Mental Load Index (MLI) User Study Report

1. Study Goal

The goal of this study is to determine how well users can interact with the Mental Load Index (MLI) dashboard, find out how clear the visualizations are, and its usefulness in scheduling academic and personal tasks.

2. Prototype:
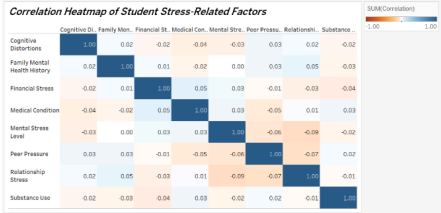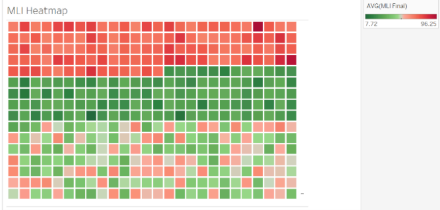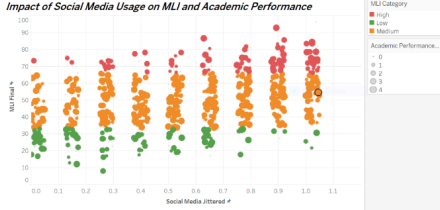
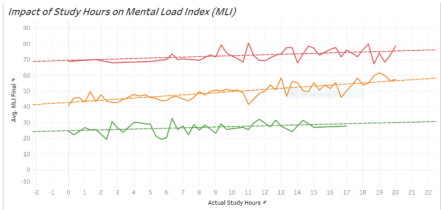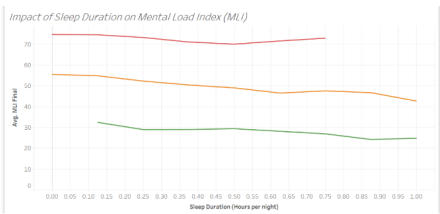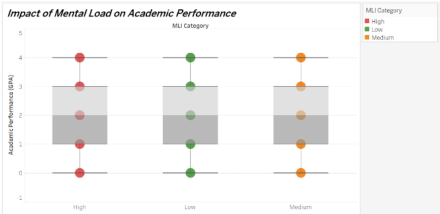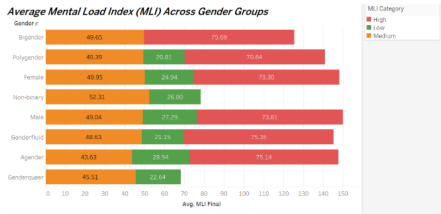## 3. Participant Background

Participant	Age	Gender	Education Level	Field of Study	Viz Tool Experience	Color Vision Issues
P1	27	Male	Master's	Data Science	High (familiar with heatmaps, correlations)	No
P2	24	Male	Bachelor's	Computer Science	Low (struggled with scatter plots)	No
P3	31	Male	Master's	Computer Science	High (comfortable with dashboards)	No
P4	24	Female	Bachelor's	Business Administration	Medium (basic chart reading skills)	No

4. The user test was conducted in person, by giving my personal screens to view participant use of the dashboard in real time. Sessions were conducted one-on-one, with participants using my own 13-inch laptops with a 1920×1080 pixels screen resolution.

Before starting the exercises, the participants were treated to a 2-minute walkthrough of the dashboard. This walk-through explained the purpose and structure of every visualization, including how to interpret and interact with the charts.

The following training script was read aloud and also shown on-screen:

> "This dashboard's goal is to allow students to understand their mental load (MLI) using lifestyle and educational factors like sleeping, studying time, screen usage, and the level of stress. We are going to go through each visualization: The MLI Heatmap

shows variation in mental load with time, with the intensity of the color representing severity. The Line Charts present trends between factors like study time or sleeping time and levels of MLI. Correlation Heatmap reveals the strength of relationships between various stressors. The Scatter Plots compare variables like social media usage to MLI and academic performance. Each chart includes color-coded MLI categories (low, medium, high) for consistency. Feel free to ask questions. You'll soon complete tasks using these charts independently."

