Breaking Down the "Wall of Text"- Software tool to address complex assignments for students with attention disorders

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Abstract. One undergraduate student's strategy to deal with long assignment instructions is to black out all of the information that they deem to be unimportant in the text, allowing them to focus just on the "important" information. While this technique may work well on paper, it does not naturally transition into a digital format. The student in the example above also identifies as having an attention disorder. In this paper we introduce a Microsoft Word add-in that enables the user to black out selected text using a new menu. Participants used the new Microsoft Word add-in to mark up a sample assignment. They were then asked in a post questionnaire to provide feedback on their experience utilizing the tool. Separately, we also conducted a survey in which we asked undergraduate students about their current strategies to understand long assignment instructions and why those strategies work for them. We then discuss their responses and compare it to the results of the previously mentioned case study.

Keywords: accessibility, attention disorders, text understanding, education tools

1 Introduction

Attention disorders such as ADHD can make university-level assignments with long textual narratives difficult to understand and follow. We were inspired by a student who used a technique of marking up assignments with a black marker in order to simplify the text and leave information directly relevant to the task visible. Informal discussions with other students indicated that such 'wall of text' assignments might present a challenge to a variety of students.

This paper is divided into two main parts. In the first part (Sec. 2), we present and evaluate a software tool designed to mimic the blacking-out technique of a marker on paper. In the second part (Sec. 3), we conduct and analyze a broader survey to understand the challenges posed by such assignments and the current techniques students use to understand them.

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2 Software Tool Study

An individual undergraduate student has a tried and true method to work on complex college assignments, especially when they are long, wordy, and resemble a 'wall of text,' rather than step-by-step instructions. A single page from an assignment identified by this student is shown in Fig. 1. When starting these assignments, their first step is to mark up the complicated project instructions using a marker and paper (Fig. 2). As instructors are increasingly assigning work digitally, the student either needs to print and then mark up all assignments, or find a simple way to perform a similar task digitally. Another advantage of a digital approach, when compared to the analog paper and marker, is the ability to "undo" any unwanted black outs, which is also a problem the student has struggled with.

The particular student referenced in the example above also identified as having an attention disorder. From past research, reading comprehension is a key issue for people with attention-deficit/hyperactivity disorder (ADHD) [1–3].

In addition, there are a number of studies that focus on reading comprehension in digital environments. Some provide feedback on ways that highlighting text affects people's comprehension [4, 5]. Other studies provide data related to the text format and explore how a person's reading comprehension changes based upon whether the text is plain or contains emphasis, images, links, etc [6, 5].

