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The Resilient Generation of UIN Malang Mathematics Education: Perspective on the Cognitive Load of Students

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Abstract
Deep learning needs to be applied in learning, so that the learning process is not limited to cognitive aspects alone. Moreover, the cognitive load that humans can accept is limited. This load does not only come from within the classroom during learning, but also from other factors such as emotions, time constraints, and existing tasks. Cognitive load theory needs to be applied to deal with this, so that the learning portion is in accordance with the conditions required by students. This study conducted on first-semester students of the Mathematics Education study program at UIN Malang aims to identify and analyze existing cognitive load. The study used a quantitative approach with 54 students as sample respondents. Data were collected through a semi-structured guided questionnaire covering aspects of intrinsic load, extraneous load, emotional load, time and task load, and resource load. Data analysis used descriptive statistics with Rasch Model validity testing. The results showed that cognitive load was in the moderate to high category, with intrinsic load, extraneous load, emotional load, time load, and task load in the moderate category, and resource load in the high category. These findings indicate that students are able to manage their cognitive load quite well. However, the high time and task load needs to be addressed as it has the potential to cause cognitive fatigue and reduce learning effectiveness. This study recommends the development of OBE-based adaptive learning strategies that take into account the balance between academic activities and dormitory life.

Keywords:
Cognitive Load; Mathematics Education; OBE; Ma'had

A. INTRODUCTION

Higher education faces complex challenges in producing graduates who are not only cognitively intelligent, but also capable of critical, creative, and adaptive thinking. However, efforts to achieve deep learning often face a fundamental limitation: the limited cognitive capacity of humans. In the context of mathematics learning in Islamic universities, this challenge becomes even more complex when students have to manage a high academic workload alongside spiritual activities and character building in a dormitory environment. To realize effective learning within these limitations, a transformation of the learning paradigm is needed that is not only ambitious in its targets but also realistic in terms of students' cognitive capacity (Mystakidis, 2021).

In line with these needs, learning policies are expected to not only emphasize cognitive aspects, but also foster meaningful, mindful, and joyful learning experiences in accordance with the deep learning framework. The application of this approach has been proven to increase students' cognitive, emotional, and affective engagement (Feriyanto & Anjariyah, 2024). By promoting 3M, education is no longer limited to the academic sphere, but also encompasses character building and self-awareness.

In realizing deep learning, there are key components that must be considered, namely the process, application, reflection, and implementation of Outcome Based Education (OBE). In this approach, learning activities do not only focus on delivering material, but also on how students experience, apply, and reflect on the knowledge they have acquired. Practical experience helps students understand the relevance of knowledge to real life, while reflection facilitates their evaluation and deepening of understanding of their learning experiences. The OBE framework ensures a learning sequence from planning, methods, to evaluation that is aimed at achieving clear and measurable learning outcomes (Hasibuan & Harahap, 2024). Thus, students do not merely attend classes but genuinely grow in their learning abilities and awareness (Chotimah et al., 2025).

In this context, the role of lecturers as learning facilitators is greatly needed. Lecturers are not the sole source of knowledge, but rather accompany and guide the learning process to make it more active and reflective. Lecturers need to have an open mindset towards innovation, be able to utilize technology and interactive media, and apply active pedagogical approaches such as project-based learning, problem-based learning, and flipped classrooms. Strong mastery of the material is essential for lecturers to facilitate in-depth discussions, while varied learning strategies help students engage actively. In Islamic education, it is also necessary to be able to integrate spiritual values into the academic process, so that learning is not only intellectually intelligent, but also character-building and ethical (Suyadi, 2022).

With this foundation, deep learning based on the 3M policy and OBE approach has great potential to transform the academic culture in Islamic universities. Learning not only produces academically competent graduates, but also shapes individuals who are reflective, have integrity, and possess spiritual awareness. Thus, Islamic higher education can become a space for the birth of a generation that not only thinks critically, but also acts with values and wisdom.

However, these high expectations cannot be realized instantly, mainly due to the limitations of the cognitive load that students can accept. Working memory capacity is limited, both in terms of quantity and duration when receiving new information (Schnotz & Kürschner, 2007). Kirschner (2002) explains that working memory can only receive two to three units of information at a time, with part of its capacity used to organize and process information. Unlike long-term memory, which is unlimited and permanent, new information can only be stored in it with the help of schemata, which are knowledge structures built based on the context of the use of that knowledge (Chi et al., 1981). This concept is the basis for the emergence of cognitive load theory.