We asked participants to use the think-aloud technique, whereby they spoke aloud their thoughts and reasoning as they completed each task. This method provided us with great insight into their decision-making and usability problems. Prior to starting, all the participants gave their informed consent to be recorded on their screen and audio for research. Each session lasted approximately 45 minutes, including the walkthrough, task completion, and post-task interview.

5. Tasks Given

- **Task 1**: Use the MLI Heatmap to identify high MLI scores

  Follow-up: "What do you think is causing these very high values?"

- **Task 2**: Choose two lifestyle factors that have the strongest positive correlation according to the Correlation Heatmap.

  Follow-up: "What does this correlation suggest about the mental load of students?"

6. Post-Interview Questions

1. How intuitive was the MLI Heatmap and color coding to read? (1–5 scale)
2. How clear were the general chart labels and legends? (1–5 scale)
3. How helpful would you consider a dashboard like this to be in planning your academic or personal schedule? (1–5 scale)
4. On a scale of 1–5, what would you rate as the general clarity of the prototype? Why?
5. Which graph would you show a friend if you needed to explain the MLI concept to them, and why?
6. Were there any graphical aspects that made the data clearer?
7. What was unclear or confusing, if anything?
8. Did any of the graphs reveal something surprising?

7. Study Findings

The user test demonstrated that the general participants found the MLI heatmap effective in expressing mental load levels through its green-to-red color gradient. However, most interviewees reported that there were no axis labels and interactive elements like tooltips,

reducing interpretation to become less intuitive, especially for new users. The high MLI scores were associated with poor sleep, long study hours, heavy use of social media, and psychological stressors such as cognitive distortions and peer pressure.

When asked to comment on the correlation heatmap, all four participants pointed out strong positive relationships between mental stress and cognitive distortions, further confirming the argument that psychological state is crucial for student well-being. While certain graphs like the sleep and study hour graphs were praised for being easy to understand and relate to, Participants struggled with interpreting the scatter plots due to overplotting and jitter, reflecting challenges identified in previous visualization research (Ridley, A. L., & Birchall, C. 45-60). A frequent unexpected discovery were students with high MLI who still had good academic performance, implicating the influence of unmeasured factors like resilience or effective coping skills.

8. Planned Improvements

Based on the feedback, several changes will be made for improvement in usability and functionality of the dashboard especially when users vary in data visualization literacy (Alyxander Burns & Cindy Xiong). Axis labels and value units will be added to charts. Specifically, the heatmap and scatter plots will have axis labels and units of value. Tooltips will also be added to graphs to provide correct values and descriptions upon hovering, which will allow users to better understand the data. The scatter plot will be adjusted to reduce visual noise, possibly by adjusting the jittering or converting to some other type of chart like a bubble chart or groupings of bars.

9. Reflections

This user research highlighted the demand for dashboards that are both visually informative and cognitively accessible, aligning with usability principles outlined by (Bahareh Ansari).While the current prototype was appreciated for its visual presentation and relevant data, the experience revealed places of ambiguity and confusion particularly for less experienced users of visual data. Users saw clear value in using the dashboard to plan and reflect on their academic and personal routines but emphasized the need for clearer explanations and more actionable data.

Works Cited

Alyxander Burns & Cindy Xiong. "How to evaluate data visualizations across different levels of

understanding." *How to evaluate data visualizations across different levels of*

understanding. https://arxiv.org/abs/2009.01747.

Bahareh Ansari. "Evaluating the usability of public health data dashboards as information sources for professionals and the public: Findings from a case study with domain experts." *Evaluating the usability of public health data dashboards as information sources for professionals and the public: Findings from a case study with domain experts*, https://pubmed.ncbi.nlm.nih.gov/38717119/.

Ridley, A. L., & Birchall, C. "Evaluating data visualization: Broadening the measurements of success." *Evaluating data visualization: Broadening the measurements of success*. https://eprints.whiterose.ac.uk/id/eprint/219436/1/Ridley-Evaluatingdatavisualization-2020.pdf.