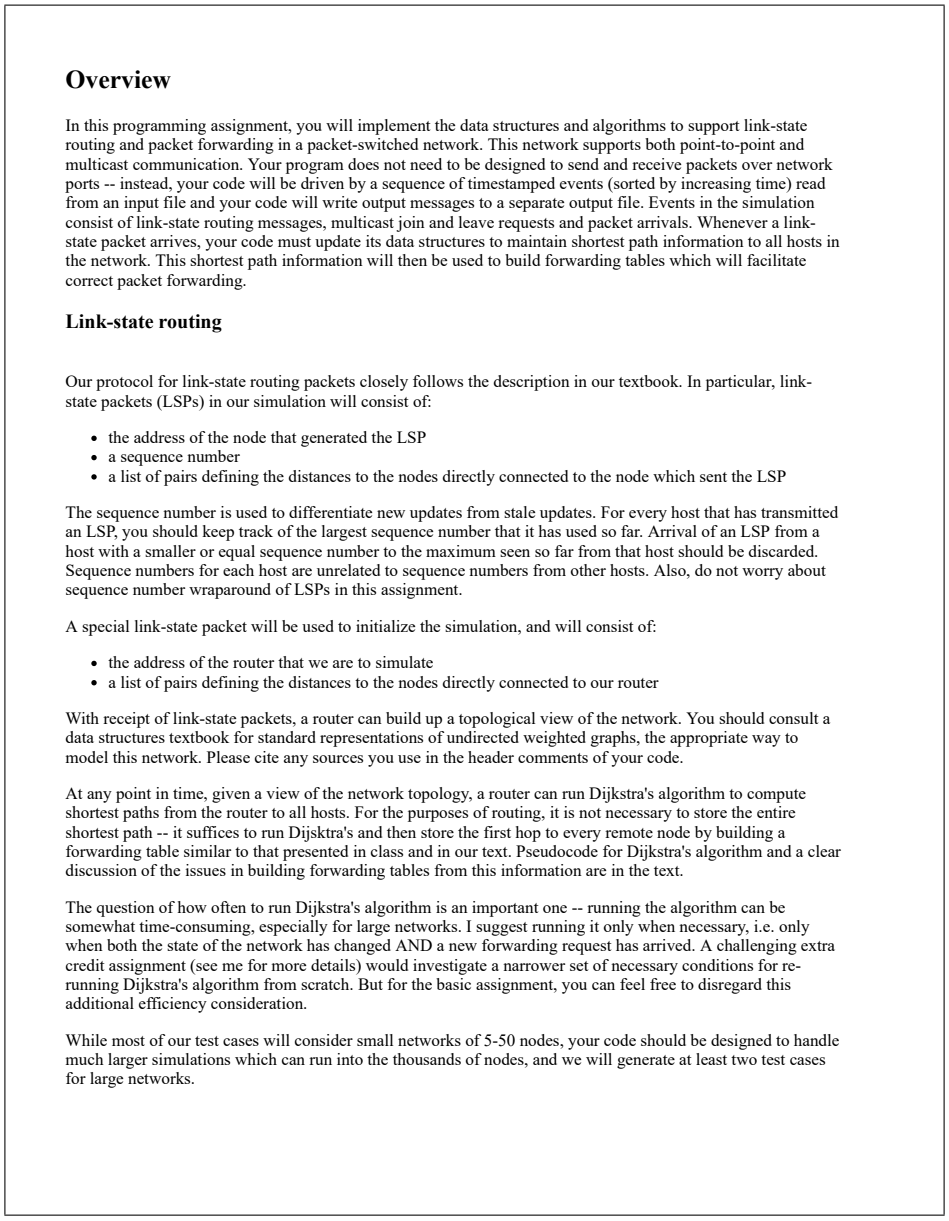
Our example student's method focuses on blacking out unimportant instructions. This allows them to remove unnecessary parts of the assignment so that they are left with only the information that they find useful. In order to bring the concept of blacking out text on paper to the computer, we created a Microsoft Word add-in tool, the sole purpose of which is to enable users to easily black out any text they choose in the document. We then recruited participants to offer feedback related to how our tool fares against the dreaded 'wall of text.'

2.1 Methods

Tool In order to mimic blacking out text on paper, we created a Microsoft Word add-in (Fig. 3). The add-in provides users with a new menu on the right of the document that enables them to easily black out selected text. It also provides the option to remove the black out from selected text, similar to an "undo" function.

Participants The subjects ($N = 5$) ranged from 19 to 23 years old ($M = 21$). Each of the participants was given an opportunity to self identify as having an attention disorder ($N = 2$).

Procedure Participants were first directed to complete a preliminary questionnaire. They were then directed to a computer science long term programming



Overview

In this programming assignment, you will implement the data structures and algorithms to support link-state routing and packet forwarding in a packet-switched network. This network supports both point-to-point and multicast communication. Your program does not need to be designed to send and receive packets over network ports -- instead, your code will be driven by a sequence of timestamped events (sorted by increasing time) read from an input file and your code will write output messages to a separate output file. Events in the simulation consist of link-state routing messages, multicast join and leave requests and packet arrivals. Whenever a link-state packet arrives, your code must update its data structures to maintain shortest path information to all hosts in the network. This shortest path information will then be used to build forwarding tables which will facilitate correct packet forwarding.

Link-state routing

Our protocol for link-state routing packets closely follows the description in our textbook. In particular, link-state packets (LSPs) in our simulation will consist of:

- the address of the node that generated the LSP
- a sequence number
- a list of pairs defining the distances to the nodes directly connected to the node which sent the LSP

The sequence number is used to differentiate new updates from stale updates. For every host that has transmitted an LSP, you should keep track of the largest sequence number that it has used so far. Arrival of an LSP from a host with a smaller or equal sequence number to the maximum seen so far from that host should be discarded. Sequence numbers for each host are unrelated to sequence numbers from other hosts. Also, do not worry about sequence number wraparound of LSPs in this assignment.

