Cognitive Load Factors in Online Home-Based Learning

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Received: 10 March 2024
Received in revised form: 30 April 2024
Accepted: 15 May 2024
Published: 25 July 2024

ABSTRACT

At the beginning of 2020, the whole world was hit by the epidemic of COVID-19, which affected the country of Malaysia. To deal with this epidemic, the country of Malaysia had to implement the Movement Control Order (MCO), which caused the closure of various sectors. Among the sectors involved is the education sector. The closure of the education sector raises serious concerns among parents about their children's education. Therefore, in order to continue the education system, the Malaysian Ministry of Education (MOE) has implemented online, home-based learning for school students. However, there are various complaints and problems that occur throughout the implementation of online, home-based learning. Among the problems that occur is when it involves students' cognitive skills. Hence, this research was undertaken to investigate the cognitive load elements present in online learning. This study uses a qualitative method involving systematic literature review analysis through past studies and an interview session with 30 teachers and 30 students from secondary schools. The findings of this study found that there are three types of cognitive load, among which are intrinsic, extraneous, and germane cognitive. Through the results of the study, the researcher found that during online home-based learning, all three cognitive loads showed a large increase in the load received. Therefore, through the results of this study, teachers can identify the factors that cause these cognitive problems to occur and reduce the cognitive load received by students. When the cognitive load can be reduced indirectly, online home-based learning can be fully used in the education system. Thus, the researcher hopes that more studies will be conducted online to make learning more effective, especially by using the best pedagogy for online classes. This will help Malaysian education keep pace with developed countries that implement fully online learning.

Keywords
Home-Based Learning; Cognitive; Intrinsic cognitive load; Extraneous cognitive load; Germane cognitive load

Introduction

In early 2020, the global community faced the COVID-19 pandemic, resulting in a daily rise in fatalities worldwide. Malaysia, too, felt the impact of this crisis. Consequently, to mitigate the spread of the COVID-19 pandemic, the Prime Minister of Malaysia implemented a Movement Control Order (MCO). According to the Department of Statistics Malaysia on March 16, 2020, this MCO was enforced for 14 days, from March 18 to March 31, 2020. The implementation led to the closure of various economic sectors and educational institutions, with the purpose of curbing the spread of COVID-19. However, during the 14 days, no positive signs were evident. Therefore, due to the absence of positive indicators, the MCO was extended for an extended period of time. This extension caused concern because daily activities could not be carried out normally, and even worse, teaching and learning activities could not proceed in schools and campuses (Rahmawati et al., 2020).

As a result, higher institutions have taken steps to implement online teaching and learning activities as an alternative to ensure continuity (Rahmawati et al., 2020). Conducting teaching and learning activities online requires the full utilization of technology (Rahmawati et al., 2020). According to Singh and Thurman (2019), these online classes necessitate the use of computers, laptops, tablets, and mobile phones connected to the internet for full access. Additionally, Dzakiria, Idrus, and Atan (2005) argue that online learning utilizing cybertechnology has been employed in Malaysia since 1969. However, for school students, this concept is not new (Mansor et al., 2021). Indeed, the level of exposure to online teaching and learning differs between school and university students (Mansor et al., 2021). Nevertheless, to ensure that student learning does not lag behind, the Malaysian Ministry of Education (MOE) has implemented home-based learning for school students (Mansor et al., 2021).

According to Asadullah (2022), home-based learning is a temporary program implemented by the Malaysian Ministry of Education (MOE) as part of their efforts to ensure continuous teaching and learning. While home-based learning and online learning may seem similar on the surface, the difference lies in the fact that home-based learning requires supervision or monitoring from parents, resembling the concept of homeschooling used before the spread of Covid-19 (Asadullah, 2022). However, because home-based learning is new to school students who have never engaged in fully internet-based teaching and learning activities, it presents various challenges during implementation (Mansor et al., 2021). Researchers have noted a significant focus on higher institutions in existing studies. Tay, Lee, and Ramachandran (2021) illustrate this trend, showing that most research concentrates on online learning in higher education institutions. Consequently, there exists a research gap where teachers lack understanding of the pressures students face in this type of learning environment (Tay, Lee, & Ramachandran, 2021). According to their study, the pressure experienced refers to the cognitive load students endure.

Student involvement serves as a cognitive, affective, and motivational strategy during interpretative transactions, enabling students to focus on learning during home-based learning. Engaging in mental and learning strategies aimed at ensuring long-term retention of information is crucial for cognitive involvement in home-based learning classes conducted by educators (Tay, Lee, & Ramachandran, 2021). However, a primary issue identified in cognitive learning arises when information processing exceeds the capacity of working memory, leading to disruptions in student learning (Plass, Moreno, & Brunken, 2010). Hence, this research was undertaken to investigate the cognitive load elements present in online learning.

Literature Review

The rapid development of technology, particularly in Malaysia (Singh and Thurman, 2019), has led to the adoption of electronic-based learning approaches in the country's education system (Singh and Thurman, 2019). This includes online learning, which utilizes electronic devices or technology to deliver knowledge (Singh and Thurman, 2019). Online learning is characterized by the use of applications or social networks (Zhu & Liu, 2020), enabling the transmission of knowledge through various mediums such as video, audio, images, text communication, and software supported by internet connectivity (Zhu & Liu, 2020).

According to Gilbert (2015), online learning can be categorized into three main types. The first category involves learning conducted entirely on the web without face-to-face interaction (Gilbert, 2015). The second category comprises mixed or hybrid format methods, which combine online and classroom sessions (Gilbert, 2015). Gilbert (2015) explains that this hybrid format is often employed based on the class's nature or instructor's discretion. For example, additional classes on weekdays, such as Saturdays or Sundays, may be conducted online, while regular school sessions may be held face-to-face at the discretion of the teacher. The last category, as described by Gilbert (2015), involves programming formats using online technology to deliver supplementary materials for traditional classroom studies. This method utilizes technology or applications, such as e-learning platforms like Google Classroom, Frog-VLE, Digital Educational Learning Initiative Malaysia (DELIMa), and other platforms provided by the Ministry of Education Malaysia (MOE) (Zainol, 2021). Despite the advancement of using technology as an alternative to facilitate teaching and learning (PdP) sessions, it still possesses weaknesses that affect the cognitive engagement of students.

Challenges of Online Learning

While online learning offers numerous advantages, it also presents challenges. One such challenge is the requirement for students to exhibit discipline (Mukhtar et al., 2020). Unfortunately, some students struggle to cultivate a disciplined approach, leading to concerns within the education sector. Teachers often encounter issues with students who fail to attend classes, sleep during sessions, and demonstrate poor attitudes (Mukhtar et al., 2020). According to Kumar and Owston (2016), the absence of strong self-discipline among students can hinder the achievement of online learning objectives, potentially jeopardizing their future prospects.

Mukhtar et al. (2020) further argued that issues related to student discipline and plagiarism in online learning pose challenges in maintaining academic integrity, leading to doubts about students' academic quality. According to their findings, teachers encounter difficulties in managing student behaviour during online lectures, with some students behaving inappropriately or neglecting assigned tasks. Moreover, instances of plagiarism, where students simply

copy materials from the web, complicate the assessment process for teachers. Another weakness of online learning is the lack of infrastructure providing internet access to students in rural areas (Bakalar, 2018). Putria et al. (2020) also emphasize the significant problem posed by the lack of technology and poor internet connectivity, particularly as not all students have smartphones. Consequently, teachers face challenges due to limited access to devices, hindering students' ability to participate effectively in online learning (Ating, 2020). According to sources from the Malaysian Ministry of Education (MOE), a survey revealed that nearly 37% of students, out of 900,000 registered during the COVID-19 period, lacked access to devices. This disproportionately affects students from the B40 group, who are economically disadvantaged (Zainol et al., 2021).