Acknowledgement:

ChatGPT was used to improve sentence flow and correct grammar throughout the report.

Appendix

Appendix A: Participant Background Questions

- **Age:**
- **Current level of education:**
- **Do you experience any difficulty distinguishing colors (e.g., color blindness)?** (Yes / No)
- **Have you used data visualization tools like Tableau, Power BI, or Google Data Studio before?** (Yes / No)
- **Rate your familiarity with the following chart types (1 = Not familiar, 5 = Very familiar):**

  - Line Chart

  - Bar Chart

  - Scatter Plot

  - Heatmap

  - Correlation Heatmap

- **How confident do you feel interpreting colored graphs with legends?**
  (1–5 scale, 1 = Not confident, 5 = Very confident)

Training Material (Script)

"This dashboard's goal is to allow students to understand their mental load (MLI) using lifestyle and educational factors like sleeping, studying time, screen usage, and the level of stress. We are going to go through each visualization: The MLI Heatmap shows variation in mental load with time, with the intensity of the color representing severity. The Line Charts present trends between factors like study time or sleeping time and levels of MLI. Correlation Heatmap reveals the strength of relationships between various stressors. The Scatter Plots compare variables like social media usage to MLI and academic performance. Each chart includes color-coded MLI categories (low, medium, high) for consistency. Feel free to ask questions. You'll soon complete tasks using these charts independently."

Appendix B: Tasks Given

Task 1: Use the MLI Heatmap to identify high MLI scores.
 Follow-up: "What do you think is causing these very high values?"

Task 2: Choose two lifestyle factors with the strongest positive correlation according to the Correlation Heatmap.
 Follow-up: "What does this correlation suggest about the mental load of students?"

Appendix C: Post-Interview Questions

1. How intuitive was the MLI Heatmap and color coding to read? (1–5 scale)
2. How clear were the general chart labels and legends? (1–5 scale)
3. How helpful would you consider a dashboard like this to be in planning your academic or personal schedule? (1–5 scale)
4. On a scale of 1–5, what would you rate as the general clarity of the prototype? Why?
5. Which graph would you show a friend if you needed to explain the MLI concept to them, and why?
6. Were there any graphical aspects that made the data clearer?
7. What was unclear or confusing, if anything?
8. Did any of the graphs reveal something surprising?

Appendix D: Participant Responses (Summarized)

Participant P1

- **Task 1 Response:** High MLI due to poor sleep and high study hours.

- **Task 2 Response:** Mental stress and cognitive distortions are highly correlated.

- **Ratings:** Heatmap clarity – 4, Chart clarity – 4, Dashboard helpfulness – 5, Prototype clarity – 4

- **Comments:** Liked the sleep vs. MLI graph. Suggested tooltips and axis labels. Surprised some high MLI students performed well.

Participant P2

- **Task 1 Response:** Attributed high MLI to family stress and peer pressure.

- **Task 2 Response:** Mental stress correlated with family issues and cognitive distortions.

- **Ratings:** Heatmap – 3, Chart clarity – 4, Dashboard helpfulness – 3, Prototype clarity – 3

- **Comments:** Liked study hours graph. Found scatterplot cluttered. Requested resilience metric.

Participant P3

- **Task 1 Response:** High MLI from social media and overwork.

- **Task 2 Response:** Mental stress linked to financial issues and distorted thinking.

- **Ratings:** Heatmap – 2, Chart clarity – 3, Dashboard helpfulness – 4, Prototype clarity – 3

- **Comments:** Scatterplot was confusing. Appreciated clear color coding across charts.

Participant P4

- **Task 1 Response:** Combined academic overload and lack of coping.

- **Task 2 Response:** Cognitive distortions and peer pressure were top correlates.

- **Ratings:** Heatmap – 4, Chart clarity – 4, Dashboard helpfulness – 5, Prototype clarity – 4

- **Comments:** Suggested adding a coping/resilience indicator. Liked the sleep chart.