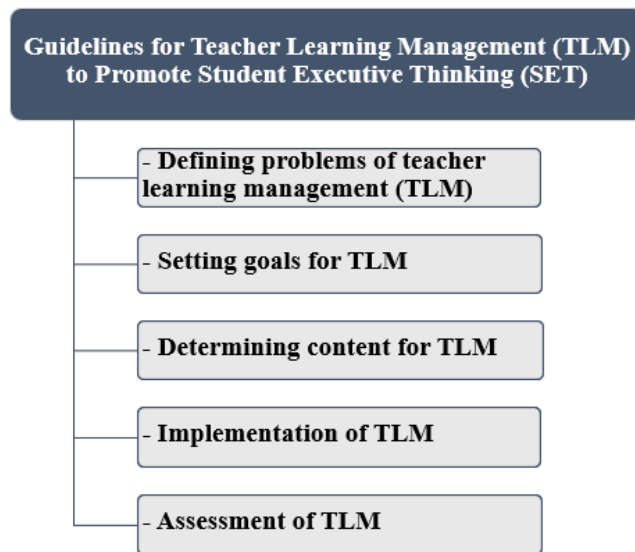
The study involved a rigorous process to create and ensure the quality of the interview questionnaire. The researchers conducted a thorough review of relevant literature and research to formulate questions targeted toward the interviewed experts.

The questionnaire was designed to extract valuable insights and knowledge from each expert, while the construction and quality checking of the research tools involved multiple steps. After conducting a literature review, the authors developed a questionnaire to extract opinions on promoting SEF thinking skills through TLM. The questionnaire was revised and sent to experts to assess its content validity. Three experts used item-objective congruency (IOC) values index, with items having IOC values $\leq .50$ being revised or deleted from the questionnaire.

Data collection was conducted by sending requests for assistance to each expert at least one week in advance. The interviews were recorded at the agreed location and time for later analysis. The researchers used a four-step content analysis method to analyze the collected data (Miles et al., 2018). In Stream 1, data reduction, conversion, and abbreviation were performed to simplify the data. Stream 2 focused on creating data formats, such as tables and diagrams, that could effectively communicate the findings to readers. Stream 4 involved data condensation, which involved data coding to identify patterns and develop new ideas. Preliminary conclusions were reached, which led to new data displays to test and verify these conclusions. In Stream 4, the researchers interpreted the collected data to understand the correlation patterns and draw conclusions.

After that, based on the data analysis, the conclusions were verified. Overall, these procedures allowed the researchers to condense, display, draw conclusions, and verify the findings from the interviews, enhancing the rigor and reliability of the research (Figure 2). The study followed a systematic methodological approach commonly used in qualitative research methods (Busetto et al., 2020). The researchers also used strategies for developing interview guides and a methodology guide for using and reporting science research interviews (Young et al., 2018). The study adhered to standards and guidelines for statistical surveys. The researchers also used thematic analysis to meet the trustworthiness criteria (Nowell et al., 2017).

FIGURE 2
TLM DEVELOPMENT PROCESS TO PROMOTE SET SKILLS



RESULTS AND DISCUSSION

General Information of Interviewees

The interviews were conducted with a total of nine experts, with six of them being female (66.67%) and three being male (33.33%). The participants represented different professional backgrounds, with three working as Faculty of Education lecturers, three as Education Supervisors or Teacher Development Supervisors with the Bangkok Metropolitan Area Office of Education, and three as Academicians.

Among the participants, eight out of nine held a Ph.D. degree, indicating a high academic qualification. Their academic experience ranged from 6 to 42 years, reflecting an extensive range of expertise and knowledge. The range of age among participants was between 35 and 65 years, representing a diverse age group with varying levels of experience and perspectives.

Defining TLM Problems

Several issues became important to evaluate from the process of defining TLM problems. These were the learner's background, development of learners, individual differences of learners, knowledge, and understanding of teachers about the brain and student learning in each age group, SEF development of learners in each age group, and the content that students want to learn (Castillo-Merino & Serradell-López, 2014).

Furthermore, ten additional TLM items were identified: 1. media and learning resources, 2. school context, 4. the landscape of the educational institution, 4. security, 5. physical facilities including the classroom, 6. personnel management, 7. teachers' learning management, 8. the interaction of people, the context around the learners both at home and school, 9. social needs, 10. Thai culture and identity, and 10. measurement and evaluation of learning management (Akar, 2006).

