Measuring the Cognitive Workload of Working Adult Students in Batam's Higher Education Institutions: A NASA-TLX Approach

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ABSTRACT

This study addresses the cognitive workload challenges faced by working adult students in Batam's higher education institutions, utilising the NASA Task Load Index (NASA-TLX) methodology. Data were collected from 157 part-time students across ten universities through a cross-sectional design and convenience sampling. Results indicate that time constraints and academic effort contribute significantly to mental workload, with an average Weighted Workload (WWL) score of 68, signifying a high level of cognitive burden. Strategies for workload reduction include enhanced academic support, effective time management, and prioritising mental well-being. This research underscores the imperative of collaborative efforts among universities, instructors, and students to cultivate an environment conducive to academic success and well-being for working adult learners.

I. Introduction

The surge in demand for higher education has given rise to the emergence of non-traditional student cohorts, notably working adults who endeavour to pursue their education while skillfully balancing the demands of work and familial responsibilities (Cho & Purtell, 2019; Zolotina & Serpukhova, 2020). These students often grapple with distinctive challenges (Kasworm, 2020), encompassing time constraints, financial pressures, and heightened stress levels, all of which can profoundly affect their academic performance and overall well-being. A prominent contributor to these challenges is the substantial cognitive workload associated with managing multiple roles and responsibilities.

In response to this challenge, this study is designed to apply the NASA Task Load Index (NASA-TLX) method for gauging the mental workload experienced by working adult students in Batam's higher education institutions. The NASA Task Load Index (NASA-TLX), initially developed by the National Aeronautics and Space Administration (NASA), serves as a valuable tool for workload assessment in intricate operational contexts, including the aviation industry (Febrilliandika & Efendi Nasution, 2020; Mustika Ari & Susanto, 2022). This method amalgamates several subjective dimensions, encompassing the mental, physical, and temporal facets associated with task execution (Pradhana & Suliantoro, 2018). The methodology integrates rating scales and interviews to delve into individuals' perceptions of their workload.

This research endeavour is directed toward identifying factors contributing to the cognitive workload of working adult students in Batam's higher education institutions and providing recommendations for its management and mitigation. This encompasses evaluating their cognitive workload employing the NASA-TLX method, identifying pertinent contributing factors, and proposing strategies to alleviate this workload.

To fulfil these objectives, the study will extensively review the literature concerning cognitive workload and its ramifications on academic performance and overall well-being. Additionally, it will underscore a notable research gap within the existing body of literature, namely the absence of inquiries into the cognitive workload experienced by working adult students within Batam's higher education institutions. The outcomes of this study are anticipated to significantly enhance our understanding

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of the mental workload encountered by working adult students within Batam's higher education institutions and to furnish actionable recommendations for its effective management and alleviation.

II. Method

A. *Study Design*

This study employed a cross-sectional design to assess part-time students' mental workload at Batam University. It aimed to collect data through the completion of paired comparison questionnaires and rating indicator questionnaires. Students were asked to mark the indicator they believed to have a more significant influence on their mental workload. The questionnaire, presented as paired comparisons, consists of 15 comparisons. Subsequently, the number of selections for each indicator is calculated, which will be used as weights for each mental workload indicator.

B. *Participants*

This study's participants are part-time students enrolled at ten universities in Batam City. The inclusion criteria for participants were that they were part-time students currently enrolled at the university. Participants were recruited through convenience sampling.

C. *Data Collection Instruments*

1) *Paired Comparison Questionnaire*

The paired comparison questionnaire consisted of a table comparing different indicators related to mental workload (Table 1).

Table 1. Paired Comparison of Indicators

Indicator	vs	Indicator
Mental Needs (MN)		Physical Needs (PN)
Mental Needs (MN)		Time Needs (TN)
Mental Needs (MN)		Work Performance (WP)
Mental Needs (MN)		Effort (E)
Mental Needs (MN)		Frustration Levels (FL)
Physical Needs (PN)		Time Needs (TN)
Physical Needs (PN)		Work Performance (WP)
Physical Needs (PN)		Effort (E)
Physical Needs (PN)		Frustration Levels (FL)
Time Needs (TN)		Work Performance (WP)
Time Needs (TN)		Effort (E)
Time Needs (TN)		Frustration Levels (FL)
Work Performance (WP)		Effort (E)
Work Performance (WP)		Frustration Levels (FL)
Effort (E)		Frustration Levels (FL)

Participants were asked to compare each pair of indicators and indicate which one they perceived as having a higher level of workload. The indicators included in the questionnaire were determined based on a review of relevant literature and expert opinions.

2) *Rating Indicator Questionnaire*

The rating indicator questionnaire involved rating each indicator on a scale of 1 to 100 as shown in Table 2, with 1 indicating a low workload level and 100 indicating a high workload. Participants were asked to rate each indicator based on their experiences and perceptions.

