Evaluation Report: Mobile Learning Application

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This evaluation report examines a mobile learning application (MLA) designed to strengthen critical thinking skills. With the integration of learning design (LD) and user experience (UX) practices, mobile learning theory continues to evolve. Looking back on twenty years ago, Sharples, et.al., (2005) offered a theoretical framework for mobile learning design. They recognized a convergence between learning and technology. Learning had become "personalized, learner centered, situated, collaborative, ubiquitous and lifelong," while technology was also "personal, user centered, mobile, networked, ubiquitous and durable" (p. 5). Mobile devices engage the learner with interactive content and learning opportunities. A decade later, Anderson (2016) applied the learning theory of Heutagogy to better understand these emerging technologies. Anderson (2016) posited that learning is self-directed, allowing the user to learn independently. Because of the self-reliant capability that the MLA offers its user, my vision was to create a mobile learning environment that could be accessed anywhere and used unassisted.

Therefore, I created the mobile learning application (MLA) called Critical Thinking in response to a need that I observed in the busy lives of pre-med students who wanted to practice sharpening their critical analysis reading skills for the MCAT (medical school entrance test). Since their phones were readily accessible and could be used whenever convenient, a MLA appeared to be the best learning tool for this target group. Also, the just-in-time connectivity could provide opportunities for them to learn in new convenient ways (Chen, et.al., 2015). Students could practice their critical thinking skills wherever and whenever they wanted.

Design Models

I initially based my MLA on the FRAME Model (Koole, 2009). Like a Venn diagram, the Frame Model considers the intersecting relationship of the device, the learner, and the social

aspects (see Appendix A). However, once I began to further consider the user, I realized that the typical pre-medical student practicing and developing their critical thinking skills may not need or have time to interact with others. Therefore, because of the constraints of the social aspect, I eliminated this consideration when designing the application. I then decided to apply the User-Centered Design (UCD) approach and adopt the design process of "identifying the user needs, requirements gathering, prototyping and wireframing" (Earnshaw, et.al., 2017). The MLA Critical Thinking Skills was designed as a personal learning experience, more than a social learning experience.

The Mobile Learning Application

The Critical Thinking app is characterized by three sections: how to understand critical thinking, how to develop critical thinking (characteristics) and a practice menu. Since some learners may only want to practice, while others may want to review the characteristics, these sections provide choice for the learner. Other personas, a fictional type of person who would be interested in using the MLA were imagined (Earnshaw, et.al., 2017). Besides the critical analysis reasoning section, the MLA also has a section for critically reading social media for the type of persona who wants to learn how to parse real and fake information. In addition, the problem-solving skills and interviewing skills sections are for young adult personas interested in improving their life-skills.

During the creation of this MLA, classmates offered suggestions for improvement. After the first iteration of feedback, it was apparent that the complexity of the content required the user experience to be seamlessly easy. The evaluation of this app continues to strive to synchronize the learning experience (LX), user experience (UX) and the user interface (UI) into a better mobile learning application.

Instructional Design Approach

The nine events of Gagne's instructional design model were used to design the MLA along with critical thinking strategies based on the new Blooms' Taxonomy. Gagne's events (Gagne, 1965, as cited in Curry,et.al., 2021) were applied through the MLA's color and visual design to capture the user's attention. Stimulating material and opportunities for practice and feedback were also incorporated (Curry, et.al., 2021). For more details see Appendix B. Considering the new Bloom's Taxonomy, performance objectives were converted into cognitive tasks for critical thinking (Shank, 2013). These were embedded in the MLA as characteristics of critical thinking that the user would need to employ while using the MLA. Within the new Bloom's taxonomy, embedded in the dimension of understanding is the cognitive process of inferencing (Shank, 2013). For more information see Appendix C. Making inferences was used as one of the characteristics of critical thinking. In addition, the opportunity to make inferences was provided in the practice critical analysis and reading section.

Learning Theory and Reflection

Though I had hoped that the interface of the application would provide the "guidance" (Curry, et.al., 2021), an important event in Gagne's instructional design, this is where the MLA needed further evaluation for improvement. Cognitive load was also a concern. According to Faudzi, et.al., (2024) it is the UI design that affects cognitive load, and not the content, especially if there is a poor user interface. Merriënboer and Sweller (2005) conclude that the intrinsic nature of learning may be affected by the extraneous cognitive load. Critical thinking, by nature, creates a heavy intrinsic load; therefore, the extraneous nature (how the material is being presented) must be lower. As a result, I decided to focus more on the interface that guides the user than the content of the MLA.

Evaluation Methodology

Overview

The main question to answer was how can the interface of the MLA offer intuitive and easy navigation to decrease cognitive load? To answer this, the evaluation methods needed to be aligned to the MLA's interface features. A questionnaire (see Appendix D), adapted from the evaluation tool that Faudzi, et.al., (2024) was used for measuring the interface and how it affects cognitive load. This provided subjective as well as objective measures for the UI (user interface). Thus, the questionnaire served as a usability test with a combination of the LX, UX and UI approaches. In addition, the questionnaire used a Likert 9-point scale to evaluate these areas: "Content Organization, Navigation, Signaling/Cue, and Aesthetic and Minimalist Design, Visual Representation-Font and Graphics' Complexity" (Faudzi, et.al, 2024, p. 18). With a total of 31 questions, each section of the questionnaire had 3-7 questions that were written as positive or negative statements. The user must choose where they fall on the scale of degrees of agreement to disagreement. Along with the questionnaire that measured the UI of the MLA, five of the study participants engaged in a "Think Aloud" protocol which works as a type of interview (Schmidt, et.al, 2020, Sec. 4.7). The think aloud protocol was a 30-minute interview followed by the participant completing the questionnaire. The interview started with a few introductory questions. Though, the user was encouraged to move through the app intuitively and to think aloud as they made decisions or voiced confusion. Several of the participants offered suggestions throughout this process.

