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April 1, 2022

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Dear faculty members of the department of Computer Science,

Here is my report, Feasible Solutions for a Successful Paperless Transition in CPSC 121. The process of preparing this report gave me insight into the difficulties that both the student and staff experience in the transition of discrete maths courses to online platforms. I believe my report will help clarify a path for successful transition, as well as lay out the framework for courses similar in nature. Thank you for taking the time to read and consider my work. Your encouragement was a vital part of the fruition of this report.

As the world becomes increasingly reliant on online platforms to meet educational needs, it is more important than ever to consider new angles to accommodate this transition. While most computer science courses, by nature, are well-suited for online platforms, difficulties arise in courses that rely heavily on mathematical foundations. There seems to be a fundamental gap between the intuitive problem-solving that occurs in paper environments versus online environments. However, bridging this gap in courses like CPSC 121 can pave the road for the transition of other similar courses in your department. Online platforms make courses more accessible and flexible to meeting both student and faculty needs, but it is imperative to keep the learning process intact.

I have enjoyed working on this project, and would be happy to elaborate any points raised in my report. Please email me at dharab@student.ubc.ca.

Sincerely,

Dhara Bhatt

Feasible Solutions for a Successful Paperless Transition in CPSC 121

for

The Department of Computer Science

CPSC 121 Instructors

University of British Columbia

Vancouver, British Columbia

by

Dhara Bhatt

English 301 Student

April 1, 2022

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Abstract

The transition of discrete math exams to an online platform raises significant challenges. There are several factors to consider, including the benefits and drawbacks for the student and staff experience, as well as unforeseen challenges like the Covid-19 pandemic.

For CPSC 121 (Models of Computation), student feedback suggests that while students appreciate the faster grading and efficiency of online midterms, most express concern over writing long and symbolic proofs in an online format. Dr. Karina Mochetti, one of the professors of CPSC 121, emphasises that online courses accommodate student safety during Covid-19, as well as provide future autograding potential. Furthermore, she suggests a new, alternate approach to exam questions. To adjust to an online format, question design and format can be changed accordingly (ie. Rather than writing a proof from scratch, students can be asked to rearrange proof statements in the correct order).

Based on a combination of student feedback and Dr. Mochetti's experience, a successful transition to online midterms and exams for CPSC 121 should follow these recommendations:

- Issue printed copies of major truth tables, pictures, graphs, and diagrams accompanying digital versions for students to mark-up, highlight and underline
- Provide the option to submit certain questions on paper for part-marks to assuage student concerns about running out of time
- Change the types of questions asked on midterms (ie. rather than asking the same types of questions previously asked on paper exams, questions should be optimised for online platforms).

Introduction

A. Background on the Complexities of the Current Paperless Transition

With the worldwide impact of Covid-19 and the progressive nature of technological advancement, many university courses are increasingly choosing to transfer their material to online formats. Though this transition is also seen in STEM courses, they are typically restricted to online lecture slides, zoom recordings, and multiple choice online quizzes. Since STEM courses often require symbolic language, proofs, graphs and tables, it can be difficult to transition to online midterms.

CPSC 121, a discrete maths course in the computer science department, recently transitioned to online midterms through the PrairieLearn platform in winter 2022 for the first time. Though the transition has come with unequivocal benefits, it has not been seamless. Many students voice concerns over the unnatural feel of problem-solving on the computer, and the struggle of translating complex symbols through the keyboard. Others prefer to be able to highlight, circle or mark-up the tables, graphs and world problems on their midterms. As well, many students find transferring from paper to online time-consuming and stressful under exam conditions.

Though these concerns are vital to the student learning experience, there are perhaps equal benefits to paperless courses. Paperless finals are better suited to being autograded, and even sans autograder, allow for faster and more productive grading. Students also spend less time writing repetitive proofs. In times of crisis, like the current Covid-19 pandemic, the format offers flexibility and safety. Consequently, the challenge of going paperless in CPSC 121 hinges on finding a way to address and acknowledge student concerns while maintaining the core benefits of a paperless transition.

