

Exploring How Students Use an Online Learning Environment

Jennifer Alexandra Thompson and Andrew Petersen

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References

[1] Venant, Using Sequential Pattern Mining to Explore Learners' Behaviors and Evaluate Their Correlation with Performance in Inquiry Based Learning.
https://doi.org/10.1007/978-3-319-66610-5_21

Background

earlier_name
Complete the following function according to its decribing description.

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def earlier_name(name1: str, name2: str) -> str:
    """Returns the name, name1 or name2, that comes first
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```

The learning tool, PCRS (above) is used to support a flipped intro to programming (CS1) course at the University of Toronto.

Our approach is to use sequential pattern mining to identify strategies in log data from multiple choice submissions, short coding questions and video watches.

Sample Log Data for Questions

User	Problem	Time	Status
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The approach we used in this research is heavily inspired by [1], which uses similar log data to explore how computer science undergraduates utilized a remote lab environment.

Method

First we defined single length strategies for our data and identified which were common.

Second, sequential pattern mining was used to find sequences of strategies that are common.

Behavioural strategies identified from log data of multiple choice and short programming exercise submissions. The exact problem being submitted (i.e., whether students jump between problems) is important.

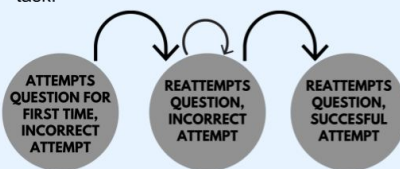
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The Common Problem Solving Strategy

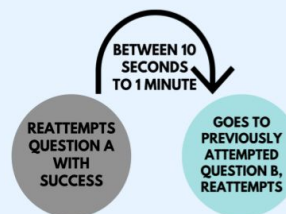
As expected, most (98%) students *primarily* solve problems in sequence. They repeatedly attempt the same problem before correctly solving it and moving to the next task.



Returning To Questions

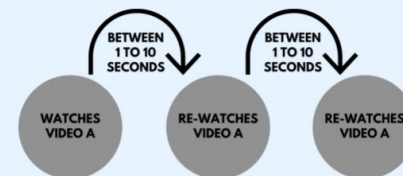
Students use video resources when they're stuck. Many students (55%) will watch a video and then return to a question.

Students also review questions they've solved before. Some students (~50%) successfully complete a different question immediately before returning to a previously attempted question.



Video Watching Patterns

Almost all students (94%) engage with the video content throughout the course. Even during a particularly busy week, ~80% of active students watched a video.



We observed many (85%) students perform multiple video watch events within a short amount of time. This suggests that they pause (and potentially rewatch) often.

Continuing Work

Overall, sequential pattern mining has given us insight into how students are utilizing this tool, which can be beneficial for educators. The work presented in this poster is part of an ongoing project. While sequential pattern mining has provided us with a valuable base, a drawback with our current technique is that we can only identify the presence of patterns in a student's usage. Our future aim is to identify the frequencies students use behavioural patterns to understand what are the most often used strategies amongst students in different performance groups.

Exploring How Students Use an Online Learning Environment

Jennifer Alexandra Thompson (Presenter)
Andrew Petersen

SIGCSE TS '21 - Poster Session 3



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Poster Overview

Today, we'll talk about how CS1 students use resources in an online learning environment to help support their learning. Specifically, I would like the listeners of this session to walk away with a better understanding of how students solve the majority of online learning questions and how students incorporate pre-recorded lecture videos in their learning.

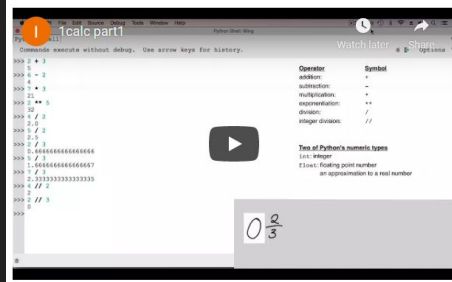
Background



PCRS: An Online Learning Environment used to support a CS1 course at UofT

Python as a Calculator (Video 1, 5:35)

Learn about Python as a Calculator



PCRS contains pre-recorded lecture content.

