

Head-Up Displays for Note Taking: Project 2 Proposal

Mobile & Ubiquitous Computing - CS4605/7470

Alex Yang
Georgia Institute of Technology
Atlanta, GA
ayang76@gatech.edu

Anum Bhamani
Georgia Institute of Technology
Atlanta, GA
anumbhamani@gatech.edu

Gahan Wang
Georgia Institute of Technology
Atlanta, GA
gwang307@gatech.edu

Siyan Zhou
Georgia Institute of Technology
Atlanta, GA
szhou324@gatech.edu

ABSTRACT

With many advancements in technology, the techniques for note taking have changed drastically. Over the years, the form of note taking has evolved from taking notes by hand, doing it with laptops, to taking notes with a head-up display. The purpose of this project is to specifically compare note taking with laptops and note taking with head-up displays and then determine which technique is more effective. The experiment we proposed will entail two groups watching a TED Talk. One group will be taking notes using a laptop while the other group will be taking notes using a heads up display. Immediately after finishing watching the video, both groups will take a NASA TLX and the Post Note-Taking Questionnaire related to their note-taking experiences. Both groups will come back a week later to take quizzes related to the TED talk they watched and they're allowed to look at their notes at the same time. The quality of each group's notes will be scored based on some predefined criteria. The combination of the quiz scores and the ratings on the "quality" of notes will be used to determine the effectiveness of each technique. The main motivation behind completing this study is to help the upcoming generations truly retain the information they are taught as well as applying that information.

Keywords: Head-Up Display, Note-Taking

AIMS & OBJECTIVES

The main goal of this project is to deliver a completed study that compares using head-up displays versus laptops for taking notes. We have already designed a study to evaluate which method is more effective and conducted a pilot study using a within-subjects design with four participants. The pilot study provided us with useful insight leading us to our first objective – improving the study. While previously researching our topic, we found another common argument, are handwritten notes better than typed notes? We used those studies as a guide for our experiment and will continue to review them for further guidance. Furthermore, in order to keep the two conditions as similar as possible to avoid con-

founding variables, our focus on typed notes will remain the same. Reviewing the results from the pilot study, we have identified one major problem with our study, familiarity with the head-up display. We believe that participants were still unfamiliar with the device given the time constraint, and performed lower than expected. Thus, we aim to find ways to avoid the issue such as providing more time during our training session so participants can become better equipped during the actual experiment. Another problem we faced was difficulty in navigating through the head-up device. We plan to make this process easier by providing a Bluetooth connected mouse for participants to use so they can navigate through the device with ease. The last issue we noticed during the pilot study was that when participants used the head-up display to take notes they were still looking at the Bluetooth keyboard in order to type. This is a major issue with our study because the main point for using the head-up display to take notes was that it would allow the user to refrain from looking away from the video. Our initial idea was that while the user was taking notes with the laptop, they would be looking back and forth at the video and their laptop screen. Thus, if the user has to look back and forth between the video and Bluetooth keyboard while using the head-up display, this will defeat the purpose of our experiment and cause bias in our results.

In order to resolve this issue, we decided to extend the training session to an hour and give the participants a tutorial on "touch typing". Touch typing is the ability to use muscle memory to find the keys instead of using the sense of sight. This concept has been proven through research to eliminate errors in typing and improve typing speed as well as allow users to type without looking at their keyboard. This addition to our experiment will greatly improve our study as it will remove the contradicting issue of looking back and forth while using the head-up display. In addition, when recruiting the participants we will emphasize the fact that people who can type without having to look at their keyboard are preferred over those who cannot. Overall, by improving our study we

will be able to effectively test how the quality of notes and performance varies between using head-up displays and laptops.