B. Background on CPSC 121

CPSC 121 is a logic, proof-based discrete maths course in the faculty of computer science. It is a core course in the computer science curriculum, and introduces students to topics like propositional logic,

predicates and sets, regex, discrete finite automata, direct and indirect proofs, and induction. While some of these topics are easily conveyed in online formats, some are substantially more difficult.

Figure 1 illustrates an example of the symbolic language used in propositional logic. **Figure 2** demonstrates the use of quantifiers in predicate logic.

01.	$\sim(a \wedge b)$	
02.	$c \rightarrow (a \vee \sim d)$	
03.	b	
04.	$(e \wedge \sim a) \rightarrow c$	
05.	$\sim a \rightarrow d$	
06.	$\sim a \vee \sim b$	De Morgan's Law from 01
07.	$\sim a$	Elimination from 03 and 06
08.	d	Modus Ponens from 05 and 07
09.	$\sim a \wedge d$	Conjuction from 07 and 08
10.	$\sim(a \vee \sim d)$	De Morgan's Law from 09

Figure 1 Discrete Maths and Propositional Logic

(g) $\exists x \in P, \sim \exists y \in P, L(y, x)$
or alternatively $\exists x \in P, \forall y \in P, \sim L(y, x)$

(h) $\exists x \in P, \forall y \in P, L(y, x) \wedge \forall w \in P, (\forall z \in P, L(z, w)) \rightarrow w = x$

(i) $\exists x \in P, \exists y \in P, x \neq y \wedge L(\text{Jennifer}, x) \wedge L(\text{Jennifer}, y) \wedge (\forall z \in P, L(\text{Jennifer}, z) \rightarrow z = x \vee z = y)$

(j) $\exists x \in P, \forall y \in P, L(x, y) \leftrightarrow x = y$

Figure 2 Discrete Maths and Predicate Logic

As displayed, there is a level of complexity involved when dealing with symbolic logic that becomes difficult to write and solve in an online environment.

C. Purpose of the Report and Proposed Solution

The purpose of this report is to signify a fully-fleshed understanding of the various elements involved when transitioning a course like CPSC 121 to online midterms. After expressing the full scope of

student concerns, staff and instructor benefits, and feasibility of solution implementation, the report aims to clarify a final recommendation.

Briefly, the proposed solution is a system that marries paper work and online midterms. That is, the solution allows students to flag questions they fail to adequately complete online, and submit their rough paper work instead. To ensure that the benefits of online grading are maintained, students are only able to acquire partial marks through scratch work. In this way, students are still incentivized to participate in the online system. However, they are not penalised as harshly if they struggle to adjust. A more detailed explanation and analysis of the proposed solution (and possible side solutions) can be found in the **conclusion** of the report.

D. Brief Description of Data Sources

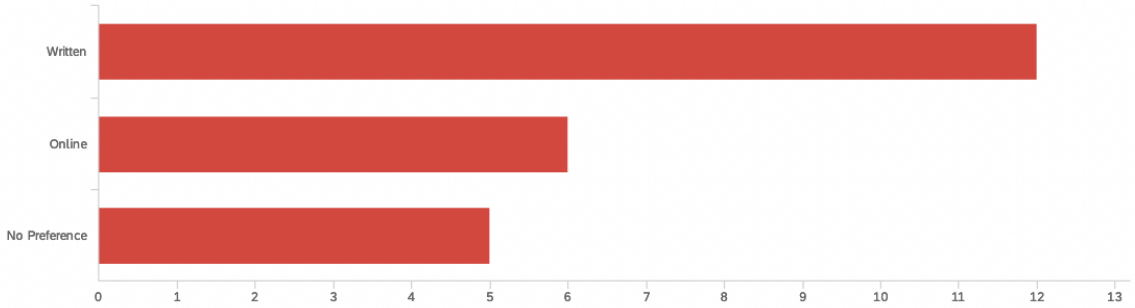
There are two key sources of data collection that pivotally inform the proposed solution. 30 students responded to a short survey on student preferences, concerns and experiences with online CPSC 121 midterms, gathered from the student discord. This data sheds light on the student experience that needs to be addressed for a successful solution. The second data source is an interview with CPSC 121 professor Dr. Karina Mochetti. This interview informs the staff perspective and long-term course goals.