Multiple Choice Question

7/5

Which operation does the symbol `**` represent?

- ☐ multiplication
- ☐ division
- ☐ integer division
- ☐ exponentiation
- ☐ modulo (remainder)

History

Submit

PCRS contains multiple choice questions to test comprehension.

Price without tax

7/2

Variable `total` contains the price for an item including tax. Variable `tax` contains the amount of tax on that item. Write an expression to calculate the price of the item without tax and store that amount in a variable named `amount`.

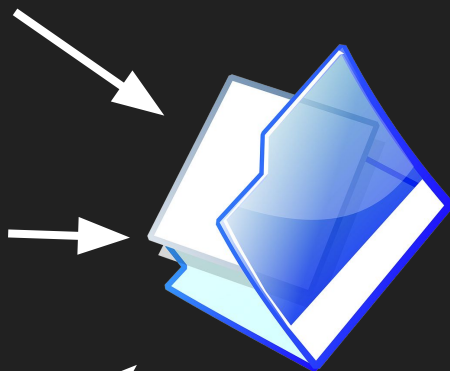
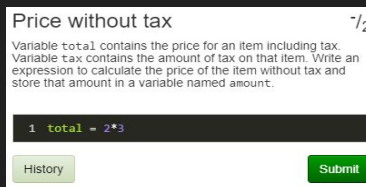
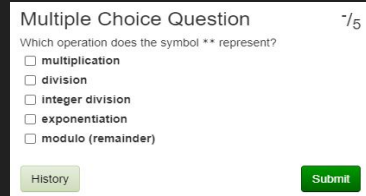
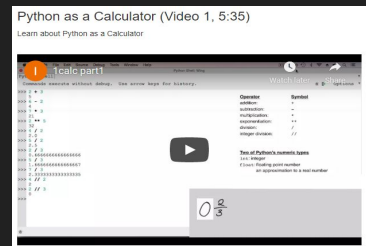
1 `total = 2*3`

History

Submit

PCRS contains coding questions to apply knowledge of content.

Background



Log Files for video,
multiple choice and
programming
questions.

Sample Log Data for Coding Questions

User	Problem	Timestamp	Status	Submission
#2	1	10:30 01/01/2020	Incorrect	<student code>
#2	1	10:35 01/01/2020	Correct	<student code>

Sample Log Data for Video Clicks

User	Video	Timestamp
#2	1	11:30 01/01/2020
#2	1	12:35 01/01/2020

Method

5-Index Question Behaviours

Question	Submission Order	Similarity	Success	Time
<u>M</u> - Multiple Choice Question Behaviour <u>C</u> - Coding Question Behaviour	<u>F</u> - First submission <u>R</u> - Resubmission to same question <u>C</u> - Revisiting finished question (review) <u>I</u> - Revisiting incomplete question (finishing problem)	<u>N</u> - New attempt <u>S</u> - Same as last attempt <u>P</u> - Same as a previous attempt	<u>S</u> - successful submission <u>F</u> - incorrect submission	<u>A</u> - 1-10 seconds <u>B</u> - 10-60 seconds <u>C</u> - 1-5 minutes <u>D</u> - 5-60 minutes <u>E</u> - >60 minutes

2-Index Video Behaviours

Video Behaviours	Time Watched
<u>N</u> - New video watch <u>E</u> - Same as last behaviour <u>S</u> - Same as last video watched but different behaviour came before <u>P</u> - Same as some previous	<u>A</u> - Between 1 and 10 Seconds <u>B</u> - Between 10 and 1 Minute <u>C</u> - Between 1 and 5 minutes <u>D</u> - Between 5 minutes and 1 hour <u>E</u> - Over 1 Hour

Method

Example: I make my first attempt on a new multiple choice question and the submission is incorrect. Resulting Behaviour: MFNF?