Our second objective will be conducting an actual formative study. We'll conduct the study in two sessions again except we're aiming for a total of 4 participants this time. Participants will be volunteers and compensated for their time. Participants will try to be put in the same room while conducting the experiment to simulate an actual lecture. Each experiment begins with the test conductor reading the "experimenter script" along with other common procedures to the participants to keep each experiment consistent. Participants will then be asked to sign a consent form, and once the forms are signed, participants will be given an hour total to become familiar with the Vuzix Blade, practice taking notes with it, and complete a tutorial on "touch typing". After the training session is over, the experiment will begin with the first session. In session one, both participants will simultaneously watch a TED Talk to simulate a real lecture. Participant 1 will take notes using the Vuzix Blade, while Participant 2 will take notes using a laptop. Immediately after finishing the video, both participants will fill out a NASA-TLX and a Post Note-Taking Questionnaire about the method of note-taking they just completed. After the first video, both participants will watch another Ted Talk; however, this time both participants will switch conditions. Again, immediately after watching the second video, both participants will fill out a NASA-TLX and a Post Note-Taking Questionnaire about the second method of note-taking they just completed. Once session one is finished, participants will be given their printed out notes a week after session one in person, thus beginning the next session. In session two, each participant will be asked to come back to complete two quizzes based on the TED Talks and post-quiz questionnaires using their respective notes. After completion of the online quizzes, the participants will be debriefed and the experiment will be completed.

Our final objective will be evaluating and interpreting the results. We will evaluate the results of the experiment and ask what users think about using the head-up display versus laptop to take notes and determine which is a more effective way of note-taking. We will be analyzing the notes based on some criteria yet to be determined in order to get an objective view of the results. We will also compare our results from the pilot study, and the actual experiment to see if our results change. Once that is complete, we will deliver a complete study (in paper form) to show our results.

BACKGROUND/PREVIOUS WORK

Note-taking is an intricate process that requires comprehension, selection of information, and some form of written production processing to facilitate learning and recall of information [9]. Thus, it's an important concern in education to study multiple areas of note-taking to improve learning and recall. Techniques for note-taking differ from each individual to another, so it'll be difficult to completely focus on this area to study; however, one thing remains similar. Everyone uses some tool to record the information whether it be a laptop or through conventional means. New developments in

this area could directly affect the rate at which information is recalled. Head-worn displays used for note taking is a relatively new concept in the field and little to no studies have been conducted on such an idea.

We leverage existing studies analyzing the effectiveness of laptops vs pen and paper approaches to note taking as a guide and foundation for our work. Past studies have shown that note taking can be either generative (e.g., summarizing, paraphrasing, concept mapping) or nongenerative (i.e., verbatim copying) in nature. Additionally, level of cognitive demand required by a note taking task can vary depending on how deeply information is processed by the writer while capturing the notes. For example, verbatim note taking has been shown to place a far lower cognitive demand on [4, 7, 12] on the writer than a highly synthesized summary. [5, 7].

Additional, studies have demonstrated both correlationally [1, 11] and experimentally [2, 6] that verbatim note taking correlates with poorer performance outcomes than synthesized or non-verbatim note, particularly when the topic matter is highly integrative or conceptual in nature.

Few studies directly analyze the potential differences in cognitive process when note taking on a laptop or personal computer vs heads up display. Current literature does not consider the natural variation in the amount of verbatim overlap between lecturer content and students' notes on that lecture. Laptops can reduce the difficulty of verbatim transcription of lecture content because most students type much faster than they can write [3]. [8] found that students who took notes on laptops exhibited worse performance on conceptual questions than the students who took notes via pen and paper. Although a higher volume of notes is beneficial, the laptop user's notes were more akin to direct transcriptions of the lectures rather than a synthesized summaries of the key concepts. These verbatim proved to be detrimental to overall learning outcomes [8].

Cognitive effort is another factor that must be taken account of when discussing the quality of note-taking and the depth of encoding. The more cognitive effort put into a task results in a deeper level of encoding [7, 8]. One such study conducted on the difference between digital note-taking and paper note-taking uses the NASA-TLX as a means to define cognitive load which can be replicated in our own study [10]. In conclusion, the cognitive effort required of a heads-up note-taking strategy is an unknown area and leaves us much to be explored.