Cognitive load theory focuses on the relationship between the structure of information received and the cognitive structure of the brain (Paas et al., 2003). Cognitive load theory aims to reduce working memory load so that it does not become excessive, and to assist in forming schemas for long-term memory (Sari et al., 2024). In general, this theory identifies three types of cognitive load, namely intrinsic cognitive load, extrinsic cognitive load, and germane cognitive load (Richardo & Aksen Cahdriyana, 2021). (1) Intrinsic cognitive load is determined by the level of difficulty of the material being studied. This load cannot be manipulated and is therefore fixed. (2) Extrinsic cognitive load is related to the learning activities being carried out. Effective learning procedures and delivery can help the brain process information better. This load is dynamic and can be manipulated. (3) Constructive cognitive load is the memory energy used to create schemas and knowledge structures by connecting concepts so that they can be understood well (Sari et al., 2025).

In the context of mathematics, this theory is very important to learn and apply, given that mathematics is often considered a difficult subject. Learning mathematics requires high cognitive load. This is due to the abstract, structured, and rigid nature of mathematics (Sari et al., 2025). Mastery of new concepts is highly dependent on understanding previous concepts. The large number of symbols, procedures, and relationships between concepts in mathematics make the process of learning mathematics intrinsically demanding (Bina & Lubis, 2025). Without good learning design, students will experience cognitive overload (Rahmawati et al., 2024).

When teaching methods do not match students' cognitive capacity, especially for difficult and abstract material, the consequences can be fatal. Expository learning, with minimal scaffolding or no step-by-step breakdown, tends to increase extraneous cognitive load, so that the cognitive load exceeds working memory capacity. As a result, students are often unable to process further knowledge, experience confusion, mental fatigue, or even a decline in learning motivation (Gkintoni et al., 2025). Mathematical material that contains symbols, abstractions, and complex logical structures tends to have a high intrinsic load. In such situations, if teaching strategies are not adapted, students are prone to cognitive overload that hinders understanding (Gupta & Zheng, 2020). The combination of heavy mathematical material and less adaptive pedagogy can lead to shallow learning outcomes, an inability to connect concepts, and even a tendency to drop out or experience academic stress.

UIN Maulana Malik Ibrahim Malang is a campus that implements a boarding school or ma'had system for first-year students. Boarding school life is characterized by routines that are rich in spiritual values and character building, such as nightly ta'lim, afternoon PKPBA activities, congregational prayers, and academic obligations during the day. These activities have high personality-building value in the context of integrative Islamic education. However, the heavy non-academic workload has the potential to drain mental energy and recovery time (resting cognitive capacity), leaving limited space for students to study, especially mathematics students, optimally. Research on the effects of the dormitory environment shows that living in a dormitory can cause psychological stress, sleep disturbances, and social burdens that negatively impact academic performance (Braim et al., 2023). In the context of Islamic education, dormitory-based coaching or guidance is viewed positively for improving religious attitudes and discipline. However, these benefits are only effective if a balance between religious, academic, and cognitive recovery activities is well maintained (Marzuki, 2024). If this balance is not maintained, students will face multiple burdens: living in a dormitory with a busy schedule and dual spiritual-academic demands, while also studying difficult mathematics material. This certainly requires the support of appropriate learning strategies.

The purpose of this study is to explore the cognitive load experienced by first-semester Mathematics Education students in mathematics learning and to identify the learning strategies they need. Understanding the cognitive load and learning strategies desired by students is important considering that first-semester students face a double challenge, namely adapting to more complex college mathematics material while adjusting to dormitory life with a busy schedule of academic and non-academic activities. By knowing the cognitive load profile of students, lecturers can design learning strategies that are more suited to the capacity and context of students' lives.

B. METHODS

The research was conducted using a quantitative approach to reveal the cognitive load of students. The research was conducted on 54 first-semester mathematics education students at UIN Maulana Malik Ibrahim Malang in early October 2025. Data collection from students was conducted using a semi-structured guided questionnaire. Data collection on students' cognitive load included the following aspects: 1) Intrinsic load: The level of difficulty and thinking required to understand mathematical concepts, 2) Extraneous load: The burden caused by teaching methods and the learning environment, 3) Emotional load: Feelings of anxiety, fear of making mistakes, and fatigue. 4) Time and task load: The amount of tasks and time pressure. 5) Resource load: Parental support that helps manage cognitive load. Data analysis was performed using descriptive statistics to describe the cognitive load on students as a whole.