A. Data Section

1. Student Preferences

To establish the scope of the problem, the discord survey investigates where the student preferences lie for CPSC 121 course formats. As **figure 3** demonstrates, the majority of students currently prefer written midterms. Specifically, 52.17% of students prefer written midterms, while only 26% of students prefer online midterms. Twenty-one percent of students have no preference.

QID1 - Do you prefer written midterms or online midterms for a course like CPSC 121?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Do you prefer written midterms or online midterms for a course like CPSC 121?	1.00	3.00	1.70	0.80	0.65	23

#	Field		Choice Count
1	Written	52.17%	12
2	Online	26.09%	6
3	No Preference	21.74%	5
			23

Figure 3 Student Preferences on Going Paperless for CPSC 121

This data suggests that tackling student needs is a significant concern for a successful paperless transition. It is possible that this preference can change if core concerns are identified and addressed.

2. Most Common Student Benefits

An online midterm format for CPSC 121 entails specific benefits for the student experience. The data in **figure 4** identifies student responses about the main benefits they find applicable to their experience of online CPSC 121 midterms. The two main benefits are receiving midterm grades quickly and wasting less time on repetitive proofs. Clear evaluation and comfortable use are comparably less beneficial.

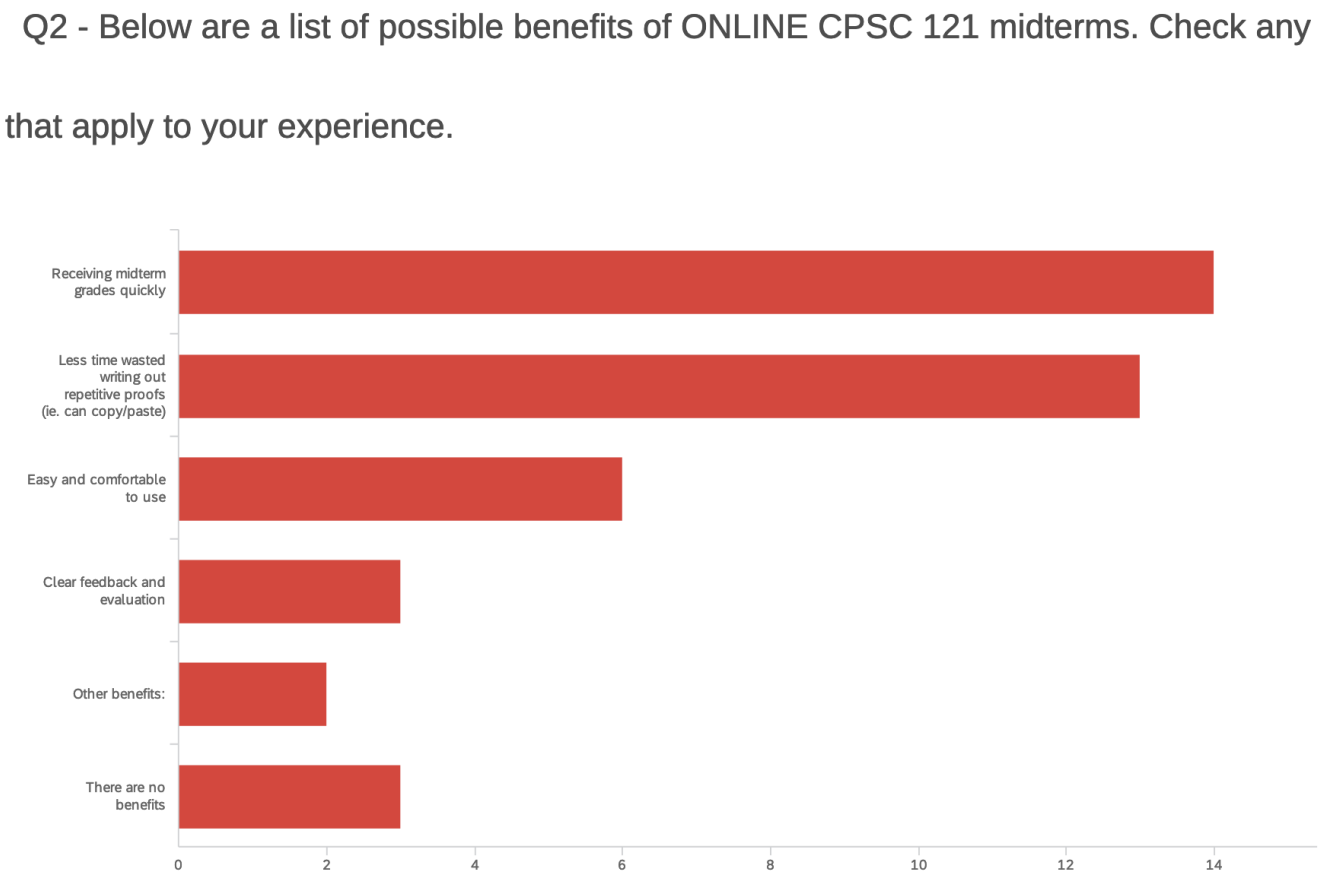


Figure 4 Student Perception of Benefits for Online Midterms

An effective solution ideally retains the two most beneficial elements of online CPSC 121 midterms.

3. Most Common Student Concerns

There are common and pressing concerns that exist amongst the student perspective toward online midterms. The data in **figure 5** identifies student responses about the concerns they find most significant in their experience of online CPSC 121 midterms. Notably, the top four concerns are nearly equally represented. This suggests that students find all the concerns applicable to their experience. There is a small percentage of students who maintain no concerns.