According to Coman et al. (2020), the adoption of online learning places considerable pressure on both students and teachers, particularly for those who lack prior experience in this mode of education. Teachers often struggle with time constraints, finding it challenging to plan and determine the most effective pedagogical approaches for online instruction (Coman et al., 2020). Additionally, the complexity of online learning is exacerbated by the myriad of software tools embedded within learning management systems, aimed at assisting teachers in course management (Coman et al., 2020). In contrast to traditional classroom settings, where evaluation and information dissemination primarily rely on teachers and schools, online learning demands a broader range of skills from educators. These include proficiency in technology usage, varied teaching styles, and other relevant skills pertinent to online education (Coman et al., 2020). Consequently, the failure to implement effective and innovative pedagogical strategies may result in students losing interest in learning (Sun, Tang & Zuo, 2020).

Pedagogy, as defined by Supriyatno and Kurniawan (2020), refers to the teaching approach utilized by educators in the classroom setting. According to Supriyatno and Kurniawan (2020), pedagogical practices are tailored to suit the specific class dynamics. Teachers engage in planning appropriate activities, identifying common student challenges, devising effective learning strategies, and evaluating the acceptance of teaching methods by students. The ultimate goal of pedagogy is to enhance the quality of teaching and learning, ensuring that students accept and feel comfortable with the instructional sessions provided by their teachers (Supriyatno and Kurniawan, 2020). Consequently, when students feel comfortable, it indirectly alleviates cognitive pressure they may experience.

Cognitive Load In Home-Based Learning

Cognitive load plays a significant role in the learning process (Hsu, 2021). However, there are distinct differences in how cognitive load manifests between face-to-face and online learning environments (Hsu, 2021). Additionally, the experience of cognitive load differs between these two modes of learning (Hsu, 2021). Notably, online learning requires a higher level of student motivation to manage increased cognitive load (Sweller, 2017). This is because online learners must independently navigate cognitive challenges, unlike face-to-face learners who benefit from direct teacher guidance (Hsu, 2021).

The concept of cognitive load arises from the load imposed on an individual's working memory during tasks, such as learning (Kostons, Gog & Paas, 2012). According to Geary and Berch (2016), received information can be categorized into two biological or evolutionary categories: primary and secondary information, ensuring that all received information can be stored in long-term memory. However, human memory has capacity limits. When working memory encounters entirely new information or information that is challenging to understand, it can lead to interference with memory processes, preventing the information from being stored effectively for long periods (Merrienboer and Sweller, 2005). Consequently, Merrienboer and Sweller (2005) assert that cognitive load theory involves the interaction between structural information and knowledge.

The higher the cognitive load received by an individual, the more challenging it becomes for information to be stored in memory for more than a few seconds. However, with training, this information can be retained in memory for longer periods (Merrienboer and Sweller, 2005). The duration of information that can be stored in memory depends on the amount of cognitive processing or mental activity involved in performing the learning task (Sweller, 2016). Thus, there are three types of cognitive load that can be imposed on a student's working memory: intrinsic load, extraneous load, and germane load (Sweller, Ayres & Kalyuga, 2011). Cognitive load during online home-based learning can indeed be a significant issue for the school education process (Hsu, 2021). When students engage in online learning from home, they often face several challenges that can contribute to increased cognitive load.

Intrinsic Cognitive Load (IL)

The first type of load is the intrinsic load, which refers to the inherent complexity of the material being studied (Ayres et al., 2021). The higher the difficulty level of the task or topic being learned, the higher the intrinsic load on students (Ayres et al., 2021). Therefore, the amount of intrinsic load experienced by students greatly depends on their level of prior knowledge, known as their knowledge advantage (Sweller, Ayres & Kalyuga, 2011). According to Sweller, Ayres, and Kalyuga (2011), students with a higher level of prior knowledge may not feel as pressured when encountering new, challenging topics. This allows students with a strong knowledge base to store more information in their working memory (Sweller, Ayres & Kalyuga, 2011). Ayres et al. (2021) also share the opinion that intrinsic load involves processing essential for understanding the material, depending on both the complexity of the material and the student's memory of previous learning experiences.

With that said, the intrinsic cognitive load cannot be directly manipulated or changed through teaching, but it can be reduced by addressing the factors contributing to its occurrence (Yu, 2021). According to Yu (2021), in a study on the effect of teacher presence in videos on intrinsic cognitive loads and academic achievements published in Innovations in Education and Teaching International, intrinsic load can be reduced when students engage in a review session. This implies that before delving into new material, it's beneficial for students to review previous learning to build upon existing knowledge (Klepsch, Schmitz & Seufert, 2017).

Extraneous Cognitive Load (EL)

The extraneous cognitive load refers to the manner in which information is delivered during teaching (Leppink et al., 2013). Therefore, extraneous load does not directly contribute to learning the material itself (Leppink et al., 2013). According to Leppink et al. (2013), an increase in extraneous load can disrupt the conveyed information to the extent of interfering with working memory. For instance, when teachers present information using unclear writing or diagrams lacking sufficient clarity, it becomes challenging for students to receive and comprehend the information, thereby affecting working memory's ability to retain information for an extended period (Leppink et al., 2013).

In addition, Skulmowski and Xu (2021) also share the view that external cognitive load refers to the teaching procedure, which encompasses the teaching delivery methods employed by teachers in the classroom. Consequently, teachers should utilize teaching delivery methods that are appropriate according to classroom conditions and the students' learning level (Skulmowski and Xu, 2021). For example, when explaining the characteristics of a square shape, teachers can utilize visual images to make it easier for students to understand (Klepsch, Schmitz & Seufert, 2017). Furthermore, according to Beege et al. (2021), while extraneous cognitive load allows students to store information in the short term, ensuring long-term information retention requires engagement with germane cognitive load. This is because extraneous cognitive load does not involve activities related to the acquisition of schema automation (Beege et al., 2021).

With that said, Beege et al. (2021) explained that intrinsic load and extraneous load are cognitive loads controlled through instructional design. Therefore, an increase in both intrinsic load and extraneous load can impose pressure on working memory (Beege et al., 2021). However, to ensure that information can be retained for a long period of time, it is essential to increase the cognitive germane load (Beege et al., 2021).

Germane Cognitive Load (GL)

Finally, germane cognitive load, as described by Ginns and Leppink (2019), refers to the processing, construction, and automation of schemes. Klepsch, Schmitz, and Seufert (2017) also concur, stating that germane load involves the processing of information to ensure that it can be stored in memory for a long period of time. Therefore, germane load will depend on the level of load received in intrinsic and extraneous load because it involves existing knowledge (Klepsch, Schmitz & Seufert, 2017). For example, after learning a topic such as linear equations, to ensure that the information can be retained for a long time, students need to engage in repeated exercises and revisions using the same topic (Klepsch, Schmitz & Seufert, 2017).

According to Sweller (2017), the increase in germane load depends on the amount of load received intrinsically and extraneously. This is because intrinsic, extraneous, and germane cognitive loads are additive (Sweller, 2017). Therefore, the combined load from these three types should not exceed the available working memory resources

during learning to ensure that information can be retained in both short and long term (Sweller, 2017). When the load exceeds available working memory resources, students may experience stress and a decrease in motivation, subsequently affecting their ability to store more information (Sweller, 2017).