A special link-state packet will be used to initialize the simulation, and will consist of:

- the address of the router that we are to simulate
- a list of pairs defining the distances to the nodes directly connected to our router

With receipt of link-state packets, a router can build up a topological view of the network. You should consult a data structures textbook for standard representations of undirected weighted graphs, the appropriate way to model this network. Please cite any sources you use in the header comments of your code.

At any point in time, given a view of the network topology, a router can run Dijkstra's algorithm to compute shortest paths from the router to all hosts. For the purposes of routing, it is not necessary to store the entire shortest path -- it suffices to run Dijsktra's and then store the first hop to every remote node by building a forwarding table similar to that presented in class and in our text. Pseudocode for Dijkstra's algorithm and a clear discussion of the issues in building forwarding tables from this information are in the text.

The question of how often to run Dijkstra's algorithm is an important one -- running the algorithm can be somewhat time-consuming, especially for large networks. I suggest running it only when necessary, i.e. only when both the state of the network has changed AND a new forwarding request has arrived. A challenging extra credit assignment (see me for more details) would investigate a narrower set of necessary conditions for re-running Dijkstra's algorithm from scratch. But for the basic assignment, you can feel free to disregard this additional efficiency consideration.

While most of our test cases will consider small networks of 5-50 nodes, your code should be designed to handle much larger simulations which can run into the thousands of nodes, and we will generate at least two test cases for large networks.

Fig. 1. One of three pages from a Computer Networks university-level programming assignment, rendered as a PDF. This assignment was identified by the participant as an example of a challenging “wall of text”.

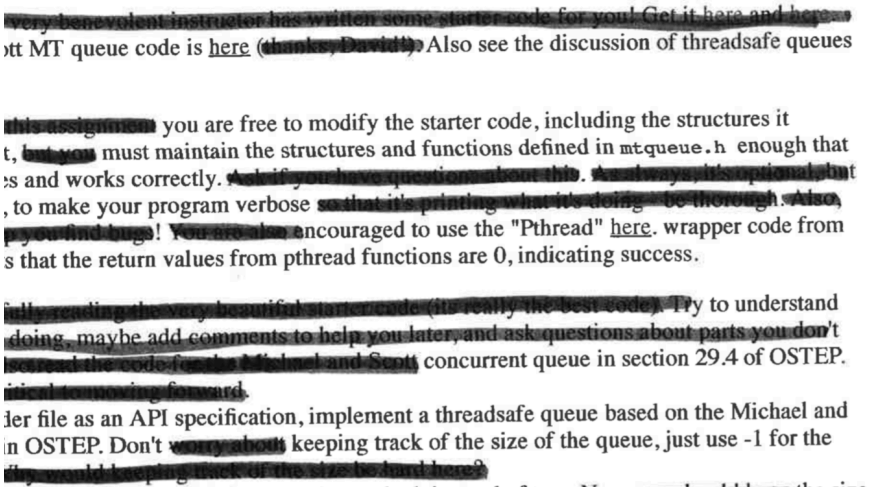


Fig. 2. A paper assignment that has been marked up.

assignment that included the new Microsoft Word add-in menu bar. Participants were instructed on how to use the new tool and were asked to act as if this was a long term assignment from one of their professors. Each participant was given as much time as they required to read over the assignment and to mark it up as though they would be referring back to it later.

After they felt they were done, participants were then given a questionnaire asking about the black out tool. The questions were open-ended and designed to allow participants to provide feedback about both the usefulness of the tool and their perceived comprehension of the assignment.

2.2 Results

Due to the open-ended nature of the questions, the overall opinion of the tool was largely neutral. When asked how the features made people feel about the assignment, one participant wrote *"It was still scary but after the blacking out it looked a little shorter"*. The majority of the responses were indifferent, with participants stating that they did not feel that the tool had significantly influenced their view of the assignment.

Participants that self-identified as having an attention disorder did not express significantly different opinions than those who did not self-identify as having an attention disorder.

Users were asked to self-report their comprehension of the assignment. On a scale from strongly disagree (1) to strongly agree (5), all users reported that they understood the assignment well ($M = 3.8$).