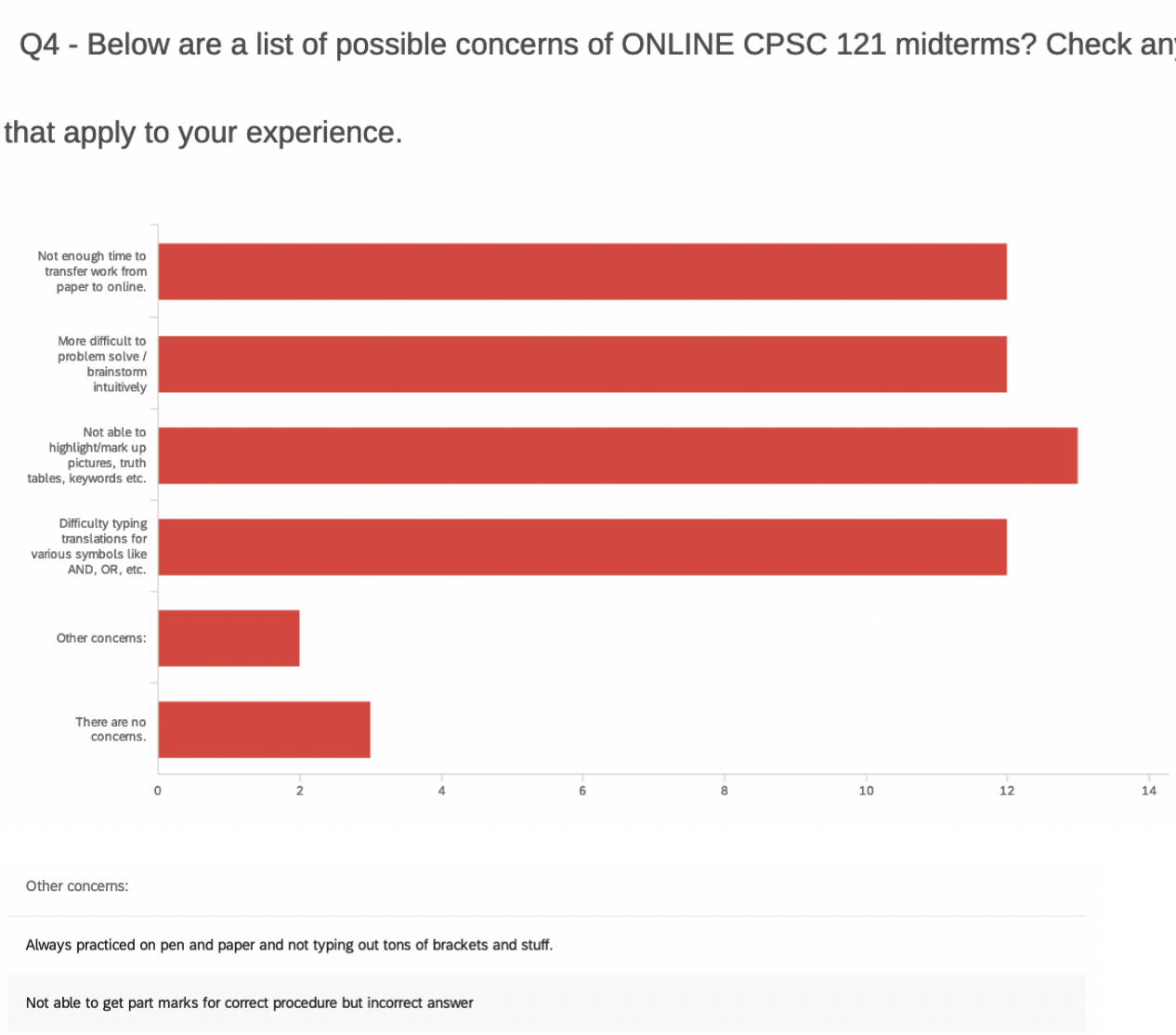


Figure 5 Student Perception of Concerns for Online Midterms

An effective solution should ideally address most (if not all) of the concerns established above.

4. Suggestions for Improvements

Through the discord survey, students are able to identify possible solutions and/or adjustments to enhance their CPSC 121 online midterm experience. The survey suggests that all three possible adjustments would impact student experience in a positive way. Importantly, having printed copies of major truth tables and pictures is ranked as the most useful.