Methodology

This study employed a qualitative approach, conducting interviews with a total of 60 respondents, comprising 30 teachers and 30 high school students. The first group consisted of secondary school teachers who had experience with home-based learning teaching sessions, while the second group consisted of secondary school students, primarily from upper secondary education, who had undergone home-based learning during the COVID-19 pandemic. The interview data was collected using the Transana method, which generates text transcripts, followed by analysis using Nvivo12 software to identify themes. The interviews were conducted using a semi-structured protocol method, based on the approach outlined by Asmussen and Creswell in 1995. This method allowed for the development of a structured interview format, providing ample space for respondents to provide detailed answers.

Data Analysis

In this study, the data was analysed to examine the factors that cause an increase in the cognitive load of secondary school students when faced with home-based learning. Table 1 below shows a summary of the data analysis methods that have been used to study factors causing increased cognitive load.

Table 1. Data analysis Method for Research Question

Research Question	Instruments	Sample	Data Analysis
What are the factors causing cognitive load in online learning and home-based learning among learners?	**Qualitative (Interview Questions)**	➢ Interviews (30Teachers) ➢ Interviews (30 Students)	➢ Thematic Analysis (Transana and Nvivo12)

To address the research question, which aims to investigate the factors causing cognitive load in online learning and home-based learning among students, the researcher conducted a systematic review utilizing thematic analysis. A systematic survey was conducted to gather data and information for the interviews. Following the interviews, the researcher organized focus groups to utilize the data in thematic analysis. Thematic analysis was conducted on the transcribed data obtained from the interviews, using Transana to produce text transcripts and Nvivo12 for data analysis to establish themes. The interviews served to support the research data.

The data collected through the Transana technique is expected to yield superior results due to its concentrated nature. The validity of the results was assessed and discussed by comparing findings from all case studies with evidence from the literature review. This process enabled the researcher to examine the transcripts for emerging patterns, which were then listed as free nodes before being grouped into main nodes (main themes) along with associated child nodes (sub-nodes). Content analysis was conducted using five general data analysis strategies: data display, code identification, information reduction, code frequency, and categories for relational data matrix and pattern matching. Nvivo12 was utilized for data analysis.

Results

This section presents the findings of the study based on the data collected. The findings were derived from the interviews conducted as part of the study's instrument. The method used to analyse the data has been previously defined in the methodology section, where thematic analysis, as described by Smith (1992), was employed. This technique involved extracting and analysing data and information obtained from the interviews. The interviews conducted in this study followed a semi-structured protocol method, which was adapted from the approach outlined

by Asmussen and Creswell in 1995. This method facilitated the development of a structured interview format that allowed interviewees ample space to provide detailed responses.

In addition, to create themes, a code-based analysis conducted. Codes identified, and definitions of code concepts explained to generate themes using the data analysis strategy outlined by Ormerod (2009). This approach involves searching for keywords in each transcript to identify codes. Subsequently, code development and definition conducted based on the literature review findings. This process enables a comprehensive understanding of the data and facilitates the extraction of meaningful themes.

Analysis of teacher interview data

Content analysis was conducted by filtering the transcripts and capturing (codes) inductively, as summarized in Table 2, which outlines the analysis conducted using Nvivo12 for intrinsic cognitive load. Additionally, Figure 1 depicts the cognitive mapping developed using Nvivo for Intrinsic Cognitive Load (Theme 1). Mapping involves integrating fields from various data sets into a centralized database or design (Mahi et al., 2021). The purpose is to combine multiple data sets into a single unit. Specifically, mapping entails determining points from various data sets in different ways, which are then combined and organized to produce accurate data usable at the final destination (Mahi et al., 2021). Figure 1 provides a comprehensive diagram of intrinsic cognitive mapping, illustrating the method used in this study to obtain a clearer understanding. Based on the data analysis in Table 2 and Figure 1, it is evident that two themes emerged after filtering the transcripts: the first relates to the task or exam itself, while the second pertains to students' knowledge.

Table 2. Summary of analysis done using Nvivo12- Intrinsic Cognitive Load (Theme 1)

Theme	Code	Sub-Code	Operational Definition
Task or exam	Teach new thing	Students' level of acceptance of new topics varies	When teaching something new, the teacher will see the level of student acceptance of the topic being learned
	Pressure in process information	Not concentrate	The instability of concentration in understanding the information received will put pressure on students to process the information.
	Level up dramatically	Task or exam not based on person ability	Test questions or assignments not given according to student ability
Knowledge	Using new terminology	Confusing words	Impact on the use of new terminology
		Challenges during online	Factors that need to be taken into account when wanting to use new terms in teaching
	Unfamiliar words	Limitation of memorizes unfamiliar words	Ability of students to memorize
		Lack explanation	Unfamiliar words are not explained in detail
	No activation of knowledge	Lack of previous learning knowledge	The level of student knowledge of past learning is different for each student

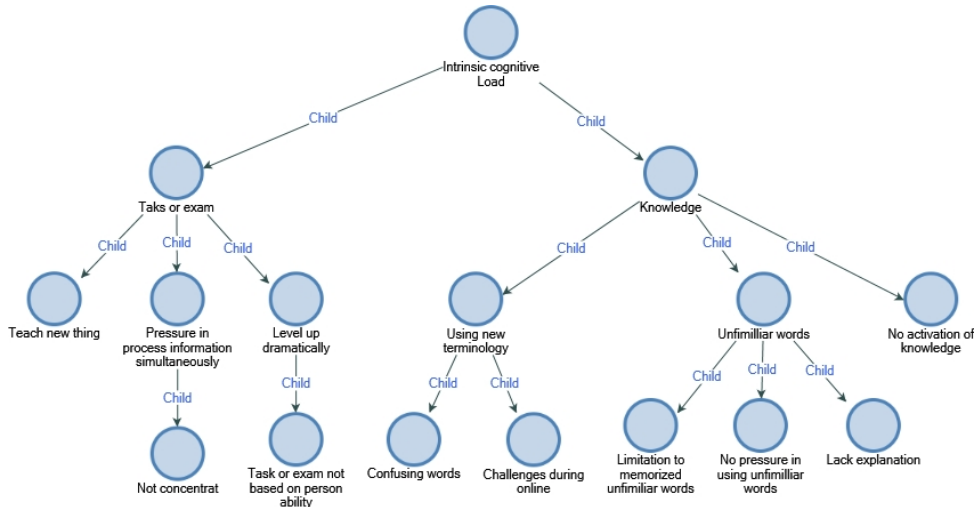

Figure 1. Cognitive mapping develops using Nvivo for Intrinsic Cognitive Load (Theme 1)

For tasks or exams, three nodes were identified where intrinsic cognitive load occurs. These assignments or exams require students to learn something new, placing pressure on them to process information. Three codes were found for these assignments or exams, indicating that students experience intrinsic cognitive load due to the need to learn new material. This was observed through interviews with school teachers, who expressed that learning something new can be stressful for students because it involves unfamiliar concepts, as stated below:

T2: *"The answer is yes. **It does put pressure on students**. For instance, even though they were mentally prepared to enter the science stream, when they were introduced to biology, which was **entirely new and had not been covered in their lower secondary education**, it posed a challenge. We know that biology is a more in-depth science subject, so it's quite difficult for them to grasp. In fact, this difficulty is also felt by the teachers because we have to teach these new concepts to students online."*

Additionally, administering exams or assignments suddenly without considering students' individual abilities leads to an increase in cognitive load. The three sub-codes generated are: (i) Varying levels of student acceptance of new topics, (ii) Lack of concentration, and (iii) Exams or assignments not tailored to individual abilities. These sub-codes result in three main codes: teaching new concepts, pressure in processing information, and a significant increase in difficulty level. These codes collectively contribute to a new theme: exams or assignments. Moving on to the aspect of knowledge, an analysis revealed three nodes. The first occurs when teaching and learning sessions introduce new terminology, causing confusion among students. This was evident in interviews with school teachers, as one expressed:

T15: *"Yes, I agree. In the Malay language, there are many words that students may not have encountered, especially when studying archaic Malay. **A single sentence can convey different meanings, leading to confusion when students attempt to construct sentences**."*

Furthermore, the use of seldom-heard words can also have cognitive effects. This is because such words are often not explained in detail, making it difficult for students to remember them. This observation was highlighted in an interview session with a school teacher, who mentioned:

T2: *"In my opinion, **encountering rarely heard words creates a lot of pressure**. For example, in the field of art, there are words like 'anthropogeny' that are seldom used or unfamiliar to us. When students come across such words, it can pose challenges. Especially when they're required to memorize something unfamiliar that they've only heard of, it seems to cause difficulties."*

Finally, the data analysis revealed that without the activation of prior knowledge, students indeed face pressure. However, due to home-based learning being conducted online, teachers have limited time to facilitate such activation. This was highlighted in an interview session with a school teacher, who stated:

T1: *"It turns out, if we don't review previous learning before introducing a new topic, it certainly poses challenges for both teachers and students. Without a recap,* ***students may struggle to understand the new material****, and teachers may find it difficult to achieve the day's objectives."*

In fact, some teachers suggest that activation learning should be tailored to specific topics, focusing on subjects related to upcoming topics as suitable review activities.

T5: *"For me,* ***it depends on the subject or topic itself. If it's relevant, of course, we have to do a recap****. People tend to forget quickly; it's human nature. So, to ensure they remember, we might need to revisit an old topic* ***just to provide a hint****."*

Overall, from the five sub-codes generated, which are: (i) Confusing words, (ii) Challenges during online learning, (iii) Limitation of memorizing unfamiliar words, (iv) Lack of explanation, and (v) Lack of previous learning knowledge, three resulting codes emerged: the use of new terminology, encountering unfamiliar words, and lack of activation of knowledge. These three codes contribute to a new theme, which is knowledge. Here are the nodes found for intrinsic cognitive load through the use of NVivo12. Next, Table 3 and Figure 2 present a summary of the analysis conducted using NVivo12 for extraneous cognitive load."

Table 3. Summary of analysis done using Nvivo12- Extraneous Cognitive Load (Theme 2)

Theme	Code	Sub-Code	Operational Definition
Pedagogy	Platform	Unformal platform Formal platform	The use of different platforms used by teachers as appropriate in online classes
	Passive	Active	The type of learning that affects student learning
	Instructional design	Materials	Learning materials used in teaching are not appropriate for online classes
		Environment learning	The teaching design used is not suitable for the students' environment
		Abilities of learners	Students' ability to understand the instructional design used in online classes
Information	Excessive information	Tired Time Limited capacity Distracted	The effect on students when receiving excessive information
	Delivery of information	Visual Text Audio Combination 3 element	The type of information delivery used by teachers in online teaching sessions

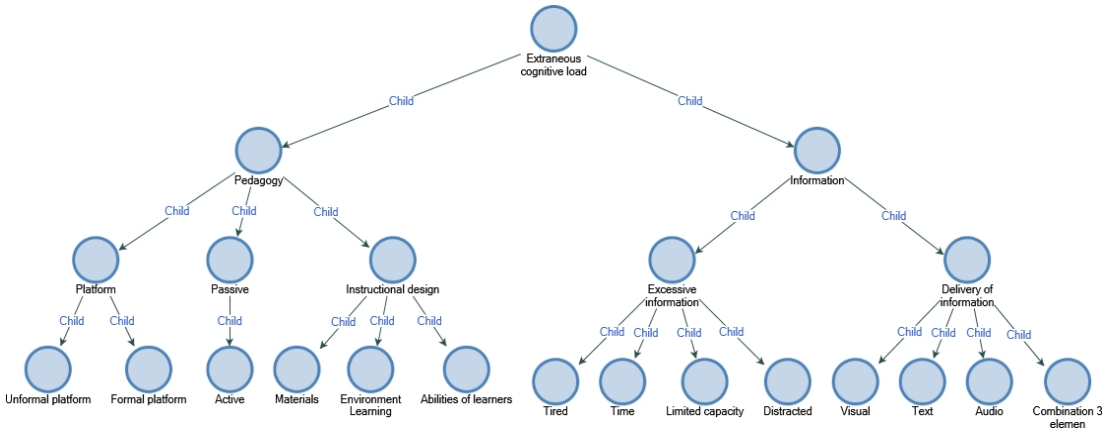

Figure 2. Cognitive mapping develops using Nvivo for Extraneous Cognitive Load (Theme 2)

Content analysis involved filtering transcripts and capturing codes inductively based on the summary of analysis presented in Table 3 and Figure 2, which was generated using NVivo12 for extraneous cognitive load. Data analysis in Table 3 and Figure 2 reveals two themes that emerged after filtering the transcripts: the first is related to pedagogy, and the second pertains to information, both of which contribute to the occurrence of cognitive load.

In the context of this study, pedagogy refers to the manner in which teaching sessions are conducted. Through the analysis conducted, three codes were identified in the pedagogical analysis. The first code pertains to the platform used. An informal platform can contribute to the occurrence of cognitive load. This is because online learning often involves passive learning, which is essentially one-way, and the materials used differ from those in face-to-face classes. This observation is supported by interviews with school teachers, as one teacher stated:

T1: *"It surely has an impact because we're aware that this is passive,* ***one-way learning where students aren't actively engaged****. The* ***material provided by the teacher is often challenging for them to grasp****."*

Overall, from the five sub-codes generated, namely (i) Unformal platform and Formal platform, (ii) Passive and Active, (iii) Materials, (iv) Learning Environment, and (v) Learners' Abilities, three resulting codes emerged: platform, passive learning, and instructional design. These three codes contribute to a new theme, which is pedagogy. Additionally, the second set of codes obtained from the analysis pertains to information, referring to how information is presented. This is evident from the interview sessions conducted, where the analysis indicates that an increase in cognitive load can occur if students are inundated with excessive information, surpassing their capacity to absorb it. This was highlighted during an interview session with a school teacher who stated:

T3: *"Yes, I agree. Our brain is like a glass of water; when it's full, adding more water means overflowing. Similarly, if we force too much information into our brains, they become overwhelmed. Just like trying to pour more water into a full glass, the excess won't fit, and it becomes too much to handle. This illustrates that* ***the human brain has limits, and trying to accommodate an excessive amount of information in one day can be very burdensome.****"*

However, the researcher discovered, after conducting the analysis, that effective information delivery through the use of visuals, audio, and text can alleviate the pressure experienced during teaching and learning sessions. This was supported by insights from interview sessions with school teachers, as one teacher stated:

T24: *"If we integrate all three elements, it becomes much more effective. Particularly in online settings, we have the advantage of utilizing various visual aids such as information graphics, animations, and videos. Take history classes, for example; although I don't personally teach this subject, many students often feel bored or sleepy during these sessions. However, by incorporating animations and creating engaging storylines, teachers* ***could potentially spark their interest in learning.****"*

Overall, from the eight sub-codes generated, namely: (i) Tired, (ii) Time, (iii) Limited capacity, (iv) Distracted, (v) Visual, (vi) Text, (vii) Audio, and (viii) Combination of the three elements, two resulting codes emerged: excessive

information and delivery of information. These two codes contribute to a new theme, which is information. Here are the nodes found for extraneous cognitive load through the use of NVivo12. Subsequently, Table 4 and Figure 3 present a summary of the analysis conducted using NVivo12 for germane cognitive load.