When asked if they would use the tool again, only one participant stated they would not use the black out tool again. The majority of the participants

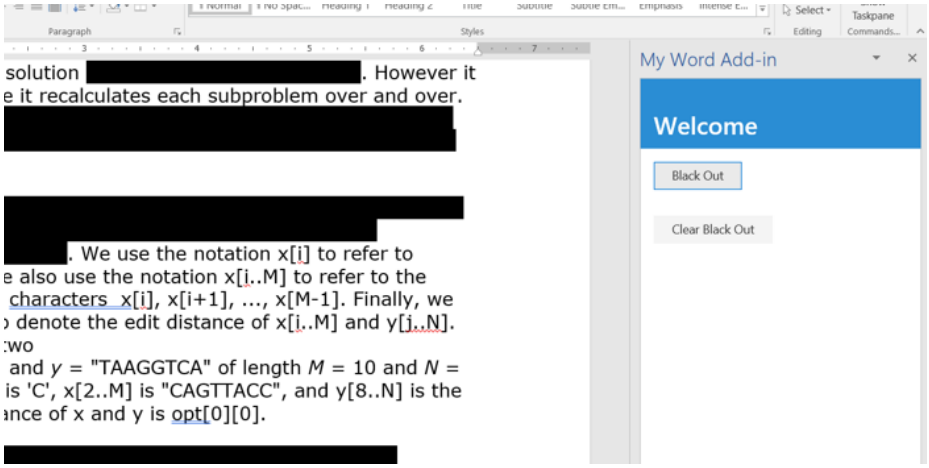


Fig. 3. A Microsoft Word document with the addition of an add-in menu on the right. The new menu has two options that allow users to select text and choose to "Black Out" or "Clear Black Out."

stated that they might use it in addition to other mark-up approaches, such as highlighting and annotating.

A number of participants expressed interest in the idea of eliminating unwanted text, but most were not comfortable with the idea of blacking out text completely. This appears to be mostly due to the fear of not being able to find something later if it was discovered to be useful and one couldn't remember where it had been now that it was blacked out. In fact, one user wrote:

> *Consider alternative styles of de-emphasis. In some cases it might be good to find a middle ground of making text de-emphasized without removing the ability to read it entirely.*

The participant reacted positively towards the idea of de-emphasis, but was hesitant about the permanence of the black out approach. Other users, however, were more interested in the complete removal of text from the assignment, and indicated that this eliminated distractions caused by the presence of unnecessary information. When asked to provide feedback, one user wrote:

> *I think the blacking out feature can be helpful to understand large amounts of text which can be overwhelming for some people.*

While participants provided a mix of both positive and negative feedback, users overall seemed to be largely indifferent towards the digital black out tool.

2.3 Discussion

On the whole, participants reported an overall neutral feeling related to the use of a digital black out tool for assignments. However, based upon the feedback

received, it seems clear the concept requires further investigation with a greater scope.

One reason for the indifference of the participants may be because the experiment was not run over a long period of time. As a result, the users never actually referred back to the assignment that they modified as they would have in real life. The participants also understood that they would never need to actually complete the assignment, which may have changed their view on what information they needed, and of how well they needed to comprehend the instructions.

Another reason for the results could be the small sample size received, and the limited number of people who self-identified as having an attention disorder. All results were also self-reported. In the future, it may be beneficial to also have users participate in a comprehension test in order to determine how well they actually understood the assignment after using the tool.

While the preliminary investigation is limited in scope, a future study that takes place over the course of a semester may be more effective in capturing real world conditions. It would allow participants to use the black out tool in a way that requires an in-depth and comprehensive understanding of the material, which could better measure the effectiveness of black out as a strategy for understanding complex assignments.

3 Survey

There are a multitude of strategies that can be used to tackle and deal with long, 'wall of text' assignments, but many of these require a physical copy of the text being read. To validate and enhance the results that were obtained from the software tool study above, we conducted a survey of undergraduate students to assess what strategies they use most frequently. In addition to providing useful statistics in analyzing the applicability of the developed software to our desired demographic, this survey also provided a basis for further work in which strategies can be merged with our software to improve its effectiveness in achieving its goal.

3.1 Participants

We recruited undergraduate college students to take the reading comprehension aid survey. A number of responses were incomplete and did not answer a majority of the questions, therefore we removed these from the dataset. The participants ranged from nineteen to twenty-one years old ($M = 20.53$). They are sophomores ($N = 1$), juniors ($N = 8$), and senors ($N = 8$). The participants studied a wide array of fields but the majority studied computer science (N=6). The majority of participants ($N = 16$) did not self disclose as having ADHD.