Table 2. Indicator Rating Questionnaire

Indicator	Question
Mental Needs (MN)	How significant are the demands for mental/cognitive and perceptual activities, such as thinking, decision-making, calculating, remembering, seeing, and analysing, during your participation in the academic process?
Physical Needs (PN)	How substantial are the physical activities required in your role as a part-time student (e.g., walking, lifting and carrying course materials, lab activities, group discussions or presentations, fieldwork, and other activities)?
Time Needs (TN)	How much time pressure do you feel while studying as a part-time student?
Work Performance (WP)	To what extent are you satisfied with your success in completing coursework as a part-time student?
Effort (E)	How much mental and physical effort do you expend to achieve your performance/academic level?
Frustration Level (FL)	How much insecurity, frustration, offence, and stress do you experience during your part-time studies?

Rating Legend:
0 – 20: Very Low
21 – 40: Low
41 – 60: Moderate
61 – 80: High
81 – 100: Very High

D. *Data Collection Procedure*

The data collection procedure involved distributing the paired comparison and rating indicator questionnaires to the participants. The questionnaires were administered in a classroom setting during a designated period. Participants were provided with clear instructions on how to complete the questionnaires and were given sufficient time to do so.

E. *Data analysis*

The data collected from the questionnaires were analysed using descriptive statistics. The paired comparison data were analysed to determine the frequency of participants selecting each indicator as having a higher workload level. The rating indicator data were analysed to calculate the mean rating for each indicator.

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F. *Ethical Considerations*

Ethical approval for this study was obtained from the relevant institutional review board. Participants were informed about the purpose of the study and their rights as participants. They were assured of the confidentiality and anonymity of their responses. Participation in the survey was voluntary, and participants were allowed to withdraw at any time without any consequences.

III. Results and Discussion

A. *Data Collection*

Data were collected by 157 part-time university students in the city of Batam, who completed paired comparison questionnaires and indicator rating questionnaires. The participating universities included Institut Teknologi Batam, Universitas Ibnu Sina, Universitas Riau Kepulauan, Universitas Batam, Sekolah Tinggi Teknologi Indonesia, STIE Galileo, STAI Ibnu Sina, Universal University, Universitas Internasional Batam, and Universitas Putera Batam. Respondent profiles can be seen in Figure 1 and Figure 2.

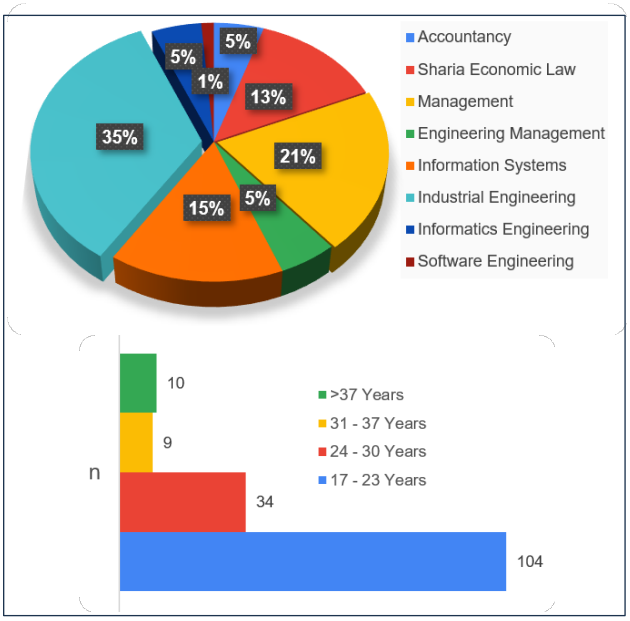

Fig. 1. Respondents according to their principal study and ages.

Profiling different majors or study programs offers a deeper insight into the potential variations in mental workload based on factors (Prastawa et al., 2018) such as subjects, program structures, and teaching methods. This analysis can be valuable in pinpointing the specific elements contributing to the mental workload that might be unique to each study program (Galy et al., 2017). Furthermore, it is essential to acknowledge that younger and older part-time students may have distinct support requirements. Younger students may necessitate more academic assistance, while older students may need to make adjustments in their time management due to family responsibilities (Tamulienė, 2014). Additionally, the semester in which students are enrolled can serve as an indicator of their academic progression. For instance, students in earlier semesters may have different experiences in managing mental workload compared to those in later semesters (Neklyudova & Verbnaya, 2020). Therefore, comprehending the semester-based profile can help one recognise how the perception of mental workload evolves.