Table 4. Summary of analysis done using Nvivo12- Germane Cognitive Load (Theme 3)

Theme	Code	Sub-Code	Operational Definition
Process	Organization learning	Providing clear guidance Help learning process Conducive environment	The ability of teachers to help students ensure that the learning process runs smooth
	Learning process	More impact on teacher More impact on student A complicated process	The impact received by students and teachers when the learning process does not go smoothly
	Learning environment	Weather Noisy Internet access Facilities Emotions Distractions	Causes that have a negative impact on the student's learning environment
Exercise	Repetitive exercises	Understanding Skill No challenge Boring	The effect that students receive on repeated exercises in learning

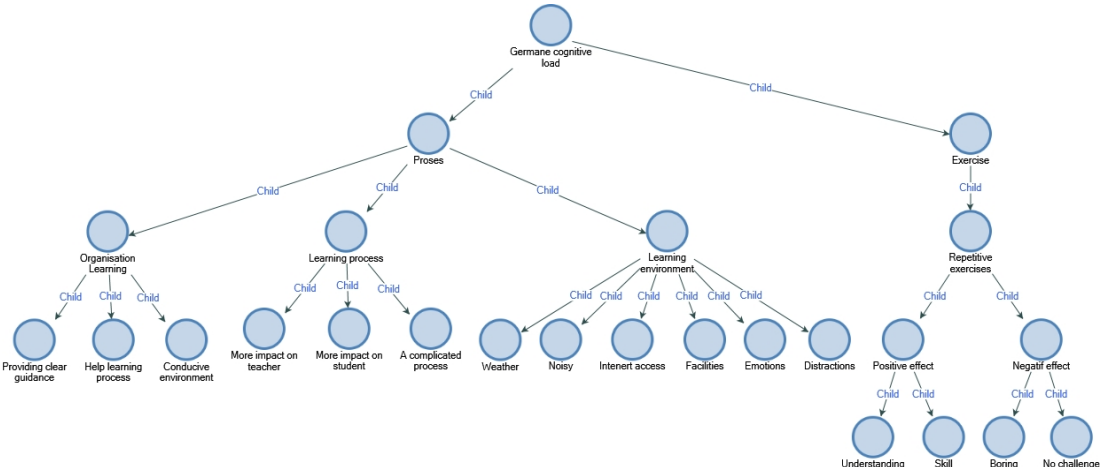

Figure 3. Cognitive mapping develops using Nvivo for Germane Cognitive Load (Theme 3)

The content analysis involved filtering transcripts and capturing codes inductively based on the summary of analysis provided in Table 4 and Figure 3, conducted using NVivo12 for germane cognitive load. Data analysis in Table 4 and Figure 3 reveals two themes that emerged after filtering the transcripts: the first is related to information processing, and the second pertains to the exercises provided. These factors contribute to the occurrence of germane cognitive load.

For the first node, which focuses on the teaching and learning process, it's evident that the learning process plays a pivotal role in reducing cognitive load levels. Analysis indicates that well-organized learning materials facilitate the initiation of the learning process. Moreover, the learning environment is crucial; inadequate facilities can lead to a negative learning atmosphere. This was highlighted during an interview session with a school teacher who stated:

T16: *"For me this **environment is important, because how they can stay focused and can make sure their level of understanding** is good, if it's noisy. So, these students need a quiet place to study. In fact, not only in terms of sound, clean environmental assets also need to be taken into account."*

Overall, from the five sub-codes generated, which are: (i) Providing clear guidance, (ii) Facilitating the learning process, (iii) Creating a conducive environment, (iv) Impact on teacher or student, and (v) Complex processes, three resulting codes emerged: organizational learning, learning process, and learning environment. These three codes contribute to a new theme, which is the process. Next, the second node found after the analysis is the exercise. Regarding training, the analysis revealed that regular and repetitive exercises have a positive impact, enhancing students' understanding. This was highlighted during an interview session with a school teacher who stated:

T1: "Absolutely, it's crucial to understand today's students. Improving skills, especially in art, requires extensive practice. ***Repetition hones students' abilities and sharpens their skills****. Therefore, regular training isn't burdensome for me; instead, it's beneficial. It trains our brains and enhances art education."*

However, the negative effect occurs to students who have a high level of skill and understanding who feel that if they are given the same question over and over again create a sense of boredom because there is no challenge. The matter can be seen through an interview session with the school teacher who stated that:

T18: "Their students not feel pressured instead they be lazy to do it. Because imagine we do the same thing day after day, ***indirectly we get bored*** *when we are bored, that's what makes us lazy."*

Overall, from the four sub-codes generated which are (i) Understanding, (ii) Skill, (iii) No challenge, (iv) Boring, there are one resulting code which are repetitive exercises. This one code led to a new theme which is exercise.

Analysis of student's interview data

The content analysis involved filtering the transcripts and capturing codes inductively based on the summary of analysis provided in Table 5 and Figure 4, conducted using NVivo12 for intrinsic cognitive load. Based on the data analysis presented in Table 5 and Figure 4, two themes emerged after filtering the transcripts. These themes elaborate on two factors contributing to cognitive load among students: the first is related to learning new topics, and the second concerns students' prior knowledge.

Table 5. Summary of analysis done using Nvivo12- Intrinsic Cognitive Load (Theme 1)

Theme	Code	Sub-Code	Operational Definition
Topic	New topic	Not a familiar subject	The topics that will be studied are topics that are not commonly heard or have not been exposed before
		May cause loss of other information	The effect received by the student when the student has to process new information
		Hard to get an explanation	Difficulty in getting detailed explanations in online classes
		Different level of difficulty	The level of each topic studied varies according to the student's ability level
	Difficult topic	Limits adapting to the online environment	The types of limitations students face in learning difficult topics
		Limitation in topic	
		Limits time to learn	
Knowledge	Uses abbreviations or new word	Easier to remember	The positive effect that students receive on the use of abbreviations or new words
		Confusing	The positive effect that students receive on the use of abbreviations or new words
		Taking time to memorize	
		Difficult understanding	
	Activation of knowledge	Weak memory	A student's memory has limited

		limits to store information for a long period of time
	Recall learning	Activities that help strengthen students' memory of topics that have been studied for a long time

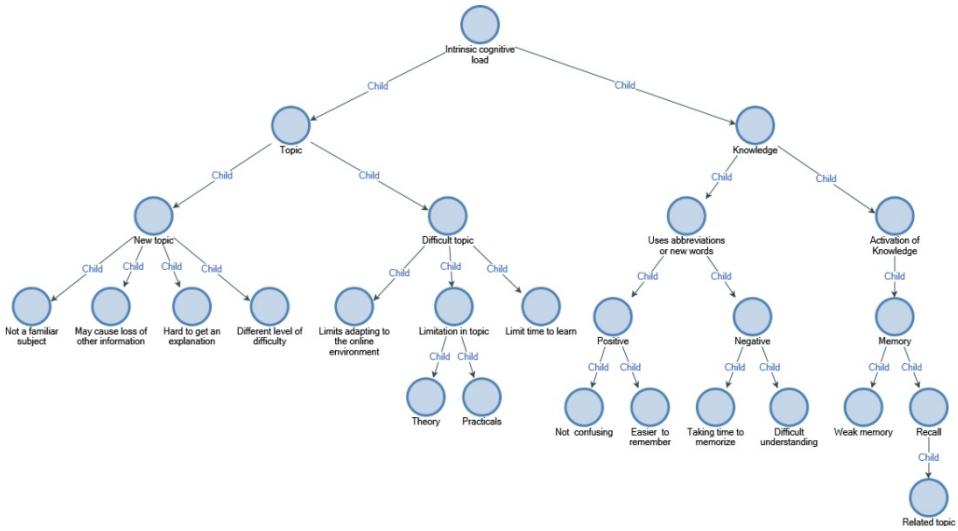

Figure 4. Cognitive mapping develops using Nvivo for Intrinsic Cognitive Load (Theme 1)