C. RESULT & DISCUSSION

This section presents the results of data analysis obtained during the research. The instrument used was a questionnaire containing 20 items covering five aspects, namely intrinsic load, extraneous load, emotional load, time and task load, and resource load with a Cronbach's alpha reliability value in the good category of 0.761. Each questionnaire item was adapted and modified from existing instruments, with adjustments to the research subject context. In addition, the quality of the instruments used to measure cognitive load was also assessed using the Rasch model approach. This model was used because it was suitable for the large number of respondents, ranging from 50 to 100 respondents, which is classified as moderate minimum according to Bond & Fox (2007). The scale used is a polytomous scale, namely a 1-5 scale. This scale was chosen because it can increase the accuracy of measurement and the discovery of diagnostic information that is not usually found in dichotomous scoring (Saepuzaman et al., 2021).

The analysis results show that the person reliability value is 0.873 and the item reliability is 0.923. These results indicate that most of the questionnaire items are considered feasible in measuring cognitive load based on the infit/outfit values. However, there are still five questionnaire items in the misfit category that need to be improved in terms of language or context. More details regarding the analysis of each aspect: the intrinsic load aspect contains ambiguous statements and two focuses; extraneous load states that the teaching method is unclear, resulting in varied interpretations by respondents; responses to the emotional aspect are quite extreme (anxiety), causing extreme response patterns; conditions that are often influenced by external factors in terms of tasks and schedules cause unstable perceptions. The aspect of parental support was interpreted very differently among respondents. These interpretation results were obtained from direct confirmation using interview techniques with respondents through dialogue in the classroom, so that the opinions of one student were supplemented by those of other students. The aspects of emotional load and time and task load showed items with the most extreme response variants. This was due to the subjectivity of each individual, as these aspects were quite sensitive for respondents. Several shortcomings need to be addressed in the future to avoid ambiguity, clarify the relevant context, use neutral language, and focus on individual perceptions.

Table 1. . Cognitive Load Category with Interval Width Formula

No	Scale	Category	Meaning
1.	25-50%	Low	Low cognitive load
2.	51-75%	Moderate	Controlled load
3.	>75%	High	High load

Before interpreting the research results, it is necessary to first understand the cognitive load categorization system used. This study uses the interval width method to classify the cognitive load levels of students into three categories based on the percentage of scores obtained. The low category (25-50%) indicates minimal cognitive load, where students do not experience significant difficulties in the aspects of learning measured. The moderate category (51-75%) indicates a controlled cognitive load, meaning that students experience challenges but are still within the limits of their working memory capacity. Meanwhile, the high category (>75%) indicates a significant cognitive load, which can be positive (such as resource support) or negative (excessive load that interferes with learning).

This categorization refers to Cognitive Load Theory developed by Sweller and his colleagues. According to this theory, cognitive load needs to be measured and categorized so that we can understand how much capacity students have in processing information (Paas et al., 2003). Leppink et al. (2013) have even developed a special instrument that distinguishes three types of cognitive load and provides a reference point for interpreting the results. This helps researchers and education practitioners identify which aspects need improvement in learning design.

In the context of mathematics learning, this categorization is very important because mathematics has abstract and structured characteristics. Richardo & Cahdriyana (2021) explain that strategies to minimize external cognitive load in mathematics learning must be based on a clear understanding of the level of load experienced by students. The moderate category (51-75%) is generally considered the optimal learning zone, where students experience enough challenges to encourage deep learning (germane cognitive load) without experiencing cognitive overload that can hinder understanding (Schnotz & Kürschner, 2007).

Table 2. Results from The Collected Data

No	Aspect	Percentage	Category
1.	Intrinsic Load	50.1	Moderate
2.	Extraneous Load	47.8	Low
3.	Emotional Load	53	Moderate
4.	Time and Task Load	72	Moderate
5.	Resource Load	80.3	High

Based on the established categorization, the results of the study show that first-semester students of the Mathematics Education Study Program at UIN Maulana Malik Ibrahim Malang experience varying cognitive loads in various aspects of learning. From the intrinsic load aspect, a percentage of 50.1% was obtained, which is included in the moderate category. This finding indicates that the level of difficulty of the mathematics material studied is still manageable, where understanding concepts is sometimes difficult and sometimes easy. This is in line with research of Gupta & Zheng (2020) which states that intrinsic cognitive load in mathematics learning is highly dependent on the complexity of the material and the students' prior knowledge. When students have a sufficiently good foundation, they can process more complex material more efficiently.