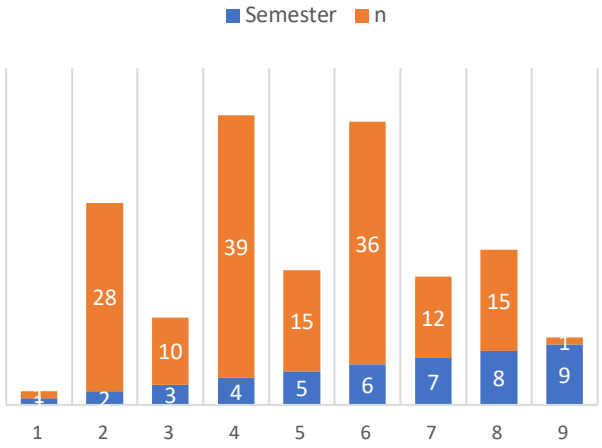

Fig. 2. The number of student respondents based on their current semester status

B. *Paired Comparison Results*

1) Weighting Data

Students were tasked with selecting one indicator from each of the previously explained pairs of indicators. They were instructed to mark the indicator they believed to have a more dominant influence on their mental workload. The questionnaire, presented in a paired comparison format, consisted of 15 such comparisons. Subsequently, the number of selections for each indicator was calculated, which would be used as the weight for each mental workload indicator. Based on data collected through the completion of paired comparison questionnaires by 157 part-time student respondents from 10 universities in Batam City, the results are presented in Table 3.

Table 3. Weighting Data for Part-Time Student Questionnaire

Respondent	MN	PN	TN	WP	FL	E	Total
1	2	3	3	3	1	3	15
2	5	3	3	1	0	3	15
3	3	2	2	2	3	3	15
4	1	3	4	3	0	4	15
5	2	3	3	1	4	2	15
6	2	5	3	4	0	1	15
7	3	2	3	4	0	3	15
…	…	…	…	…	…	…	…
157	5	4	3	2	0	1	15
Grand Total	374	358	545	359	275	444	

According to Table 3, the study with 157 participants found that part-time students experience the highest mental workload due to time constraints or TN (weight 545) and the effort (E) required for academic tasks (weight 444). Additionally, cognitive factors like thinking and mental stress or MN (weight 374) contribute significantly, along with high academic performance expectations or WP (weight 359) and physical comfort or PN (weight 358). Surprisingly, frustration, dissatisfaction, or FL (weight 275) had a lesser impact. This data helps us understand the factors affecting part-time students' mental workload and can guide strategies for reducing it.

2) Rating Data

As a continuation of the weighting phase, ratings on a scale of 1-100 are assigned to each indicator based on the student's experiences. The results are shown in Table 4.

Table 4. Rating Data for Part-Time Student Questionnaire

Respondent	MN	PN	TN	WP	FL	E
1	90	90	80	80	30	70
2	60	50	50	80	50	70
3	60	70	80	60	50	50
4	50	70	80	70	60	80
5	80	70	80	70	70	80
6	80	60	90	70	60	70
7	50	60	50	80	30	80
…	…	…	…	…	…	…
157	90	90	100	90	90	90
Average	67,83	63,12	68,54	69,49	55,99	72,93

The findings suggest that part-time students face varying levels of mental workload, influenced by those multiple factors. Notably, they perceive a significant need for effort or E (indicated by the high rating of 72.93), possibly due to the challenges and pressures of fulfilling academic responsibilities. Additionally, the expectation to excel academically or WP (69.49) and the importance of having adequate time or TN (68.54) contribute substantially to their mental workload. Mental demands, including critical thinking and psychological stress or MN (67.83), also play a significant role. Physical factors, such as comfort and well-being or PN (63.12), have a comparatively lower impact. Surprisingly, frustration levels or FL (55.99) are relatively low, indicating that students manage academic tasks with less frustration. These findings highlight the complex nature of part-time students' mental workload and provide insights for developing tailored strategies to manage and reduce academic pressures effectively.

C. *Calculation of Weighted Workload (WWL)*

Calculating the Weighted Workload (WWL) is to obtain values for the mental workload of each indicator. The calculation method to determine the mental workload value is as follows:

Indicator = (Weight x Rating) / 15

MN = (2 x 90)/15 = 12
WWL = MN + PN + TN + WP + FL + E
WWL = 12 + 18 + 16 + 16 + 2 + 14 = 78

Table 5 provides a summary of the WWL calculations. The WWL scores indicate the mental workload of each student to generate mental workload scores based on the NASA-TLX. To calculate these scores, the weights and ratings of each indicator are multiplied, then divided by 15, and subsequently summed with the other indicators. The results show that the WWL score for the first respondent is 78, for the second respondent is 59, and for the third respondent is 60, as detailed in Table 5. Furthermore, the average WWL score across all 157 respondents is 68, falling within the range of 61 to 80, indicating a high level of mental workload.