When it comes to new topics, students' express difficulty in grasping them during online learning. It poses a significant challenge as they navigate understanding and processing unfamiliar content independently. Moreover, students struggle with absorbing completely new concepts that haven't been previously introduced. Some students fear that learning something new might overshadow their memory of older topics. Human memory has its limits in retaining information, so introducing a new and complex topic adds to the cognitive load, potentially impairing memory retention. This sentiment was echoed during an interview session with high school students, as one student stated:

S14: "Online learning is incredibly stressful for me. Think of the human brain like a computer desktop with different folders we've created. When we ***encounter a new topic, our brain creates a new folder for it. However, there's a risk that the old topics might lose some data****. If the new topic is easy, it's manageable; it won't affect our memory of the old topics much. But if the new topic is difficult, it can have a significant impact."*

Moreover, topics that are challenging to learn independently contribute to an increase in the cognitive load experienced by students. Humans have limits to their understanding, so encountering difficulties with a topic can dampen students' enthusiasm for learning. This perspective was shared during an interview session with high school students, as one student expressed:

S14: "To me, it's similar to art. Initially, the teacher introduced drawing as something easy, but gradually increased the difficulty level, leading to student struggles. While I can handle this in a face-to-face class, it's more challenging online. Learning art online requires a phased approach. If it's just theory, that's manageable, but it must involve practice. So, for me, increasing difficulty is acceptable, but it needs to be gradual. ***When it's sudden, it disrupts my ability to retain and understand the day's learning."***

Overall, from the seven sub-codes generated which are (i) Not a familiar subject, (ii) May cause loss of other information, (iii) Hard to get an explanation, (iv) Different level of difficulty, (v) Limits adapting to the online environment, (vi) Limitation in topic, (vii) Limits time to learn, there are seven resulting code which are new topic and difficult topic. This one code led to a new theme which is topic. Next, the second theme in increasing the intrinsic load is in terms of student knowledge. where the student's knowledge of old learning is the cause of this

increase in intrinsic cognitive load. For students, when they enter a new topic, the things learned in the old topic cause them to forget. This is because their memory is too weak to accommodate various types of information. Therefore, teachers should recap before entering a new topic. This is because the matter can be seen through an interview session with secondary school students who stated that:

S10: "Hmm, in my opinion. It is quite difficult because there may be students that he can remember for topics that he studied before. But for some students, he also needs a brief review or summary of the story from the previous topic. So, when entering a new chapter, he can remember it again. Enjoys telling stories in English; refreshes for the previous topic; and for ***the previous topic, they are easier to understand and can relate the previous topic to the new topic. So, it's quite difficult if the teacher doesn't give an overview of the previous topic****."*

Finally, an increase in intrinsic cognitive load occurs due to the involvement of the student's knowledge of words that have been learned or never heard and learned throughout learning. This is because when there is a situation where they find words that they rarely hear in learning, it difficult for them to remember. What's more, if the words or things learned have nothing to do with the student's daily routine, then this make it difficult for the student to remember them. This matter can be seen through an interview session with high school students who stated that:

S22: "When we talk about new words, like biology, I can say many new words that I have never heard. I think this is something new for me to understand. So, this puts a ***little pressure on me to process information and remember the words, which takes a lot of time****."*

Therefore, the conclusion is that if the teacher can plan the teaching topic well by providing interesting activities this help the students. Overall, from the six sub-codes generated, which are: (i) Easier to remember, (ii) Confusing, (iii) Taking time to memorize, (iv) Difficulty understanding, (v) Weak memory, and (vi) Recall learning, six resulting codes emerged, which are the use of abbreviations or new words and activation of knowledge. These codes led to a new theme, which is knowledge. Next, Table 6 and Figure 5 provide a summary of the analysis conducted using NVivo12 for extraneous cognitive load.

Table 6. Summary of analysis done using Nvivo12- Extraneous Cognitive Load (Theme 2)

Theme	Code	Sub-Code	Operational Definition
Platforms	Special techniques	More creative Interactive platform Attract students' attention	The use of special techniques in online teaching sessions that use technology fully in learning
	Online platform	Unformal platform Formal platform	The use of appropriate platforms according to the subject
		Improve students understanding	Positive effects received by students through the use of online platforms in learning sessions
		Detailed explanations	Steps in ensuring that the information and instructions presented are well received by students
		Clearer instructions Not clear instructions	The negative impact that students receive on the delivery of ineffective instructions and information
		Practical	The ability of teachers to use online platforms for topics or subjects that require practical and experiments
Information	Positive	Information widely Help understanding Easily to search information	Effects received by students in finding and receiving information online

Negative	Need to learn Limitation to access Excessive information

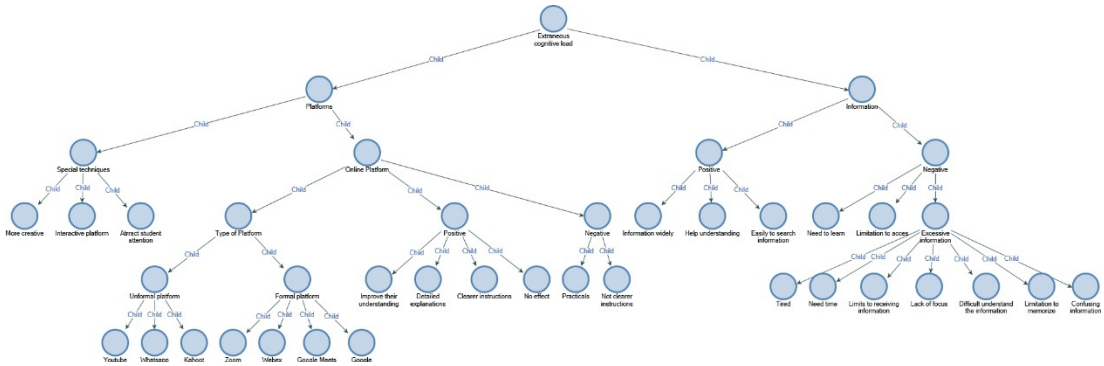

Figure 5. Cognitive mapping develops using Nvivo for Extraneous Cognitive Load (Theme 2)

For the first theme of the platform, students expressed the view that teachers should employ specialized techniques. This is due to the distinct teaching methods required for face-to-face and online classes. Online learning demands that teachers possess proficiency in utilizing technology. Therefore, if teachers possess specialized techniques in online teaching, leveraging technology effectively can indirectly capture students' attention during learning. This perspective was shared during an interview session with high school students, as one student stated:

S18: *"For me, teachers must have a special technique to teach online because it uses a lot of technology. There are many functions of the technology, so the teachers have to be smart and more creative, again with math objects, because the* ***teacher has to attract the attention of the students****."*

In addition to employing special techniques in online teaching, students believe that using attractive platforms can effectively capture their attention. Formal platforms like Google Meet and Webex serve as virtual equivalents to traditional face-to-face classrooms. Conversely, informal platforms such as WhatsApp and Kahoot offer engaging activities and entertainment during teaching and learning sessions. This perspective was shared during an interview session with high school students, as one student expressed:

S21: *"For me, this platform is important because a* ***good platform can explain or help students learn in a positive way.*** *The example of a teacher teaching bio via WhatsApp and then telling students to watch YouTube didn't work for me. We need classes as usual, but online, where there is interaction between teachers and students and detailed explanations of topics."*