Participants and Process

Fifteen **i**ndividuals participated in the MLA evaluation. All participants were between the ages of 24-30. Eight of them are female and seven are male. Most of them are pre-med while one

is a medical resident. One is a nursing student and another works outside of the medical field. Twelve of them were part of a Special Masters Physiology cohort from the class of 2023-2024. The other three participants were selected for their perspectives that were outside of the pre-med cohort.

Ten pre-med school participants were invited to take part in the evaluation of the Critical Thinking MLA. An email was sent to each participant explaining the evaluation and requesting that if they chose to participate, to sign and return the consent form that was attached to the email. The email included a link to the questionnaire (see Appendix D) that was created in Microsoft Forms. Within the directions of the form was an embedded link to the MLA prototype created using the software Figma. Participants were asked to test drive the Critical Thinking app prototype and then answer the questionnaire. Participants were also asked to complete the task within two weeks. At the end of the first week, emails were sent to all the participants reminding them to complete the task and thanking those who had completed it. The questionnaire was anonymous, and to encourage honesty and critical analysis the participants were aware of their anonymity.

Among the fifteen participants, five were randomly selected and invited through an email to engage in the "Think Aloud" interview (Schmidt, et.al, 2020, Sec. 4.7). Two of them were pre-med and three were not pre-med. Each person was interviewed using the Usability Evaluation Guide (see Appendix E) to steer the interview and capture notes. During the interview, observations and quotes were noted and then later compiled on a spreadsheet where common themes were identified (Creswell and Guetterman, 2019, p. 237).

During the "Think Aloud" protocol (Schmidt, et.al, 2020, Sec. 4.7), the participant was first welcomed and thanked, and then they listened to directions that described the interview

process. Each participant was asked if they use mobile applications and for what purposes. If they used mobile applications, then they were asked to explain what they liked and disliked about them. They were also asked if they ever used a mobile *learning* application (MLA). After this, the participants were guided to the Figma link where they found the MLA prototype, and they were asked to express their general impression of the first and second screens. Once participants arrived at the first menu, they were prompted to drive the app freely and to speak their thoughts aloud. They were also encouraged to intuitively use the application. Notes were taken based on observation and feedback. When participants were finished or were stopped to honor their 30-minute commitment, they were given the questionnaire to complete.

Evaluation Plan vs Reality

The evaluation was closely followed as planned. However, the Think-Aloud questions were slightly changed to avoid leading the user or making suggestions about the interface. Instead, the user's responses were closely noted. McQuiggan, et.al., (2015) say, "In order to capture the most useful information, it is important to first consider the most basic actions users perform within the app" (p. 202). Observing the user's actions, listening to their comments and clarifying their reactions proved to be more valuable than following the questions that I initially planned.

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Data Analysis and Results

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Qualitative and quantitative data were collected from adapting a questionnaire designed to measure extraneous cognitive load (ECL). Faudzi, et.al (2024) conducted a study with the purpose "to develop and evaluate an instrument that can be used to measure ECL caused by UID [user interface design] of an MLA. By understanding the UID factors that contributed to ECL, MLA designers, developers and teachers can identify ways to have better UID for MLA" (p. 2).

The adaptation included using a Likert scale 1-9 from Strongly Disagree More to Strongly Agree More. Each section of the adapted questionnaire was used to measure a different aspect of the user experience (see Table 1).

First, data was numerically coded to analyze the answers in each section. Questions were divided into positive statements that elicit satisfaction or agreement and negative statements that draw out dissatisfaction or disagreement with the app. This aided the coding process. For the positively stated questions, strongly disagree more was coded a one and strongly agree more was coded a nine. With the negatively stated questions, the reverse order of coding was used. The strongly agree more was given a one and the strongly disagree more was given a nine. This kept the two types of questions from skewing the data. It also kept the data consistent and provided insight into correlation among the data, so if a participant agreed that the mobile app was organized, they should also disagree that the app was incomplete or inconsistent.

Table 1

Types of questions and codes

| Positive		Negative	
Strongly disagree more	1	Strongly agree more	1
strongly disagree	2	Strongly agree	2
Disagree More	3	Agree more	3
Disagree	4	Agree	4
Neutral	5	Neutral	5
Agree	6	Disagree	6
Agree more	7	Disagree More	7
Strongly agree	8	strongly disagree	8
Strongly agree more	9	Strongly disagree more	9

Descriptive statistics

Once the data was coded, then central tendency and variability were identified for each question. The mode became a more helpful way to understand the mean. According to Creswell and Guetterman (2019) mean is not as helpful in reporting meaningful categorical information. With the closely assigned points of the 9-point scale, a strongly agree more (9) is different than a strongly agree (8) or a agree more (7) or an agree (6). Faudzi, et.al. (2024) determined as they studied the measurement tool that the 9-point scale "enhanced reliability" (p. 1).

The content organization section had six questions. The mean of each of these responses ranged from a 6.1 to 7.3 indicating participants agreed to agreed more with the positive questions and disagreed to a disagreed more with the negative responses. However, the mode for all the questions except for one question was strongly agreed for the positively stated questions and strongly disagreed with the negatively stated questions. The mode of 6 (disagree) was the outlier in this section as a response to finding excessive words on the page.