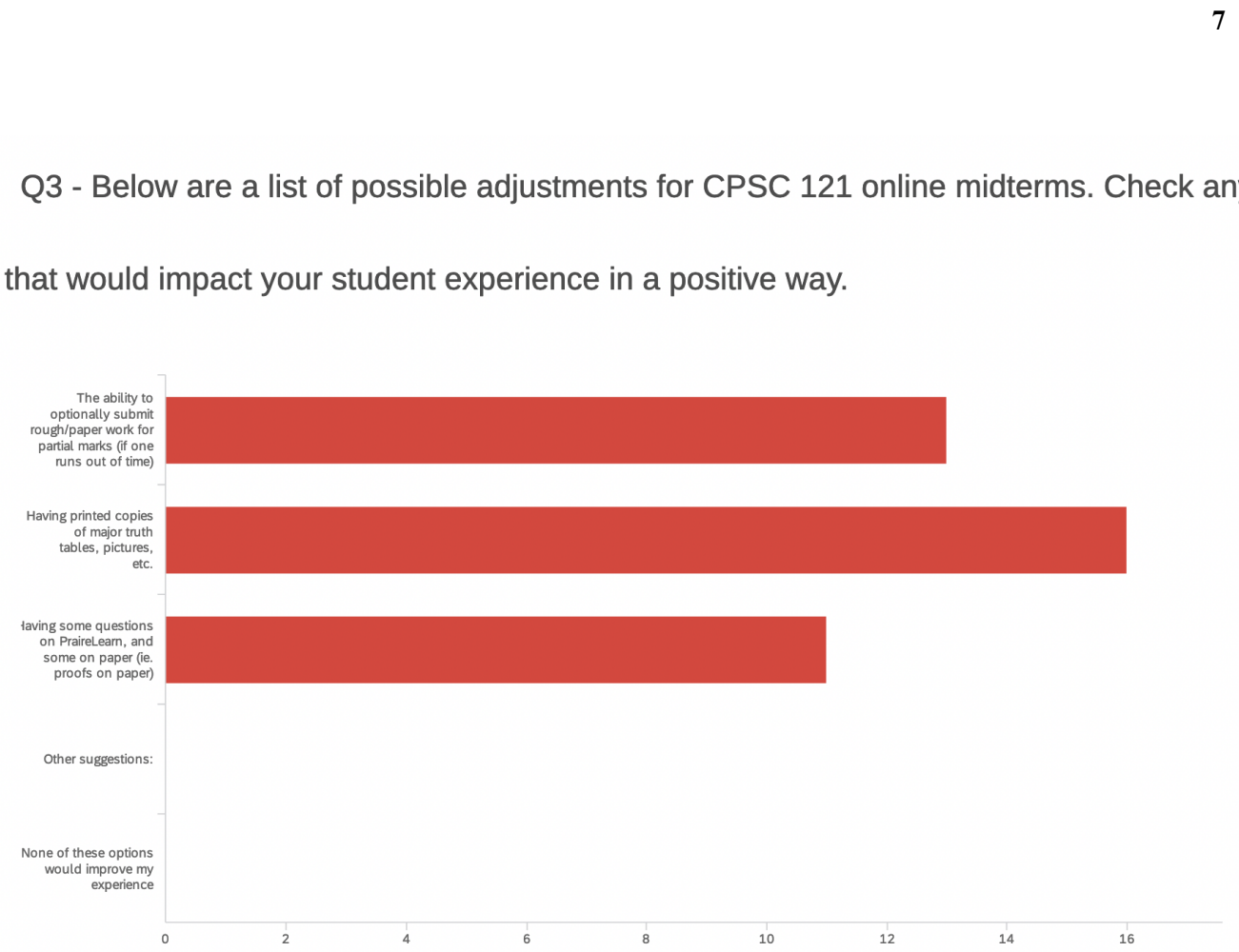


Figure 6 Student Perception of Possible Adjustments for CPSC 121 Midterms

A complete solution attempts to implement the adjustments that students find pertinent for a positive experience in the course.

B. Interview with Dr. Karina Mochetti

1. Reasoning and Background for Paperless Transition

Dr. Karina Mochetti, a professor of CPSC 121 and contributor to the PrairieLearn transition, provides vital feedback on the reasoning and benefits of going paperless. According to Dr. Mochetti, prior to online midterms, the amount of time teaching assistants and professors were spending on grading was exorbitant. Since proof-based questions are often long and elaborate, grading them becomes immeasurably difficult because there are multiple correct ways and orders to complete a proof. This

results in late feedback and grading for students, as well as evaluations being prone to human error. As per Dr. Mochetti, no matter how much time teaching assistants and staff would spend on grading,

there always remained a backlog because of the nature of discrete maths courses. Online platforms not only provide the means to eventually autograde some or all questions, via programming languages like python, but they are cleaner to read and digest. This allows teaching assistants and staff to spend time on more meaningful course improvements and lesson design. As well, students get feedback quicker and with more accuracy.

Furthermore, Dr. Mochetti emphasises that while the long-term goal of going paperless was always in the works, the Covid-19 pandemic accelerated the process. During December 2021, the surge of the omicron variant made it unsafe for many students to take the CPSC 121 exam, and the course had a record high of exam deferrals. Dr. Mochetti thinks that it is important for students to have flexibility when situations like this arise.