Table 5. Weighted Workload (WWL) Value Calculation

Respondent	MN	PN	TN	WP	FL	E	Total
1	12	18	16	16	2	14	78
2	20	10	10	5	0	14	59
3	12	9	11	8	10	10	60
4	3	14	21	14	0	21	74
5	11	14	16	5	19	11	75
6	11	20	18	19	0	5	72
7	10	8	10	21	0	16	65
…	…	…	…	…	…	…	…
157	30	24	20	12	0	6	92
				Average WWL Value			68

The average WWL score of 68, as shown in Table 5, categorised as a high mental workload, suggests that the majority of the 157 respondents experience a significant level of cognitive workload in their academic activities. Part-time students in this research context face substantial challenges and pressures in managing their educational tasks. While W. Cheng et al. (Cheng et al., 2023) the study does not mention those specific factors. However, it does imply that the additional demands of part-time work can contribute to psychological distress among students, which indirectly aligns with the notion of high academic performance expectations and the need for comfort to balance these demands.

A high mental workload can impact students' mental well-being and academic performance (Hidayati & Basyari, 2024) (Syahid et al., 2023). Therefore, universities and students need to take appropriate steps in managing and reducing this mental workload. This could include better time management strategies, psychological support, or the development of coping skills to deal with potential stress during their studies. Strategies to mitigate the high levels of mental workload, as revealed by research findings (Longo & Orrú, 2020; Lytras et al., 2022), can involve multiple stakeholders, including universities, instructors, and students. These strategies encompass a multifaceted approach to fostering a more conducive academic environment.

One crucial aspect revolves around providing robust academic support. Universities can extend their academic support resources by enhancing counselling services, offering comprehensive academic guidance, and imparting specialised training in effective time management (Carr & London, 2017). On the other hand, instructors play a pivotal role in offering clear directives and support for task management, including constructive feedback and additional guidance as required. Meanwhile, students are encouraged to proactively seek academic assistance and counselling if they find themselves grappling with an excessive mental workload (El-Hachem et al., 2023). They can also form study groups or discuss with peers to create a supportive academic community.

Effective time management is another key facet of these strategies. Universities can conduct workshops and offer guidance on efficient study planning to help students optimise their schedules (Zhang et al., 2017). Instructors can further aid students by assisting them in creating well-structured task and project timelines, prioritising assignments, and discouraging procrastination (Pereira & Díaz, 2021) (Bora et al., 2024). Students are urged to employ effective time management techniques, such as devising daily or weekly schedules, identifying task priorities, and avoiding undue delays (Trentepohl et al., 2022) (Ahmad Uzir et al., 2020). Furthermore, the provision of comfortable and conducive study facilities and environments is crucial (Xu et al., 2022). Universities should ensure that their learning facilities, such as libraries and study rooms, are comfortable and well-suited to students' needs. Instructors can recommend suitable study environments to their students, taking into account their individual preferences and requirements (Valtonen et al., 2021). Meanwhile, students should actively seek out comfortable and distraction-free study spaces that promote efficient learning (Schmidt, 2020).

Promoting mental well-being is equally important, with universities tasked with raising awareness and implementing programs that bolster student mental health (Campbell et al., 2022). Instructors should be equipped to recognise signs of stress or mental workload in their students and provide appropriate referrals to support resources. Students, in turn, are advised to strike a balance between their academic commitments and personal lives, ensuring they receive adequate rest, engage in physical activity, and seek support when overwhelming feelings arise (Fauziah & Hanami, 2024) (Picton, 2021).

Finally, maintaining a system of regular evaluation and review is vital to the success of these strategies. Universities should conduct routine assessments of their implemented programs designed to alleviate mental workload (Kong & Yuen, 2022) (Idris et al., 2021). Notably, both instructors and students should actively participate in this process by providing feedback on the strategies' effectiveness. This iterative approach allows for continuous improvement and ensures that the academic environment supports student mental well-being (Simonsmeier et al., 2020) (Bell et al., 2024) (Yang et al., 2021). Ultimately, the successful implementation of these strategies hinges on collaboration between universities, instructors, and students (Awasthy et al., 2020), working together to create an environment that prioritises the mental health and academic success of all involved.

IV. Conclusion

This study has provided valuable insights into the cognitive workload experienced by working adult students in Batam's higher education institutions. With 157 participants from 10 universities, we observed that time needs (TN) and academic effort (E) were the most prominent contributors, each receiving weights of 545 and 444, respectively. These findings underscore the significant challenges part-time students face in managing their academic responsibilities. However, it's important to acknowledge the limitation of convenience sampling, which may not fully represent the diversity of the working adult student population. A more diverse and extensive sample could be employed for a more comprehensive understanding of future research. Additionally, exploring tailored interventions and support systems, such as targeted time management workshops and mental health resources, would be crucial in alleviating the high cognitive workload faced by these students. By addressing these challenges, we can create a more inclusive and supportive learning environment that empowers working adult students to thrive academically and personally.

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