Also discovered in the content section are the two highly correlated questions shown in Figure 1. Each, a positive question, showed a mean of 7 (agree more) with a mode of 8 (strongly agree). This may suggest that images do not overwhelm the learner and do not create too much visual noise. It might also indicate that extraneous cognitive load (ECL) is not an issue with the MLA images.

Figure 1

High correlation for images not creating ELC

Question: 8. +I can see that the images are organized appropriately.
Question: 9. + I think the information displayed in the mobile learning app is not crowded appear highly correlated.

Question 9 Rating Scale: 1=Strongly Disagree More to 9=Strongly Agree More

Question 8 Rating Scale: 1=Strongly Disagree More to 9=Strongly Agree More
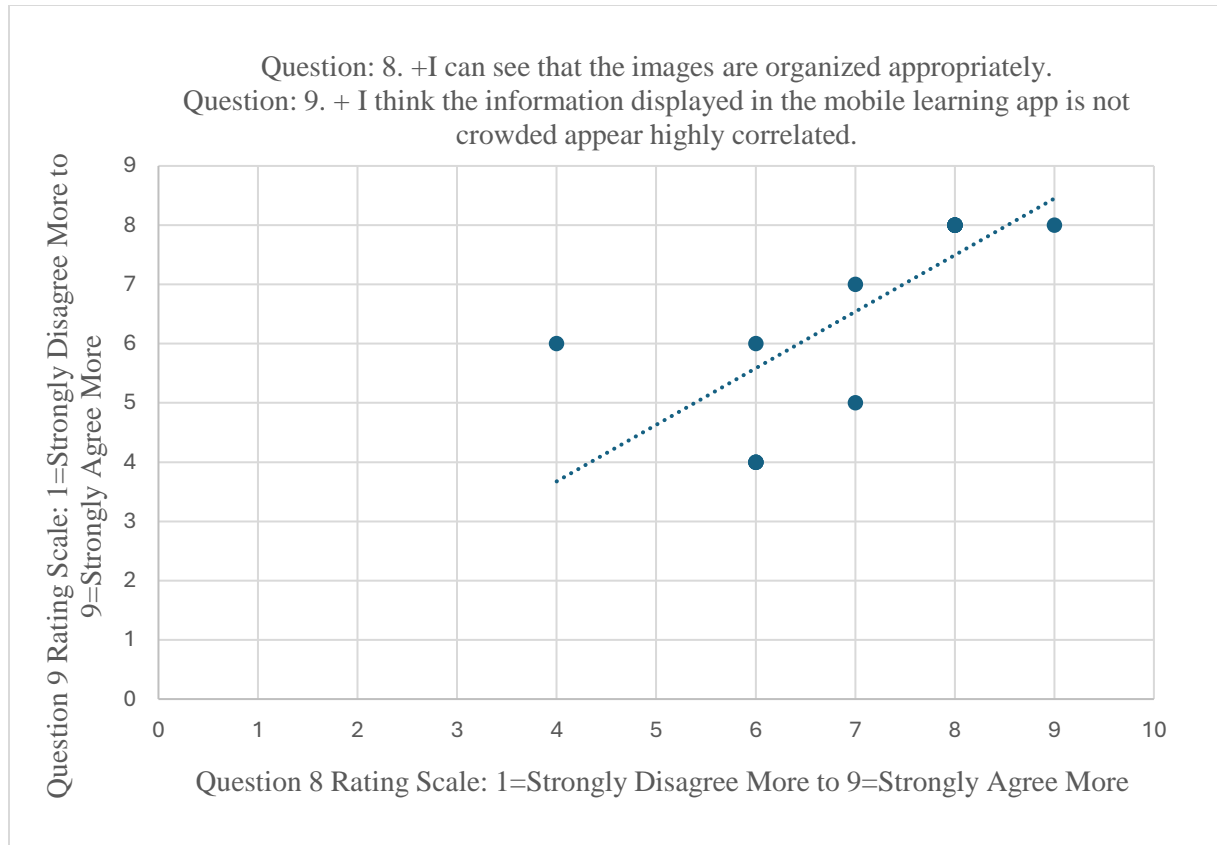
In the navigation section two questions were closely related but evoked different responses (see Table 2). One question asked if the navigation was confusing while the other asked if the navigation was easy. Each question generated the same mode for the positive question as it did for the negative question. Users agreed they found the app easy to navigate and disagreed with the navigation process being confusing. However, degree of variation between their answers suggests there was no correlation between responses. For example, five participants disagreed or were neutral that the MLA was confusing to navigate but agreed to strongly agreed more that it was easy to navigate (see Figure 2 and Table 3). Though the standard deviation and variance are not significant, the Think Aloud interviews (Schmidt, et.al, 2020, Sec. 4.7), showed the buttons to be problematic with some screens only having a button going forward. This frustrated some who wanted a back button. The different menu labeling was

also confusing, and this too was reiterated with each participant during the interviews as shown

in Table 4.