3.2 Distribution

Using Facebook and emails, we distributed the survey to an undergraduate population. The survey was hosted on Qualtrics and anonymous data was collected.

Participants were asked questions about their current attitudes towards long, 'wall of text', assignments or instructions and what types of strategies they use to deal with them. The questions were a mixture of multiple choice and short answer questions in order to gather this information.

3.3 Results

Participants show a diverse attitude towards 'wall of text' assignments. They were asked to acknowledge if they have struggled with wall of text assignments in the past, using a scale of "Strongly disagree" (1.00) to "Strongly agree" (7.00). The results ranged from 1.00 to 7.00 with a mean of 3.29 and a standard deviation of 1.67. The mode of the results was at somewhat agree (5.00), which indicates that users somewhat agree that they struggle with 'wall of text' assignments. See Fig. 4.

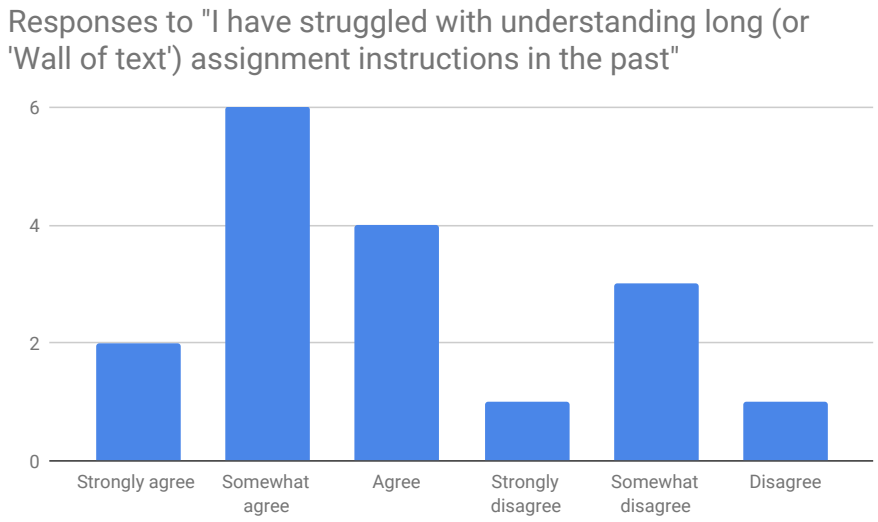


Fig. 4. Survey responses asking about struggles with large assignments.

Participants reported a number of strategies including highlighting text, making comments, rereading certain sections, taking notes, and underlining text. The most used strategy was underlining text ($N = 10$). However, a few individuals ($N = 3$) reported as having no current strategy to deal with long assignment instructions. See Fig. 5.

The participants were then asked to elaborate with their own words their strategies for handling 'wall of text' assignments. The majority of answers ($N =$

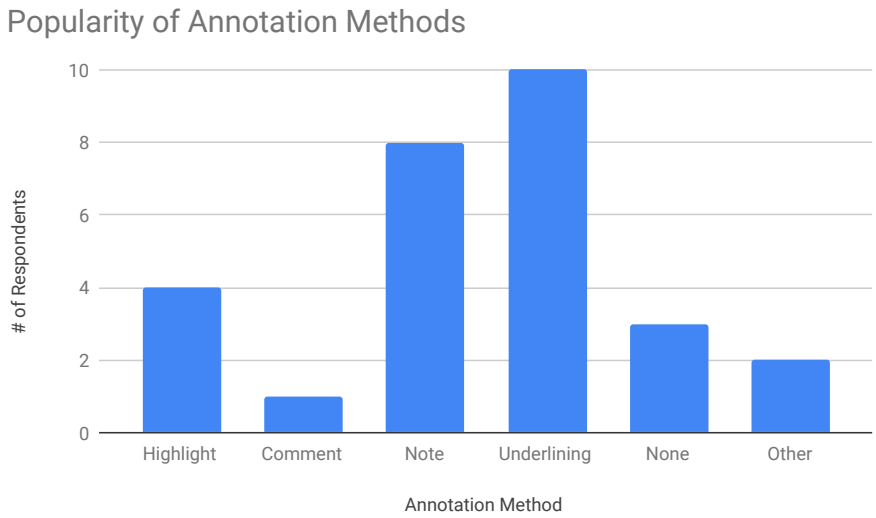


Fig. 5. Survey responses asking about struggles with large assignments.