The results from our pilot study showed that the overall mean TLX score was higher for the Vuzix Blade HUD when compared with the mean TLX for the laptop computer. The participants reported a strong preference towards the laptop computer on post note-taking questionnaire. Not a single participant selected the Vuzix Blade HUD as their preferred note-taking system in regards to overall preference, accuracy, comfort, or learnability. Participants noted that the laptop was familiar interface and thus was more comfortable to utilize for note-taking. Additionally, some found Vuzix Blade HUD hard to view when overlapping the screen displaying the TED talk and a couple of participants reported experi-

encing mild motion sickness when using the Vuzix Blade.

On the quizzes, participants displayed a stronger conceptual understanding of the lecture content after taking notes via computer instead of using the Vuzix Blade HUD. A similar result was observed in the factual accuracy of the participants' quiz results. When taking notes on a computer, participants demonstrated superior overall performance with regard to both board concepts and small details. In the Post Quiz Questionnaire, the participants judged themselves to have stronger grasp of the material on the post note-taking questionnaire when using the laptop to take notes instead of the HUD.

CHALLENGES & ALIGNMENT TO CLASS

The main challenge for our project is knowing and understanding how to use the head-up display. More specifically, we have to make sure participants are familiar enough to take notes using a head-up display. As not being able to understand and use the head-up display properly may cause skewed results. The idea for taking on this challenge is for every participants to familiarize themselves with the head-up display that will be used in the experiment. We will assist the participant with learning how to utilize the head-up display to ensure fairness in the experiment. We will make sure to give them enough time before experiment to learn how to use head-up display and get comfortable. This challenge directly aligns with the scope of the MUC class as part of the class is to do user research and learn how to use certain equipment for the experiments.

Another challenge we are faced with in this project is how to determine the quality of notes. What makes the notes taken by Person A better than the notes taken by Person B? We will face this challenge with further research as well as using the expertise of our mentors. Some smaller issues that may arise throughout the duration of this project are: how to select participants for the experiment, receiving approval from the IRB, and how to analyze the data we receive. All of these challenges are within the scope of the class since a big majority of this course entails conducting experiments, completing user studies, and getting certified to actively participate in human-interaction studies.

OUTCOMES & DELIVERABLE

The expected outcomes from this project are results that allow us to determine which form of note taking is more effective. From here, we can provide educators and students an explanation of how to best utilize technology in order to produce better quality notes. The main motivation behind completing this study is to help the upcoming generations truly retain the information they are taught as well as applying that information

We want to learn if head-up display is more efficient way of note-taking than computer/laptop. We also want to know if using head-up will affect their performance and will result in improvements or not. The deliverable will be formative, and completed study of our research and experiment results, a video (demo), project presentation, and a final report.

PROJECT PLAN & TIMELINE

The main goal of this project is to deliver a completed study that compares a head-up display based interface against a traditional mouse and keyboard-based computerized note-taking system. Initially, we thought to conduct an actual experiment and collect the data after our first pilot study, but since we are still waiting on IRB approval and also we realized we may have some errors that may have impacted the results. So to get better results we will perform another pilot study with 4 people. Overall we have four weeks. In the first week (11/5), Siyan and Anum will find the four new participants for pilot study 2, Alex will update and improve our post-quiz and consent forms based on pilot study 1. George will create a schedule to conduct the pilot study 2 in next two weeks. In week 2 (11/11), we, as a team, will conduct the first session of our pilot study 2 with 4 participants at different times depending on everyone's schedule. We will make sure to follow the script in order to have same conditions to avoid any confounds. We are still keeping the same videos as pilot study 1 but with different post-quiz. In week 3 (11/18), we, as a team, will conduct the second part of the research and will continue to update our paper. Week 4 (11/25) Alex and Siyan will analyze the data and get the results. George and Anum will update the other parts of the final paper like discussion and changes to be made in future. George will also work on the video. All the other team members will make a final presentation.