Table 2

Navigation Process Variation

10. -For me, the navigation process is confusing.		12. +I find that navigating the app is easy.	
Mode	6	Mode	6
Mean	6.333333	Mean	6.6
		Standard	1.12546
Standard Variation	1.447494	Variation	3
Variance	2.095238	Variance	2.4
			0.17052
COV	0.228552	COV	5
		CoV	LOW
CoV High/Low	LOW COV	High/Low	COV

Figure 2

Variation of Rating

Confusing vs Easy Navigation

- ■ 10. -For me, the navigation process is confusing.
- ■ 12. +I find that navigating the app is easy.
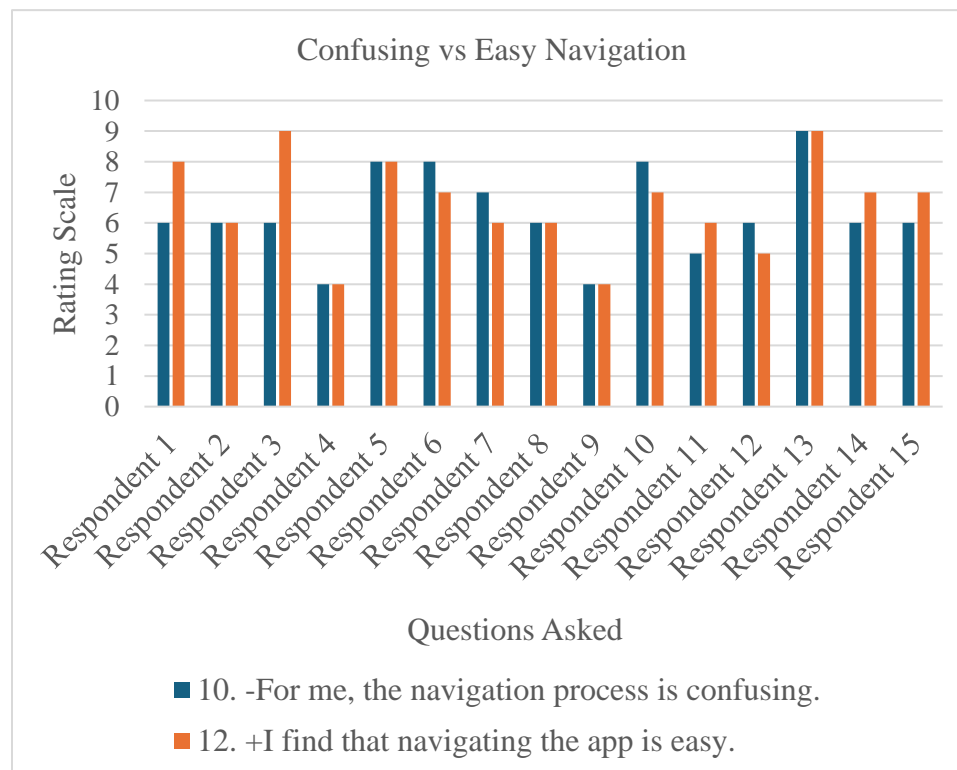
Table 3

Variation in Rating Scale

Question 10		Question 12	
Strongly agree more	1	Strongly disagree more	1
Strongly agree	2	Strongly disagree	2
Agree more	3	Disagree ore	3
Agree	4	Disagree	4
Neutral	5	Neutral	5
Disagree	6	Agree	6
Disagree More	7	Agree more	7
strongly disagree	8	Strongly agree	8
Strongly disagree more	9	Strongly agree more	9

The signaling and cue section of the questionnaire showed a normal distribution. Participants agreed there were clues that told the user what to do within the application. However, the interview revealed something different. One of the salient points made was that the users wanted more direction throughout the application (see Table 4).

Table 4

Think Aloud Themes and User Feedback

Areas	Problems	Participants' Feedback		
Navigation	Buttons	*button not clear of where it's taking me ---should be an arrow*	*Home takes to next page instead of the beginning of the app---confusing*	*Practice menu –not sure what it means --All three choices at once or confusing maybe one at a time*

		characteristic page---left and right buttons **<-----** *should go back to the characteristics page while* **---->** *should go deeper into the characteristics*		
Signaling and Cueing	Need more direction from one section to the next		*I would probably start with practice menu*	
Content development	Practice menu needs more information	*I want feedback screen to first say the correct answer*	*Like color coding but would like a header*	*Switch directions and outcomes want directions first*
Flow	Combining characteristics sections	*combine bubbles so have 2 info bubbles on page--need to clarify menus*	*I want the flow to go from what is critical thinking to how to think critically*	
Clarity	Clarifying menus	*I don't know what to practice menu means*	*The menu feels like an FAQ page*	*Home takes to next page instead of the beginning of the app--- confusing*
Purpose	Purpose of profile	*create an account, but it doesn't say why do I have to do it.*	*Make my own profile---do I have to make this make profile fine with name and email don't want to make pic.*	*Set up an account? I don't know what the app is about yet. Do I want to interact with app?*

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For the aesthetic and minimal design section the mean and variance for each question was

similar as the users agreed more with finding the MLA aesthetically pleasing and easy to

understand. Moreover, participants generally agree that the visual representation font is suitable for them. However, two participants were either neutral or disagreed that the font was suitable (see Figures 3 and 4) During the think aloud interview, one person suggested using all the space on the screen.