TLM Objectives

- 1) Define TLM behavioral objectives that encourage learners to create interest in pursuing knowledge goals. Aims should be defined clearly and specified, describing the behavior in terms of knowledge. Behavior should be specified regarding observed knowledge, course skills, and attitudes.
- 2) Establish behavioral objectives in TLM to encourage learners to build interest toward EF thinking *skill* goals.
- 3) Define behavioral objectives in TLM to encourage learners to generate interest to achieve *attitude* goals.
- 4) Define behavioral objectives in TLM to encourage learners to build *cognitive control and flexibility*.
- 5) Define behavioral objectives in learning management to encourage learners to create a *systematic management plan*, take action, and monitor self-evaluation. Objectives should be clearly defined and specific. Behaviors need to be observed and assessed. Which encourages and trains students to control their thoughts. Because mind and thinking development is a cognitive process, it is a mental ability and behavior that should be flexible. The SEF process should start with *goal setting, planning, organization* of ideas, *time management*, memory remembering, *self-monitoring*, and *self-control* (Learning Center, 2019).
- 6) Defining behavioral objectives in learning management to encourage learners to create a *change of mind* according to the goal. In a new era of learning, the teacher's creativity and growth mindset should be used to develop activities for learning that respond to the needs of the students (*student-centered learning*) effectively, leading to in-depth learner development. This is consistent with multiple studies and projects which have put students at the center of learning, including Thailand's National Scheme of Education 2017-2036 education plan (Charungkaittikul & Henschke, 2014).
- 7) Define behavioral objectives in learning management to encourage learners to create *working memory*. Numerous studies have noted the importance of working memory in SEF development and academic achievement (Ahmed et al., 2020). To accomplish this, teachers should ask questions

like: What skills must a student have? What are the conditions for showing skills and specifying the criteria? What process should I use to best measure learner success?

Systematic Planning, Action, and Follow-Up Self-Assessments

Learning management content determination (LLMCD) involves systematic planning, action, and follow-up self-assessments. In an LMCD, content should be outlined as projects which provide additional guidance and content. Planning is scheduled by dividing tasks and prioritizing them so that work can go smoothly and more efficiently as sub-components. Content should focus on allowing students to practice finding answers and developing their potential (Chen et al., 2018).

Similarly, teacher focus should be given to highlighting community problems that students can identify with and offer real-world solutions as to their resolution. Good LMCD involves selecting appropriate and necessary content suitable for the daily-life development and learning of learners. Learning management content should be organized according to the nature of the subjects, such as language, mathematics, and science (Siriwan et al., 2018).

Content for Goal-Based Change of Growth Mindset Learning Management

Effective student-teacher growth mindset management models should contain personalized and self-directed learning, internal coaching, authentic assessment, and reflection (Patphol et al., 2021). Learning management consists of students who control their learning and participate in activity design, creative learning, creative learning activity management, learning development assessment, and creative feedback.

Yeager and Dweck (2020) also noted that a growth mindset is a belief that intellectual ability can be developed but questioned whether a growth mindset can predict student outcomes and whether educators can successfully develop a growth mindset in learners. Tseng et al. (2020) partially answered these questions by determining that two critical elements for first-time online learners were their growth mindset and their learning self-efficacy, which had a positive relationship to effective online engagement. These studies emphasize the importance of personalized self-directed learning, internal coaching, authentic assessment, and reflection in promoting a growth mindset in students and the critical role of educators in developing this mindset in learners.

Assigning Content for Cognitive Flexibility/Control and Resilient Learning Management (CRLM)

Cognitive flexibility is the ability to quickly adapt an individual's thinking and switch tasks in response to the environment (Braem & Egner, 2018), which shows their cognitive ability to adapt their behavior according to the new context requirements (Stemme et al., 2007). Mobile phone-based content development can positively influence users and is considered to appeal to the range of strategies mentioned. Control and resilient learning management should help organize ideas and be suitable for the target learners. The content should be consistent with the student's daily lives and valuable in a practical way. The use of modern digital technology in CRLM is also essential, and it can include various applications, learning management systems (LMSs), and platforms such as Kahoot, Ping Pong, YouTube, TED-Ed, and Krutube (Niemi, 2021; Zain et al., 2019).

Cognitive flexibility is essential due to its ability to deal with complex tasks and help individuals deal with change. Teachers can assist students in developing their cognitive flexibility by encouraging them to take risks and try new things. Additionally, cognitive flexibility is related to learners' academic achievement, cognitive ability, and creativity development, and it is a significant predictor of academic performance for children.