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Head-Up Display for Note Taking Project Schedule

Team Members:

Siyan Zhou, Gahan Wang, Alex Yang, Anum Bhamani

Project Start Date:

11/8/2019 (Friday)

Today's Date: [1]

11/8/2019 (Friday)

Display Week:

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Team Contract - Heads Up Display Note Taking

Team Member Information:

Name	Contact Info (email, phone number, etc.)	College Major/ Program of Study / or Area of Expertise	Knowledge, Skills, or Abilities you think will be relevant for this project
Alex Yang	ayang76@gatech.edu 404-697-8647	Computer Science Information internetworks and Devices	User Research, User Study
Gahan Wang	gwang307@gatech.edu 678-549-7710	Computer Science People/Media	User Research, User Study
Siyan Zhou	szhou324@gatech.edu 330-322-6219	MS-HCI	Qualitative/QuantitativeRes earch
Anum Bhamani	anumbhamani@gatech.edu 404-610-6185	Computer Science Media/People	User Study, User Research

Research Question your team will pursue: Is note taking with a heads up display (e.g. Google Glass) more effective than note taking with a laptop?

Logistics

- a) Will your team have regular team meetings? When and where will your team meet?
 - We will have regular meetings every Wednesday at 9:00 AM at Thad's Office.
 - In the event someone cannot make this meeting, that person will be updated by the rest of the team in person or through GroupMe.
- b) How will you meet as a team? (face-to-face, using video conferencing, etc.)
 - We will have in-person meetings.
 - In the event everyone cannot meet in person, we will video call through Google Hangouts.
- c) What are the rules for your team meetings?
 - Everyone should contribute to the meeting.
 - All ideas are welcomed.
 - Each team member should update the team on their progress and any work they have completed since the last meeting.
 - The team should agree on what each person should be working on for the coming week (and to present in the next meeting).
 - Everyone is supposed to complete the task that they are assigned to.
 - Try not to miss too many meetings.
- d) What will be your method of completing assignments (virtual meetings, face-to-face meetings, splitting up the work, etc.)
 - We will be splitting up work.
 - Everyone can work on their part individually, but before the assignment is due the team will meet in person or through video call to conjoin all parts and make sure everyone is satisfied with the deliverable.
- e) What are the norms for responding to virtual communication? (e.g., respond to emails within 24 hours, etc.)
 - We will try to respond to emails and group messages within 24 hours.
 - If there is an urgent issue, there should be an immediate response!
 - GroupMe will be the main source to communicate

Expectations

- a) How will your team make decisions?
 - We will try our best to come to a common consensus.
 - If the team cannot come to a consensus, then we will have a majority rules decision.
 - If there is a split decision, then the team will ask the mentor or facilitator for advice and use that to make our decision and move forward.
- b) What are your team's expectations regarding team member performance and contribution quality?
 - As a team, we believe everyone should contribute equally to the project.

- However, we do understand that some team members skill set might be geared towards different aspects of the project. This is totally fine.
 - Encouraging and appreciating attitude.
- c) What are your team's expectations regarding cooperation and attitudes?
 - As long as everyone has a positive attitude, there will be no issues.
 - Everyone is willing to work together.
- D) What are your team's expectations regarding meeting attendance, punctuality, and participation?
 - Everyone should attend meetings and be on time.
 - However, family emergencies, conferences, personal issues, and academic related problems are excusable. Anything else is up to the team to decide whether the absence is excusable.
 - Everyone is required to participate in meetings. Also everyone should feel comfortable with sharing their thoughts and ideas about the project.

Strategies

- a) What strategies will your team will use to resolve differences of opinions among members?
 - We will welcome everyone's opinion.
 - However, in the event that differences of opinions begin to cause issues, we will try to resolve them as a team first.
 - If the issues cannot be resolved, then we will address our mentor and facilitator for further help.
- b) What strategies will your team use to deal with non-cooperative or underperforming members?
 - The team will address this team member first. We will make sure that the team member is doing okay personally and then address the issue of performance (hoping to resolve the issue).
 - If the issue continues, we will address the professor and/or TAs.
- c) How will your team handle unexpected issues (e.g. family emergencies, illnesses, etc.)?
 - As a team, we whole-heartedly understand things happen. We will be understanding with these kind of events.
- **Indicate full team agreement on these decisions:** All Team members must indicate their agreement by typing their names at the bottom of this document.

Signed by:

Gahan Wang
 Alex Yang
 Anum Bhamani
 Siyan