Figure 3

Normal Distribution Chart with Outliers
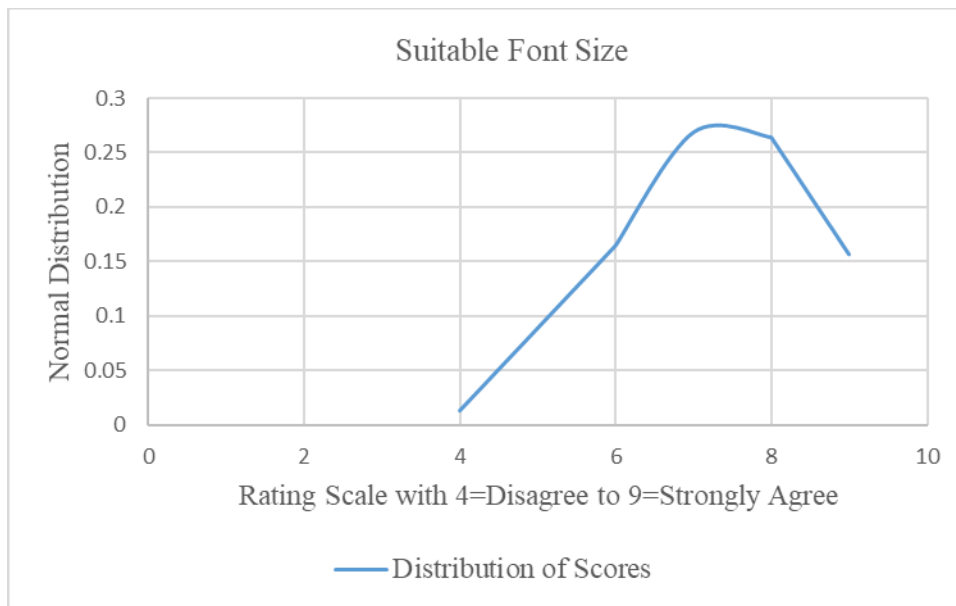
Figure 4

Font Size and Ease of Reading

VISUAL REPRESENTATION FONT

Questions

- 20. +The font style is suitable for me to read.
- 22. +The font size is suitable for me to read.
- 23. +The font size is suitable for me to explore the necessary material

1=strongly disagree more to 9=Strongly agree moree
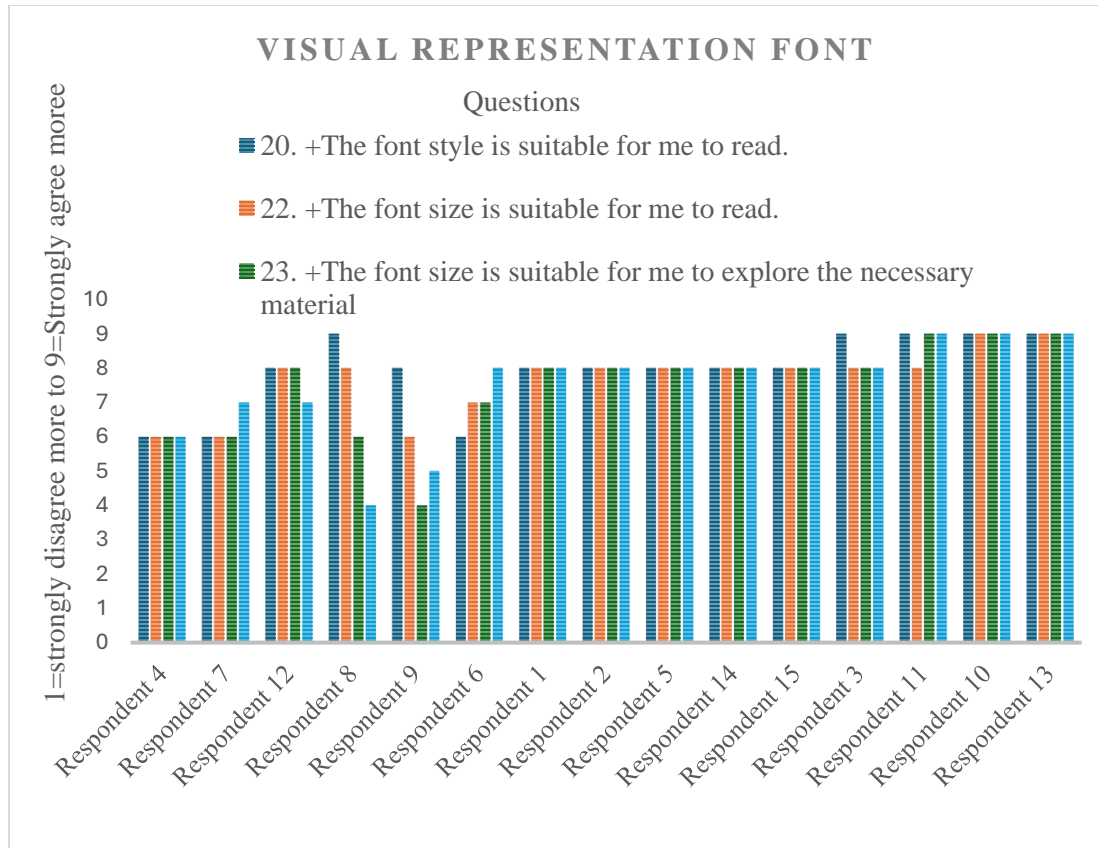
The final section of the questionnaire displayed negative statements about the visual representation of the graphics' complexity. The questions elicited a general mean of 7 (disagree more) and a mode of 6 (disagree). The low coefficient of variation indicates that the data is not highly dispersed in relation to the mean (See Table 4). Though, participants disagreed more that there were too many objects on the screen. This may suggest that the graphics were not adversely affecting extraneous cognitive load.

Table 4

Summary Survey Visual Representation Graphic Complexity

Question	Rating	Mean	Mode	Standard Deviation	Variance	COV	CoV High/Low
25. -There are too many objects in a	Disagree more	7	6	1	2	0.2	Low

single page of the app,
I need to scroll.