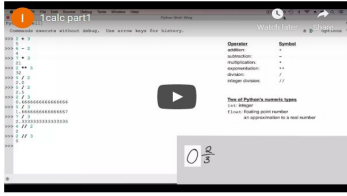
(where ? depends on the time between this submission and the previous submission)

5-Index Question Behaviours

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Method

Python as a Calculator (Video 1, 5:35)
Learn about Python as a Calculator



Multiple Choice Question 7/5
Which operation does the symbol `**` represent?
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Price without tax 7/2
Variable `total` contains the price for an item including tax.
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```
1 total = 2*3
```

History Submit

Log Files for video,
multiple choice and
programming
questions

MFNFA, MRNFB, MRNSB,
MFNSD, MFNSE, MFNSC, VNB,
VEB, MFNSA
MFNFA, MRNFB, MRNSB,
MFNSD, MFNSE, MFNSC, VNB,
VEB, MFNSA
MFNFA, VNB, VEB, MFNSA

Behaviours parsed
from log files.

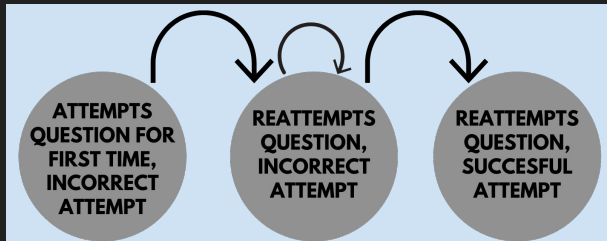
Sequential
Pattern Mining
is used on
behaviours to
find patterns.

(CM-SPAM %0
Minsup) detects the
presence of certain
patterns.

Observations

A Common Problem Solving Strategy

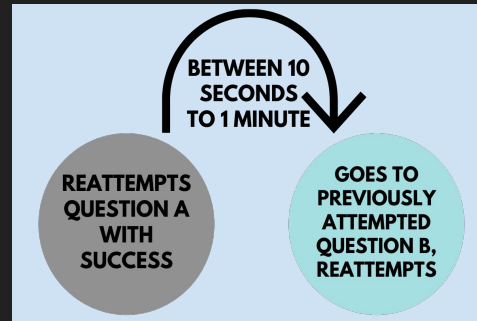
As expected, most students primarily solve problems in sequence (98% of students display this pattern at some point in the semester). They repeatedly attempt the same problem before correctly solving it and moving to the next task.



Returning to Questions

Students use video resources when they're stuck. Many students (55%) demonstrated watching a video and then returning to a question.

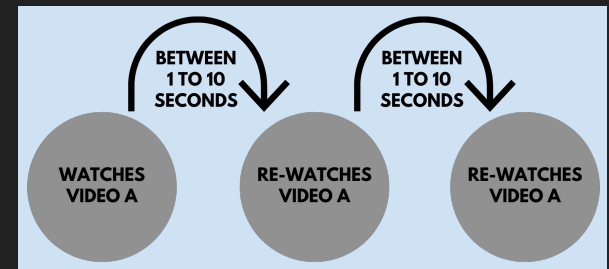
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We observed many (85%) students perform multiple video watch events within a short amount of time. This suggests that they pause (and potentially rewatch) often.



Future Work

While sequential pattern mining was an interesting tool to find the presence of behavioural patterns in students, it does not speak to how frequently students perform a pattern.

Future work goal: Conduct a frequency analysis on behavioural patterns of interest found in this work.

Additionally, it would be interesting to see how students of different performance levels use these behavioural patterns. Then, it may better understood which strategies are correlated with success or lack therefore of, in the course, if any.

Future work goal: Analyze patterns and frequency in groups of students of different performance levels.

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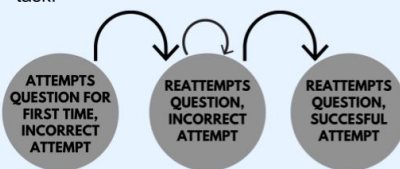
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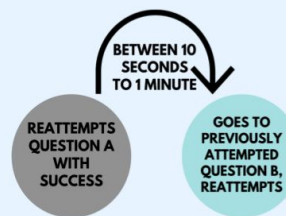
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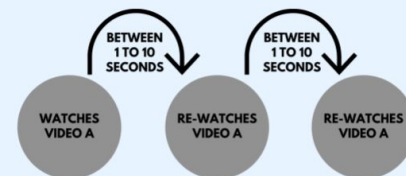
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