9) emphasis the point of the strategies is to identify key information, meaning what they as the student view as the most significant parts of the assignment. Many of them do this by bringing more attention to the parts they deem valuable such as: "I highlight the most important information" and "I often take notes on the side about the most important pieces of information about the assignment and underline information to look at later."

They were then asked about how they implement these tools, digitally or physically with pen and paper. Participants were asked to rank their usage of these methods on a five point scale from "Never" (1.00) to "Always" (5.00). This showed that they used physical tools ($M = 3.56, \sigma = 1.12$) more than digital tools ($M = 2.63, \sigma = 1.05$), and it is notable that no participant reported as to never using physical tools.

Participants were then asked to describe why these tools helped to improve their understanding of 'wall of text.' Once again, participants brought up the idea of using the strategies to emphasize key points, as one user said: "[The strategies] help with picking out important information." One participant said that "[The strategies] break them down into macro information involving steps, while removing the non-critical components on the micro scale like detailed instructions." This answer emphasizes the ease of reading and the removal of information viewed unimportant by the student. Another participant said "It helps to break it into parts that are easier to read, instead of just one huge chunk of text to go through." Overall their reasons fell into four categories: makes the assign-

ment easier to read/understand, emphasizes/extracts important parts, removes non critical information, and breaks down the 'wall of text.'

When asked if they felt their current approach was sufficient for understanding 'wall of text' assignments, the majority ($N = 11$) of respondents said that they did feel their approach was sufficient.

3.4 Discussion

Overall it is clear that 'wall of text' assignments are not something that every student has figured out. Participants' wide range of answers to the question asking if they have struggled with 'wall of text' assignments, shows that there is a large spectrum of competence levels with these assignments.

The attitude paired with the wide array of reported strategies for dealing with the long assignment instructions indicate that there is not a clear and widely used solution at this time. The users that reported not having a current strategy also are not equipped to deal with long assignment instructions, which could then lead to poor reflections of their assignments. Most of the participants report that the strategies they use are there to bring key information to their attention. They use strategies such as highlighting or underlining text in order to make these parts easier to access later. Other participants also use note taking in a similar way in order to pull out the key details and store them in a separate place, thereby making the rest of the 'wall of text' assignment instructions unnecessary. This implies that there is text that the student does not need and could benefit from removing.

Overall, participants reported that they used physical tools, such as pen and paper, more than digital tools in order to handle 'wall of text' assignments. The tools may depend on how the assignment is distributed, whether it is a physical sheet of paper or if they directed to a website for assignment instruction. The method of distribution may affect strategies students feel comfortable using. If there is only one copy students may not feel comfortable permanently marking the instructions which may lead to more strategies such as note taking.

When users were asked how their strategies helped improve their reading, participants' answers mentioned four key themes about their strategies: making the assignment easier to read/understand, emphasizing/extracting important parts, removing non critical information, and breaking down the 'wall of text.' These methods all indicate that there is essential instructions and non essential instructions. Removing instructions in order to emphasize critical information may enhance understanding of assignment instructions.

4 Conclusion

Connecting our software tool study on blacking out text with the survey results, it is evident that all these strategies share similar themes when it comes to comprehending 'wall of text' assignments. The goal is to emphasize key information and remove the focus from non-critical text. The results demonstrate that even

though feelings towards this new tool were generally neutral, most participants were open to using this feature for marking up future assignments. Further development of this software can be aimed at providing a way to de-emphasize text without making it unreadable altogether, or a way to hide text temporarily so there is simply less space taken up by the document, making it easier to get through without interrupting the flow of reading.

In terms of the survey that was conducted, the next step would be to introduce those without a current strategy, or those that said their strategies were not effective, to the concept of blacking out text. The software that we introduced in the beginning of the paper could be a good method to introduce the strategy of blacking out text to students who are given digital assignments. Having the students use our software, as well as this technique in general, for the course of a semester would allow the study to take place over a longer period instead of an hour or so and allow students to engage with assignments that are actively assigned to them in a more natural school setting.

5 Acknowledgments

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