In terms of extraneous load, the results show a low percentage of 47.8%. This is a positive indicator that the lecturers' teaching methods and the learning environment sufficiently support the students' learning process. Low extraneous load indicates that the delivery of material does not add unnecessary burden to students. Research by Sari et al. (2024) emphasizes that reducing extraneous load can be achieved through structured learning strategies, the use of appropriate media, and the presentation of clear and systematic information. This finding is also supported by Rahmawati et al. (2024) who state that the application of cognitive load theory in mathematics teaching can reduce unnecessary burdens through good learning design.

The next aspect that is taken into account in cognitive load theory is emotional load. Sunawan et al. (2017) explains that emotional load affects all aspects of cognitive load. Brockbank & Feldon (2024) agree that emotions and cognition dynamically influence each other. In the instrument created, the higher the emotional load score, the heavier and more detrimental it is to the learning process. The score obtained during the field research was 53% and was in the moderate category. The emotions of learning experienced by students can still be controlled. However, at certain moments, these emotions cannot be held back and are eventually vented elsewhere. This can interfere with focus while studying.

Another thing that cannot be separated from learning is the matter of study time and existing assignments. The score obtained in this aspect was 72% and was in the moderate category. This burden is quite felt by students, so that sometimes the existing assignments cannot be completed optimally. Deng & Wang (2022) argue that the heavy workload and limited time force students to multitask, which is not effective for learning. However, this burden can still be managed by students. The final factor is resource load. It cannot be denied that social and family support greatly impact the learning process. Fang et al. (2020) dan Sujarwo & Herwin (2023) state that family support is directly proportional to student achievement. The score obtained in this aspect is 80.3% and is in the high category. Thus, this is not a problem in the learning process.

D. CONCLUSION

Based on the results of a study of 54 first-semester Mathematics Education students at UIN Maulana Malik Ibrahim Malang, it can be concluded that the cognitive load profile of students shows a relatively balanced condition, but there are several things that need attention. Intrinsic load is in the moderate category (50.1%), indicating that the level of difficulty of mathematics material is still within the limits that students can manage. Extraneous load is classified as low (47.8%), indicating that the teaching methods of lecturers and the learning environment are sufficient to support the learning process. The students' emotional load is in the moderate category (53%), indicating that students can still control their learning emotions even though they occasionally experience anxiety when facing mathematics material. Meanwhile, the time and task load showed a fairly high figure (72%), although it was still in the moderate category but close to the upper limit. This condition needs special attention because it has the potential to affect the quality of learning if it continues to increase.

On the other hand, a very positive finding is the high level of social and family support (resource load 80.3%), which is a protective factor for students in facing various academic challenges. Overall, first-semester Mathematics Education students are able to manage their cognitive load quite well, supported by an effective learning system and strong environmental support. However, challenges in time management and workload need attention, especially considering that students also have busy dormitory activities. These findings contribute to the development of Cognitive Load Theory in the context of Islamic education through the integration of emotional, temporal, and social support dimensions, and offer a Rasch model-based measurement instrument that can be adapted to similar settings.

Based on these findings, researchers recommend the development of adaptive teaching strategies based on Outcome-Based Education (OBE) that are appropriate for the actual conditions of Islamic campuses. These recommendations cover several important aspects: first, the arrangement of coursework that takes into account students' cognitive capacities and dormitory activity schedules; second, the development of more flexible and varied learning interaction models; third, the strengthening of feedback mechanisms during learning so that students can monitor their learning progress; and fourth, the provision of academic support strategies that can be integrated with the schedule and routine of the ma'had.

For further research, several things are recommended. First, research with a larger sample size and covering students from various batches is needed in order to provide a more comprehensive picture of the cognitive load of Mathematics Education students. Second, further research using a qualitative approach is needed to explore in greater depth the subjective experiences of students in managing their cognitive load, particularly in relation to the learning strategies they use and the specific challenges they face in dormitory life. A qualitative approach can also reveal students' emotional and social experiences that are not visible from quantitative data, thereby providing a deeper understanding of how mathematics learning takes place on an Islamic campus that combines academic and spiritual aspects.

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