Overall, from the nine sub-codes generated, which are: (i) More creative, (ii) Interactive platform, (iii) Attracting students' attention, (iv) Informal and Formal platforms, (v) Improving students' understanding, (vi) Detailed explanations, (vii) Clear instructions, (viii) Unclear instructions, and (ix) Practical, two resulting codes emerged: special techniques and online platforms. These codes led to a new theme, which is platforms. The second theme pertains to information, wherein the information received through the use of technology presents both advantages and challenges. Regarding the benefits of using this technology, it offers access to a variety of information, making the search for information broad and easily accessible. This perspective was shared during an interview session with high school students, as one student stated:

S1: *"This technology actually helps. Because if it's like our example, I think I can find that* ***information extensively using technology****. For example, if I don't understand how to use a formula, I can probably look it up on YouTube to get tutorial videos. Indirectly, this* ***can improve my understanding****. There are many platforms that we can use. So, the use of this technology is not burdensome."*

However advanced technology may be, it still harbors accepted weaknesses. Online classes struggle to replicate practical aspects that demand simulation or experimentation. Moreover, utilizing technology necessitates students to learn its usage, which consumes considerable time. This viewpoint was expressed during an interview session with high school students, as one student mentioned:

S8: *"I answer based on my experience because I learned RTB, so we use AutoCAD and Sketchup. So, when the online class starts, we need to download this application ourselves. So, it is difficult for me to understand and learn the use of technology without full guidance from the teacher, where the class is online, and I have* ***to find all the information and guidance through information searches on the internet****."*

In addition to the challenges posed by technology in classes involving simulations or experiments, the delivery of information and instructions presents a significant hurdle for online classes. The extended duration of online classes often leads to the reduction of students' break time by teachers, resulting in the inundation of information within a single day. Consequently, when students are bombarded with a plethora of information in a short span, they are prone to confusion and misunderstanding regarding the instructions or information provided. This perspective was shared during an interview session with high school students, as one student articulated:

S1: *"Stress because we* ***need time to understand each topic****. So, if the teachers do everything in one day, it's really stressful. For example, one day there be several topics to learn, so if there are many things to learn, this confuses me, and we cannot focus. That's the first. The second is that we be confused with learning because there are too many things we need to adjust."*

Therefore, the conclusion is that if teachers employ effective teaching techniques in online classes, coupled with the use of attractive and user-friendly platforms, they can indirectly manage the amount of pressure students experience. Overall, from the six sub-codes generated, which are: (i) Widely accessible information, (ii) Aiding understanding, (iii) Ease of information retrieval, (iv) Learning necessity, (v) Access limitations, and (vi) Information overload, two resulting codes emerged: positive and negative effects. These codes led to a new theme, which is information. Next, Table 7 and Figure 6 provide a summary of the analysis conducted using NVivo12 for germane cognitive load.

Table 7. Summary of analysis done using Nvivo12- Germane Cognitive Load (Theme 3)

Theme	Code	Sub-Code	Operational Definition
Repetitive exercise	Positive	Retention of information for long-term Increase understanding Increase the knowledge	Student-perceived effects of repeated exercise
	Negative	Performance cannot increase No improvement No challenge Easily bored	
Process information	Internal disturbances	Need time to understanding Hard to memorize	Students' ability to process information when facing an online learning session
	External interference	Environment disturbances	
Environment	Causes	Disturbed by noise Conducive environment helps mental in good conditions	The impact received by students on the distractions encountered during online learning
	Effect	Lose focus Effect understanding	

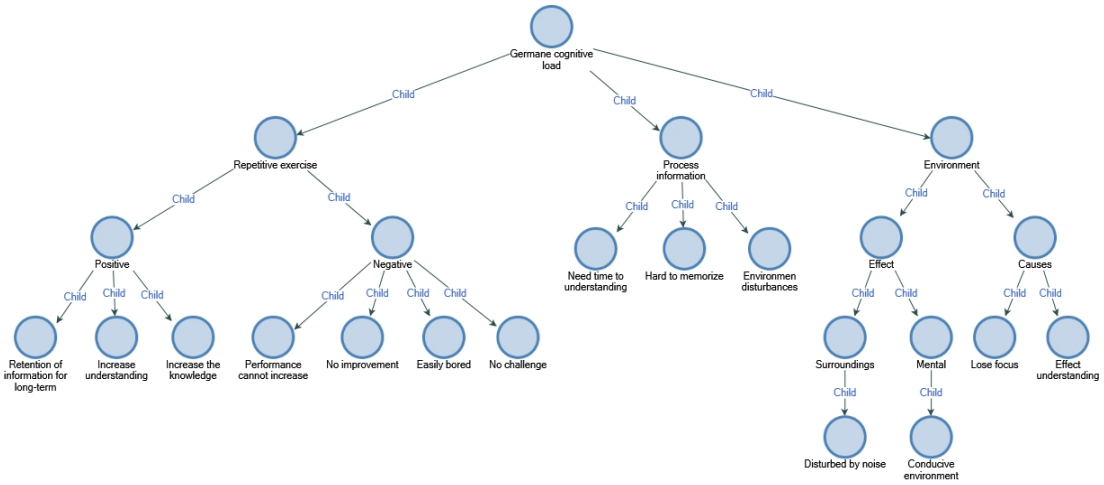

Figure 6. Cognitive mapping develops using Nvivo for Germane Cognitive Load (Theme 3)

For the first theme of repeated exercises, the impact can be either positive or negative for students. Regarding the benefits, engaging in repeated exercises allows students to enhance their understanding and knowledge of the topic being studied. Consequently, this aids in the retention of information in long-term memory. This viewpoint was expressed during an interview session with high school students, as one student mentioned:

S10: "Hmm, in my opinion, we can remember because we practice a lot. For example, like RBT, there be the use of applications like SketchUp if we always do the same thing where the exercise is repeated. I believe this ***help our memory to be stronger****. Therefore, if our memory is strong, indirectly,* ***we do not need guidance to do this because not reacting to our memory act on the stored memory.****"*

However, repetitive training can also present challenges. For some students, engaging in the same activity repeatedly can lead to boredom. They perceive a lack of novelty or challenge, which may result in a stagnation of their performance level. This perspective was shared during an interview session with high school students, as one student expressed:

S21: "For me, this would burden me because ***when we do the same thing over and over again, we feel bored, because if we have understood and remembered everything, then repeating the same thing for me is a waste of time****. I used to tutor from a Kumon tuition center, where the tutor gave me the same homework and said the same 10 sets of questions. The first time I was serious about doing it, the second, third, and fourth time I could go again. By the 7th or 8th time, I was getting bored, so I just copied the answers. Because when it's the same thing, I don't think it's a challenge; it kind of affected my performance to that extent."*

Overall, from the seven sub-codes generated, which are: (i) Retention of information for long-term, (ii) Increased understanding, (iii) Increased knowledge, (iv) Performance cannot increase, (v) No improvement, (vi) Lack of challenge, and (vii) Easily bored, two resulting codes emerged: positive and negative. These codes led to a new theme, which is repetitive exercise. The second theme pertains to the learning process, which is closely linked to the environment. To ensure a smooth learning process, students should be situated in a conducive environment, preferably a quiet one. This facilitates a calmer and more comfortable learning session. Conversely, if the learning atmosphere is noisy, students find it difficult to remember and process newly learned topics. This perspective was shared during an interview session with high school students, as one student mentioned:

S14: "For me, it is important because this ***environment helps in controlling the pressure received through online classes****, where I believe, a good environment led to a good mental state. If we want to study for me, we have to be in a good mental state, calm, and ready. So, if our environment is in a state of chaos, it is inevitable that our mentality be disturbed. For example, in the middle of an online class, suddenly my brother turns on the TV. We are not focusing on learning, but we are focusing on the TV because, mentally, we are distracted by the sound and other things. This is my opinion."*

Overall, from the four sub-codes generated, which are: (i) Disturbed by noise, (ii) Conducive environment helps maintain good mental conditions, (iii) Loss of focus, and (iv) Impact on understanding, two resulting codes emerged: causes and effects. These codes led to a new theme, which is environment..