Statement							
26. -I find that there are long menus with subcategories of links.	Disagree	6	6	1.2	1.4	0.2	Low
27. -I find that there are an excessive number of links.	Disagree more	7	6	1.4	2	0.2	Low
28. -I can see that there is/are irrelevant image/images in the pages.	Disagree more	7	6	1.5	2	0.2	Low
29.-I can see that there are too many colors used for fonts, headlines, tables, menus and backgrounds.	Disagree more	7	6	1.6	2.6	0.2	Low
30. +I found form in the mobile learning app.	Disagree more	7	6	1.5	2	0.2	Low
31. +To me, understanding the graphics in the app is easy	Disagree more	7	6	1	1.4	0.15	Low

Recommendation

Some components of the user interface design (UID) were creating extraneous cognitive load (ECL). Based on the questionnaire data and the themes from the think aloud protocol (Schmidt, et.al, 2020, Sec. 4.7), the MLA app needs improvement in several areas to decrease the ECL and to reduce confusion and frustration (see Appendix F). Participants had issues with navigation, signaling and cueing, and content development. They also voiced concerns with the flow of the characteristics section of the MLA and wanted clarity with the two menus. Moreover, they wanted to know the purpose of the profile screen and questioned why the MLA was asking for their full name and email address.

First, by revising the back and forward buttons throughout the app, the navigation can be improved. This will help to give more direction and flexibility within the app. In addition, the MLA will also need to make clear directions for the sections, and this will include making the two menus in the MLA distinctly labelled. Using all the "real estate" on each screen will be another change based on a suggestion. This would help to improve the interface. Minimizing some of the background graphics that may create visual noise and expanding the reinforcing images are other changes. This should also increase the rating scale from agree and disagree to strongly agree and strongly disagree in response to statements about the graphics. Using the entire screen will also make the font size larger and more satisfying for all. It will also help to diminish any extraneous cognitive load due to font readability issues. Finally, though I chose not to focus on the content of the MLA practice tests, three of the five think aloud users suggested that the feedback slides give the correct answer first before explaining why it was correct. I hope to also adjust this area of the MLA. Appendix F shows the steps to follow as I revise the MLA

Reflection

The evaluation process requires pre-detailed planning and justification. If the evaluation plan is well-developed, then it provides a valuable road map to follow for the evaluation process. The evaluation plan was closely followed except for the "think aloud" questions (Schmidt, et.al, 2020, Sec. 4.7). Deciding prior to meeting with participants, it was important to see how the user navigated the application. Though concerns were about extraneous cognitive load, no questions lead them to say the app was confusing. Instead, participants were encouraged to think aloud and explain their reactions. By the third interview, a similar pattern of issues emerged. Each participant expressed the issue in their own words. The MLA interface had some problems to solve. Also, these issues helped to explain some of the data from the questionnaire. I had

wondered about the discrepancy with the font size. Then during the interview, one person shared an app that uses the entire screen. The interviews answered some questions about the meaning of the data.

Having access to a questionnaire that had been evaluated and studied over a few iterations was a valuable tool for measuring cognitive load and mobile learning applications. I removed a section on the original questionnaire because it was for a video on an MLA. Also, adjusting the Likert scale to give terms to the numbers (strongly agree more, strongly agree, agree more, agree) was another adjustment. It gave more meaning to the numbers, though maybe it was unnecessary. This might have been something that I overthought.

As I felt the numbers alone were meaningless, I also initially struggled with the descriptive statistics. Since the Likert scale shows variation and refinement more than polarity in opinion, the measures of central tendency did not provide highlighted areas to consider. Generally, the participants favored the usability of the app. However, it does give me pause to consider how much they agreed or disagreed. The lowest degree of a 6 for agreeing or disagreeing as in questions related to graphic complexity might be a basic starting point. I would prefer my users to select higher degrees of agreement or disagreement. This desire for excellence holds true for all the questions. Certainly, this MLA is far from finished and after I revise it based on the feedback, it would benefit from another round of evaluation.

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Appendix A

Frame Model

Appendix B

Gagne's Nine Events of Instruction

1	"Gain attention"
2	"Inform the learner"
3	*"Stimulate recall of prior knowledge"*
4	*"Present stimulus material"*
5	*"Provide guidance"*
6	*"Elicit Performance"*
7	*"Provide Feedback"*
8	*"Assess performance"*
9	*"Enhance retention and transfer"*

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Note: From Gagne, 1965, as found in Robert Gagné and the Systematic Design of Instruction.

Design for Learning: Principles, Processes, and Praxis. Curry, J. H., Johnson, S., & Peacock, R.