2. Long Term Goals

Since the course is early in its transition, Dr. Mochetti sympathises with student concerns on the current instability of online midterms. However, she stresses that long-term, the transition will be more accessible for all students. One of the long-term goals is to change the formatting of questions on online midterms. For example, a common student concern is converting elaborate proofs from paper to online. Dr. Mochetti assures that online midterms will be fundamentally designed for online use. Rather than having students write proofs from scratch, students will be able to drag-and-drop proof statements, or fill in the missing statement. Students must still understand the reasoning behind the proofs, but will find this new design amply suited for online learning.

Conclusion

A. Summary and Interpretation of the Findings

Based on the data from the CPSC 121 discord, students currently prefer paper midterms to online midterms. They cite concerns about transferring work online, translating symbolic logic through a keyboard, an unnatural problem-solving environment, and the inability to mark-up the page. Still, students list several benefits to the online transition as well, including receiving grades faster and writing more concise proofs with less repetition. Furthermore, student responses suggest that the online midterm experience can be improved with a few adjustments to the current format.

The interview with Dr. Karina Mocheti informs the staff perspective. She notes that there are several benefits with regards to the speed and efficiency of grading and feedback. She also deliberates on a structural design change in the format and model of questions used for online versus paper midterms. This adjustment provides insight on possible paths to take to fully establish a successful online discrete maths course.