Some researchers have explored how smartphones achieve cognitive flexibility in the digital age. In one such study, Alexopoulou et al. (2020) stated that smartphone-based content development can positively affect learners and be a powerful intervention.

Content Determination for Working Memory Learning Management (WMLM)

Working memory is a crucial cognitive skill for learning, and its importance has been emphasized by researchers (Lestari et al., 2017). Low working memory abilities can lead to learning difficulties for students (Chang et al., 2013), underscoring the need for teachers to understand and recognize this skill.

The relationship between cognitive abilities, including working memory, reasoning, executive function, and academic achievement, has been explored. Studies have shown that these cognitive abilities predict each other's development and are connected to effective working memory development and learning styles (Peng & Kievit, 2020).

Students should engage in listening, speaking, reading, writing, discussions, and reflections to build knowledge effectively. Collaboration with classmates and teachers in class and online is also valuable. Digital learning tools like smartphones, learning management systems (LMS), cloud-based learning tools, and social media platforms (e.g., Line and Facebook) can facilitate online activities (Poondej & Lerdpornkulrat, 2019). The selection of appropriate teaching materials is essential, with behavioral objectives serving as a guide.

In terms of content, it should address current problem-solving needs and be relevant to learners' daily lives. The content should be connected to their experiences so that they can relate to and apply what they have learned (Gathercole et al., 2019).

Learning Management Evaluation

How to Measure Learner Knowledge Achievement

Measuring learner knowledge achievement in learning management evaluation involves considering various factors and assessment methods. Hartman-Haas (1984) identified key areas of difference in measuring EF thinking skills, including the age of the population, targeted skill development, strategies used, program alignment with the existing curriculum, design of curricular components, and teacher training.

The measurement criteria should align with the learning objectives when comparing students within their groups. Real-world learning can be facilitated through classroom-based learning (CBL), which emphasizes hands-on and skill-building processes to develop real-world skills (Verma & Nichols, 2022). Technology has significantly enhanced real-world assessment, allowing for international comparisons (Bidgood, 2010). For example, in an Australian undergraduate science program, technology is integrated into real-world tasks. Assessment approaches include opinion pieces, online blogs, student conferences, research publications, and work-integrated learning (McKinnon et al., 2014).

Assessments should be tools to identify the next steps in the learning and teaching process. Assessments should also help promote reflection and demonstration of ideas and identify areas of difficulty for learners and teachers (National Academies of Sciences, Engineering, and Medicine, 2001). Educators gain valuable insights into teaching challenges by encouraging learners to reflect on their ideas and identify sources.

How to Measure Student Skill Achievement

Various studies and reports have suggested how student skills and academic achievement can best be measured. However, caution needs to be given that the assessment process measures the content that students undertook. Student skill assessment and measurement are also best served by observing and recording students' real-world conditions and behaviors during the learning process or assigned activities. Andrade (2019) has also argued that student self-assessment should focus more on formative self-assessment's cognitive and affective mechanisms. This is consistent with Ruenphongphun et al. (2022), who observed that leading educational thinkers have reported that *personalized learning* and *student-centered learning* leads to higher assessment scores and improved academic achievement. However, the childhood promotion and development of social-emotional skills are essential for later well-being and positive life outcomes (Sánchez-Pérez et al., 2018). However, skill assessment is associated with methodological and conceptual challenges.

Methods for Measuring Student Attitude Achievement

Using questionnaires, interview forms, behavioral observations, and assessments from the observations and recordings of learners' behaviors can show changes in their cognitive abilities, attitudes, values, interests, and learning preferences. The measurement process can be divided into five levels, including 1) perception, 2) response, 3) creating value, 4) organizing the value system, and 5) creating characteristics (Lin et al., 2020).

Determination of Student Academic Achievement Evaluation Criteria

Measuring and evaluating student learning is crucial for improving educational quality. It helps determine if students have achieved the expected learning outcomes and standards set by assessments. These assessments are categorized based on objectives (Helda & Syahrani, 2022). Evaluating learning outcomes benefits students and educational management quality. Therefore, according to Al-Adwan et al. (2021), teachers and institutions should gather information on students' learning outcomes at various levels, including class, school, and higher levels.