(2021). https://edtechbooks.org/id/robert_gagn_and_systematic_design

Appendix C

New Bloom's Taxonomy

```
                    Creating

                  Evaluating

                Analyzing

              Applying

            Understanding
              ➢ Inferring

          Remembering
```
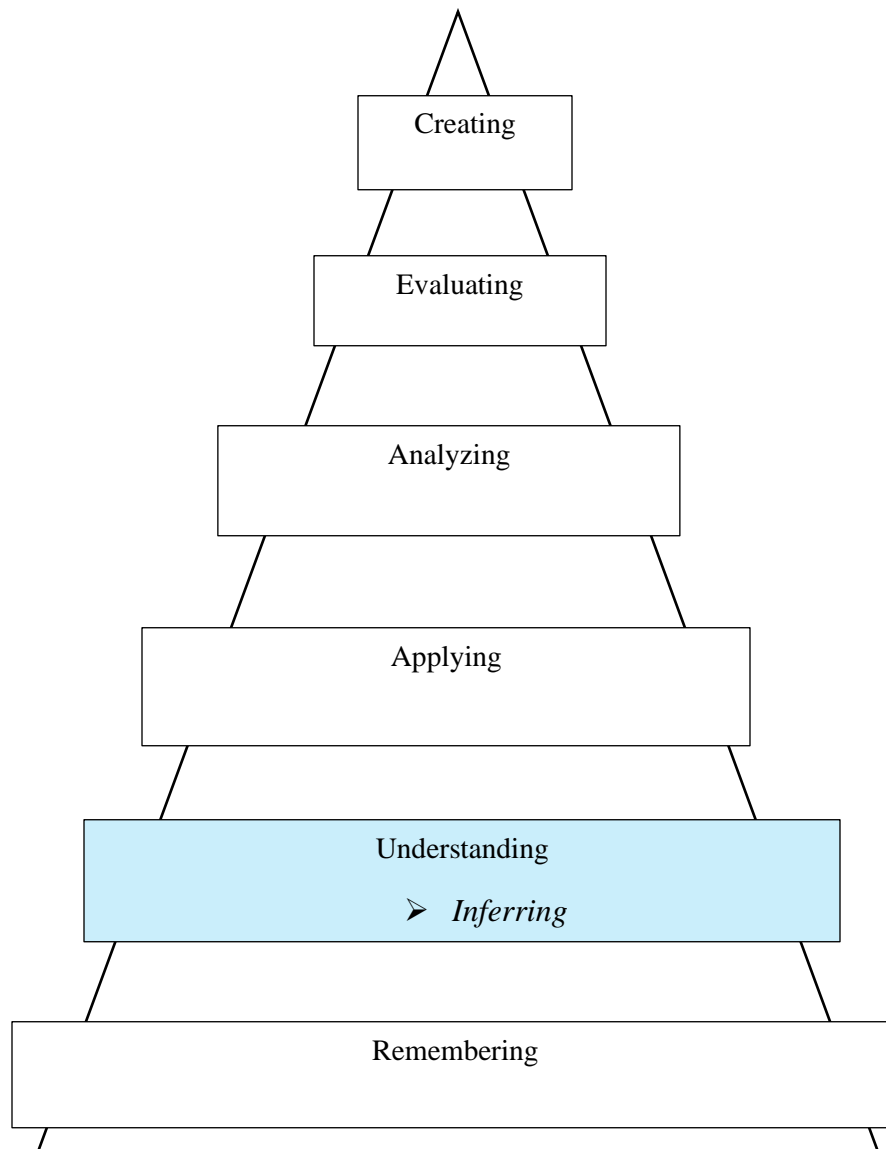
Note: Adapted from *Elearning Guild Research: Reconsidering bloom's taxonomy (old and new).* Shank, P. (2013, February 14). The Learning Guild.

Appendix D

Questionnaire

#	DEMOGRAPHIC QUESTIONS	YES	NO	PREFER NOT TO SAY
1	Are you pre-med			
2	Have you taken the MCAT or GRE before?			
3	Have you ever used a Mobile Learning Application before			

#	CONTENT ORGANIZATION	STRONGLY DISAGREE MORE	STRONGLY DISAGREE	DISAGREE MORE	DISAGREE	NEUTRAL	AGREE	AGREE MORE	STRONGLY AGREE	STRONGLY AGREE MORE
	How is the data organized? If it is organized well, you should have no problem in implementing your task PERFECTLY and in a SHORT PERIOD of time.									
4	I find that the structure of the mobile learning app is organized correctly.									
5	I find incomplete/inconsistent information.									

#	Statement									
6	I can see that the related items and information are being grouped and arranged together.									
7	I find pages with excessive number of words.									
8	I can see that the images are organized appropriately.									
9	I think the information displayed in the mobile learning app is not crowded									
	NAVIGATION	**STRONGLY DISAGREE MORE**	**STRONGLY DISAGREE**	**DISAGREE MORE**	**DISAGREE**	**NEUTRAL**	**AGREE**	**AGREE MORE**	**STRONGLY AGREE**	**STRONGLY AGREE MORE**
	How do you move around the MLA? Do you need to scroll up and down many times before you can find the item that you need? If it is easy to navigate the MLA, then you should find the item in MINIMAL SCROLLING.									
10	For me, the navigation process is confusing.									
11	For me, the provided links lead to the correct destination									
12	I find that navigating the app is easy.									
13	I think the scrolling is too long.									

	SIGNALING/CUE	STRONGLY DISAGREE MORE	STRONGLY DISAGREE	DISAGREE MORE	DISAGREE	NEUTRAL	AGREE	AGREE MORE	STRONGLY AGREE	STRONGLY AGREE MORE
	Do you know what button/link to click when implementing your task? Do you know that a text is a link? Or do you just click and see where it goes? If it is clearly signed, then you would NOT accidently CLICK on text that are NOT LINKS.									
14	There is a clue (such as color code, highlights and labels) that tells me what to do.									
15	There is a clue (such as color code, highlights and labels) that tell me where to go.									
16	I can clearly differentiate sections/chapters/activities with the use of colors, highlights, or labels.									
17	I can clearly see the system progress.									
	Aesthetic and Minimalist Design	STRONGLY DISAGREE MORE	STRONGLY DISAGREE	DISAGREE MORE	DISAGREE	NEUTRAL	AGREE	AGREE MORE	STRONGLY AGREE	STRONGLY AGREE MORE
	Is the user interface design easy on the eyes? Or is it irritating?									