B. Recommendation

The final recommendation, based on input data from the student survey and staff feedback, is as follows:

I. Printed copies of major truth tables, pictures, graphs and diagrams accompanying digital versions for students to mark-up, highlight and underline

II. A design change on the sorts of questions asked to students. Rather than re-creating paper midterms on an online platform, questions should be fundamentally suited for online platforms. For example, rather than writing proofs from scratch, students can drag-and-drop proof statements in the correct order, or eliminate which statements in the proof are incorrect.

III. For questions that cannot be designed to suit online needs, a rough answer booklet can be provided to every student. On PrairieLearn, if a student feels they cannot answer the question online, or they run out of time, they can flag the question to indicate that the work is done in this booklet. When the professor marks the student's work, they are able to access the scratch problems and award partial marks. Importantly, the paper option only allows for partial

marks. It is a fail-safe, rather than a go-to solution. In this way, the benefits of online grading, such as autograding potential, remains mostly useful. Students are incentivized to submit online for full possible marks. In the case of another lockdown, the rough booklet option is removed without many overall complications (though student experience inevitably suffers).

Appendices

Survey Questions

Survey Questions to the CPSC 121 discord can be directly accessed with this link: Survey questions – Qualtrics

Ethical Introduction

I am a UBC BCS student in ENG 301 engaged in writing a formal report about going paperless in CPSC 121. The purpose of this survey is to obtain primary data for an analysis and investigation that aims to collect feedback about the paperless transition in CPSC 121.The final formal report will be addressed to Dr. Karina Mochetti, a CPSC 121 professor. Along with an interview with Dr. Mochetti, the data I gather from this survey will serve the purpose of providing a feasible solution to address potential concerns and benefits of going paperless. The survey contains 4 multiple-choice questions, and it should not take more than 3 minutes of your time. Your responses are voluntary and anonymous. Thank you, I appreciate your generous participation in my survey.

Question 1

Do you prefer written midterms or online midterms for a course like CPSC 121?

Written

Online

No Preference

Question 2

Below are a list of possible benefits of ONLINE CPSC 121 midterms. Check any that apply to your experience.

Receiving midterm grades quickly

Less time wasted writing repetitive proofs (ie. can copy/paste)

Easy and comfortable to use

Clear feedback and evaluation
Other benefits
There are no benefits

Question 3

Below are a list of possible concerns of ONLINE CPSC 121 midterms? Check any that apply to your experience.
Not enough time to transfer work from paper to online.
More difficult to problem solve / brainstorm intuitively.
Not able to highlight / mark up pictures, truth tables, keywords, etc.
Difficulty typing translations for various symbols like AND, OR, etc.
Other concerns
There are no concerns

Question 4

Below is a list of possible adjustments for CPSC 121 online midterms. Check any that would impact your student experience in a positive way.
The ability to optionally submit rough / paper work for partial marks (if one runs out of time)
Having printed copies of major truth tables, pictures, etc.
Having some questions on PraireLearn, and some on paper (ie. proofs on paper)
Other suggestions
None of these options would improve my experience.

Interview Questions with Dr. Karina Mochetti

Question: What were your initial reasons for deciding to go the paperless route for CPSC 121?

Response:

- planning to do it because CPSC 121 is a large course and TAs spend a lot of time on manual grading. Humans make errors, while there is automatic grading on PraireLearn.

- symbols in 121 can be difficult to decipher in student writing
- many other compsci courses are trying PraireLearn as an online alternative
- long-term goal: changing exam format completely, randomised midterm scheduling for students
- can use html to draw and create questions on PraireLearn, can use python for autograding and randomly generating questions
- Covid-19, new variant last term, couldn't convert to online so only paper option was afforded, better to have a safe and healthy choice available

Question: Are there any drawbacks from the faculty perspective?

Response:

- not really many drawbacks on staff side
- there are drawbacks on the student side, but this is because the first term that everything changes will always be stressful and have some bugs / issues that need to be worked on
- Since Covid-19 accelerated the process, the change has been stressful on students and there are still certain aspects that we have not been able to fully transition adequately, but in the future, online midterms should be beneficial and less stressful for students

Works Cited

Mochetti, K., Tien, Geoffrey. (Winter 2022). *CPSC 121: Models of Computation.* University of British Columbia.