Moreover, measuring and evaluating learning in a 21st-century global society involves teacher learning management development which helps them to understand what students learn and how well they learn (Kim et al., 2019). Teachers should have various measuring tools and assessment techniques, including agreements between instructors and learners that provide feedback on student learning outcomes (Supena et al., 2021). A clear definition of TLM objectives is necessary to determine if student learning is done as specified.

Instructors should listen to learners' opinions, encourage self-assessment, and promote self-improvement in learning (Schellekens et al., 2021). The results of learning assessments should be used to improve the organization of learning activities and the sustainable development of learners' process skills.

The criteria for evaluating student achievement should include Assessment for Learning (AfL), Assessment of Learning (AoL), and Assessment as Learning (AaL) (Schellekens et al., 2021). These criteria should be compared with other learners and external standards or learning outcomes. AfL, initially defined in 2002 as a tool to monitor student progress, was modified in 2009 to emphasize the importance of learning with students and teachers through conversation, demonstrations, and observations to accelerate and improve ongoing learning (Klenowski, 2009).

Guidelines for Applying the Results of the Learner Assessment to Develop Learners

The placement assessment is an assessment to determine what level of a group of learners are competent in a subject matter. Teachers use the assessment results to determine the appropriate learning management style for the learners. Although there are various evaluation methods, commonly mentioned methods since 1990 include *diagnostic evaluation, developmental, formative, and summative evaluation* (Schellekens et al., 2021; Stein et al., 2014).

The ideas of formative assessment (FA) and summative assessment (SA) are now extensively used, with FAs used to support and improve student learning. In contrast, SAs are used for accountability, certification, or ranking students' competence by academic achievement (Black & Wiliam, 2009). Eventually, FA evolved into today's Assessment for Learning (AfL), which focuses on improving the learning and teaching processes (Schellekens et al., 2021). Additionally, SA evolved into an Assessment of Learning (AoL), which now focuses on formal learning activity student performance evaluation and measurement of each learner's outcomes (Crooks, 2011).

Diagnostic evaluation is a pre-teaching assessment considering whether the learners have basic knowledge (Stein et al., 2014), which is used after a course to assess and compare what was learned. As a snapshot of the learner's current knowledge, it should assess where they are emotionally, intellectually, or ideologically, thus allowing each educator to make effective instructional choices regarding methods.

Formative evaluation/developmental assessment is an assessment that uses the assessment results to improve the learning management process. This type of assessment is used to develop a course and focuses on the program processes (Savedoff et al., 2005).

Summative evaluation is an assessment to judge the learning management results after the students have finished their course (Savedoff et al., 2005). This may be an assessment after completing one or more learning units, such as an end-of-semester or end-of-year course. The results are then used to judge the outcome of teaching and learning or to judge students. It should provide feedback to learners through suggestions that link previous knowledge with new knowledge, making learning accumulating, correcting ideas, and correcting prior misunderstandings.

The Assessment Results From the Credibility of the Students

Finally, evaluation results are used to change and improve the learning management process to achieve maximum efficiency and effectiveness for students. It also helps to manage the classroom properly, promoting learning as necessary. Teachers encourage learners to use their learning assessment results to improve themselves by seeking additional knowledge, helping with self-development, and creating motivation for lifelong learning and success.

CONCLUSION

From the investigation of teachers' learning management guidelines, it was found that teacher learning management problems should be defined while taking into account the individual differences of learners along with an environment that will facilitate learning. The assessment was determined to impact students' learning significantly and significantly influence what students consider necessary. Moreover, assessment affects a learner's understanding of learning tasks and impacts the quality of a student's involvement in these tasks, as it impacts how insights get transferred to future learning. This highlights the importance of personalized learning management that considers individual differences and creates an environment that facilitates learning. Teachers should focus on learner understanding assessment during the learning experience to guide instruction and measure each learner's knowledge and understanding after a task/session has been completed. This creates a mechanism in which a learner's prior knowledge can be assessed and compared to what has been taught and learned.

Teachers should take on additional roles to share responsibility for student learning and change their classroom approach from lecturing to assessing. These findings help shape teacher education and professional development programs for STEM teachers, allowing them to incorporate student-centered teaching methods and increase their effectiveness.

In simpler terms:

- Teachers need to do more than just lecture; they should share the responsibility for student learning and shift their focus from talking to evaluating.
- These findings can guide the development of teacher training and professional development programs, especially for STEM teachers.
- By implementing student-centered teaching methods, these programs can help teachers be more successful in their classrooms.

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