18	I find the layout of the mobile learning app is aesthetically pleasing.									
19	I find the layout of the mobile learning app is easy to understand.									
	VISUAL REPRESENTATION - FONT	STRONGLY DISAGREE MORE	STRONGLY DISAGREE	DISAGREE MORE	DISAGREE	NEUTRAL	AGREE	AGREE MORE	STRONGLY AGREE	STRONGLY AGREE MORE
20	The font style is suitable for me to read.									
21	The font style is suitable for me to explore the necessary material.									
22	The font size is suitable for me to read.									
23	The font size is suitable for me to explore the necessary material									
24	To me, reading the font of the app is easy.									
	VISUAL REPRESENTATION - GRAPHICS COMPLEXITY	STRONGLY DISAGREE MORE	STRONGLY DISAGREE	DISAGREE MORE	DISAGREE	NEUTRAL	AGREE	AGREE MORE	STRONGLY AGREE	STRONGLY AGREE MORE
25	There are too many objects in a single page of the app, I need to scroll.									
26	I find that there are long menus with subcategories of links.									

27	I find that there are excessive number of links.									
28	I can see that there is/are irrelevant image/images in the pages.									
29	I can see that there are too many colors used for fonts, headlines, tables, menus and backgrounds.									
30	I found form in the mobile learning app.									
31	To me, understanding the graphics in the app is easy.									

_____

Note: Adapted from User interface design in mobile learning applications: Developing and evaluating a questionnaire for measuring learners' extraneous cognitive load. Faudzi, M. A., Cob, Z. C., Ghazali, M., Omar, R., & Sharudin, S. A. (2024). *Heliyon.*

Appendix E

Usability Evaluation Guide Document

<table>
<tr>
<td rowspan="5">Pre-Evaluation</td>
<td>Title of Your Artifact & Access Link</td>
</tr>
<tr>
<td>Critical Thinking App called: Deep Thinking
https://www.figma.com/proto/ycIgPuqywwobfpx59aUAn8/ORIGINAL-crit.-think.-app.-DUP-4.3(Copy)?node-id=7-42&t=UnwdY1q71SpY8aby-1&starting-point-node-id=7%3A42</td>
</tr>
<tr>
<td>Research Question– What you want to evaluate?</td>
</tr>
<tr>
<td>

</td>
</tr>
<tr>
<td>Test Scenario – How will you evaluate?

I will observe the user thinking aloud as they use the application from the first screen. I will ask the user to make their thinking visible as they try the app prototype and to state what they understand about what is happening on each screen of the application. I will ask them to comment on what they are thinking and feeling as they go through the prototype and to explain their reasoning with each response. If they do not comment on the logical groupings of the buttons and the pathways of the navigation system, I will ask them to analyze this as well at the end of the interview when we debrief. I will be especially interested in their impression of the menus, symbols and text. I will also be interested in if they get lost in using the app and if they are able to follow the logical flow of the material. Finally, maybe they will think the app is boring. I will be interested in discovering this as well.
</td>
</tr>
<tr>
<td rowspan="5">During Evaluation</td>
<td>Record both of your user's names</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Welcome and Test Overview</td>
</tr>
<tr>
<td>The purpose of this interview is to see how you respond to this mobile application prototype. Because it is a prototype, some things may not work. The name of the prototype application is Deep Thinking. The prototype is designed to help the user develop their critical thinking skills. You will begin on the opening screen and then move through the application describing what you are thinking and feeling on each screen. Your honesty is most important. Do not worry about offending me. I'm especially interested in seeing how you navigate so please make your thinking visible as you navigate from one screen to the next. The data from this test will give valuable insight on what can be improved to make this app better. I have some questions for you in the beginning and then when you are finished, I have some final questions for you. Also, I will ask you some questions along the way, but I'm most interested in listening to you. So, do you have any questions before we get started?</td>
</tr>
<tr>
<td>Pre-test Questions (if any)</td>
</tr>
</table>

1. Do you use mobile applications? What do you use them for? Which ones do you use? Or is there a reason why you don't use them?

2. What do you like or dislike about mobile applications?

3. Have you ever used mobile learning applications?

4. Have you ever used Figma before? We used this design software in the mobile learning class that I took where this prototype was created. This will lead us into the application prototype

Begin the test

During the think aloud:
1. What is your initial impression of this app?
2. What do you understand from the first screen?
3. What do you think about the second screen?
4. Let's go to the home screen.
5. Where would you like to start? Why?
6. Let's go there and try it out.

If the evaluator is not describing what they understand and why they are choosing a button on the app related to usability, I will ask them to explain why. Below identifies some questions I might use.

Notes and Observations

Question	Eval response	Observations	Notes
What is your initial impression of this app?			
Where do you think you go to continue?			
What do you understand from the screen?			
What do you think about the second screen?			

	What do you want to do next and why?			

Subjective Metrics

Please click on the link and complete the evaluation after the interview:
I will share the following link to be completed after the open-ended questions have been answered:

Thank your user and close the evaluation

Note: Form adapted from <u>Process Street's Usability Testing Template</u>.

Appendix F

Recommendations Based on User Feedback

Navigation	Clear Directions/ Cueing	Screen Real Estate	Profile Screen	Feedback Screens
How?	How?	How?	How?	How?
Improve Back Buttons Forward Buttons	Succinct Directions for Each Section	Make Use of the Entire Screen	Identify Purpse	Revise Content to Give Correct Answer First
Revise flow of Characteristics Menu	Menu Labeling	Remove boundary lines	Make Optional	
Rethink Home Button		Minimize cluttered backgrounds	Remove Image	
Rationale: Less frustration and allows the user to intuitively use the MLA	Rationale: Clear directions reduces ECL allowing the user to focus on content	Rationale: Font is easer to see when there is more space on the screen and less objects on the screen decreases ECL	Rationale: Give the user a choice by explaining why they may want to include profile information, but not require it.	Rationale: Give user immediate feedback so they know if they were correct or not