Discussions

Overall, based on Table 8 which shows a summary of factors that cause cognitive load in online home-based learning based on interviews with secondary school teachers and students.

Table 8. The summary of factors that cause cognitive load in online home-based learning based on teacher and student's interviews

Factors Causing Cognitive Load						
Intrinsic cognitive load			**Extraneous cognitive load**		**Germane cognitive load**	
Knowledge	**Task/ exam**	**New topic**	**Pedagogy**	**Information**	**Process**	**Exercise**
-No activation knowledge: •*Weak memory*	-Level up dramatically -Task or exam not based students' ability	-Time to learn new topic -Not familiar	-Platform: •*Interactive platform* •*Unformal platform*	-Delivery of information	-Organization learning: •*Provide clear guidance* •*Organized learning structure*	-Repetitive exercise
-Using abbreviation: •*Taking time to memorize* •*Lack of explanation* •*Confusing* •*Difficult to understanding*			-Instructional design: •*Environment learning* •*Not clear instructions* •*Not creative* •*Special technique*	-Excessive information: •*Need time* •*Difficult to understand* •*Lack of focus* •*Tired* •*Limits to receive information* •*Confusing* •*Limitation to memorize*	-Learning process: •*Complicated process* -Learning environment: •*Surroundings* •*Mental*	

Overall, the analysis of interviews with school teachers and high school students who have faced home-based learning during the spread of the COVID-19 epidemic has shown the factors that cause cognitive load to occur, based on Table 8 above. There are three cognitive factors involved: intrinsic cognitive load, extraneous cognitive load, and germane cognitive load.

As for intrinsic cognitive load, there are three factors that cause intrinsic cognitive load to occur, one of which is the involvement of student knowledge. Analysis has been made showing that the weakness of students' knowledge is the main cause of their intrinsic cognitive existence. This is because no knowledge activation is made. This can be seen through the study of Kalyuga (2009) where students will struggle to identify the meaning of new terms and understand how one idea is related to another idea when students lack knowledge. Therefore, when students come across words that are rarely used, or perhaps they learn them while studying old topics, this causes difficulties (Kalyuga, 2009). This is because, the use of words that are rarely used will cause students to take time to remember them, thus this is the cause of intrinsic cognitive knowledge overload (Kalyuga, 2009). Therefore, teachers should do scanning learning, which will help students better understand and get easier explanations so as not to confuse them.

In addition, the second factor that causes intrinsic cognitive load to occur is because the task or exam given by the teacher suddenly increases in difficulty. This is because when the teacher suddenly increases the difficulty level of assignments or exam questions, this causes students to be more stressed, and maybe the assignments or exam questions are not based on the student's ability (Impelluso, 2009). So, this puts pressure on students to do assignments and answer exam questions. Therefore, teachers need to plan the level of questions or assignments that will be given based on the student's ability level, this will help the teachers in meeting the learning objectives set (Impelluso, 2009). Also, the last factor that causes intrinsic cognitive load to occur is when students have to learn a new topic. This is because maybe the topic is unfamiliar to them, or their weak understanding of old topics is the cause. Therefore, in order to learn new topics, students must be proficient in old topics, and they need time to learn new topics (Impelluso, 2009).

Next, there are two factors that cause cognitive extraneousness to occur, one of which is that the pedagogy used may not be appropriate, and the second factor is how information can be presented well. In terms of pedagogy, this can be seen through the platform and teaching design used in home-based learning classes. In terms of platforms, the analysis made can be seen with the use of interesting platforms that are able to provide entertainment to students. This can indirectly attract the interest of students to continue to focus on the ongoing teaching and learning (PdP) session. This can be seen through the study of Merrienboer and Sweller (2010), who stated that the teaching platform is very important in attracting students' interest. For example, when home-based learning classes are fully used when COVID-19 occurs, we can see the use of interesting applications such as the use of slides in the form of Netflix, where the use of slides can attract students' attention (Agormedah et al., 2020). In fact, the matter became a phoneme where students raced to explore various interesting platforms to create another trend (Agormedah et al., 2020). With this, we can see the enthusiasm of the students through the use of the platform.

Next, in terms of the analysis made on the delivery of information, it can be seen that good delivery of information can help students understand what is being delivered. In addition, problems will occur if the information provided excessively causes students to feel stressed. This is because, to process all the information, students need time to understand (Sands, 2019). Therefore, if students receive a variety of information in one day, this will cause them to tired easily and lose focus because they have limitations in receiving information (Sands, 2019). Therefore, teachers should plan their teaching and learning time well. With the time allocated by the school based on Table 9, which shows the maximum screen time guide according to age that has been made by the Malaysian Ministry of Education (MOE), teachers must obey and follow this set time guide because it can indirectly help students to focus more and be able to process information well (Kassim, 2021).

Table 9. Maximum Screen Time Guide According to Age (MOE, 2020)

Level of Schooling	**Duration of Screening Time per Day**
Preschool	1 hours
Primary school	1-2 hours
Lower secondary	2-3 hours
Upper secondary	3-4 hours

The third element is germane cognitive, where there are two factors that cause the increase of this factor, one of which is that the learning process may be complicated, and the second is in terms of training. Through the learning process, analysis has been made to find that a good arrangement of learning materials can launch the learning process (Impelluso, 2009). Where the daily planning plan (RPH) provided by the Malaysian Ministry of Education (MOE) can help teachers plan the teaching content that will be done in class (MOE, 2021). In addition, to launch the learning

process, the surrounding conditions also need to be taken into account. This is because, with good conditions, it will help students mentally be better prepared for learning (Kalyuga, 2009).

Finally, the factor that causes germane load involvement to occur is through repeated training. The analysis found that repeated training can have positive and negative effects. On the positive side, students will easily remember, and the level of student understanding of the topic learned will increase (Conrad and Bliemel, 2016). However, for students with a higher IQ level, their speed towards the learning level is fast (Conrad and Bliemel, 2016). These people will easily get bored if they do the same thing over and over again (Conrad and Bliemel, 2016). This is because they feel there is no challenge and will even make their performance level not increase (Conrad and Bliemel, 2016). Therefore, teachers should plan content and assignments that are appropriate to the student's ability level through appropriate learning pedagogy.

Conclusion

In conclusion, this study shows that home-based learning that fully uses technology can have positive and negative effects, which contribute towards increasing cognitive load, which is an important issue for the school education process. Especially when the government launched teaching and learning sessions completely online when COVID-19 hit. Through this study, it can be seen that controlling the amount of load received through intrinsic and external cognitive processes can indirectly reduce the amount of load in the general cognitive process. This is because germane load involves the learning process, so to know if the learning and teaching process is going smoothly, we can see the amount of intrinsic and external load. Therefore, to ensure that the amount of cognitive load received is not too high, teachers should use good home-based learning pedagogy. So, with the correct use of pedagogy, you can indirectly control the amount of load received throughout the class. Therefore, through this study, researchers in the future can design a good and effective pedagogical framework for online learning by knowing the causes that cause the occurrence of cognitive. With this, the use of learning at home can be fully utilized at school, which indirectly helps Malaysian education keep pace with developed countries that follow the trend of modernization.

Acknowledgement

The authors would like to thank Universiti Teknologi Malaysia and Ministry of Higher Education Malaysia for their support in making this project possible. This work was supported/funded by the Ministry of Higher Education under Fundamental Research Grant Scheme (FRGS/1/2021/SSI0/UTM/02/16).

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