

6.UAP Final Report  
Design and Implementation of a Student Submission History for a  
Tablet-based Classroom Interaction System

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# 1 Introduction

This report describes my Undergraduate Advanced Project (UAP) working with the Classroom Learning Partner (CLP) team on augmenting their current software system. It outlines the process by which my specific feature was deployed, from brainstorming to design to implementation, and an analysis of its success and potential future improvements.

## 2 Background

### 2.1 Classroom Learning Partner

Classroom Learning Partner is a software system built to run on Tablet PCs and intended for use in 4-8<sup>th</sup> grade math and science classrooms to assist teachers while they give their lessons [Koile et al. 2010; Koile & Rubin 2013; Rubin et al. 2013]. The ultimate goal of the software is to facilitate interaction between students and instructors. It aims to accomplish this by supporting pen-based in-class exercises, providing direct feedback to the instructor about her students' work. Ideally, this feedback can be used to judge students' progress and gain insight into student understanding in real-time throughout the lesson, allowing the instructor to make changes on the fly or give extra attention to specific students. In order to provide useful feedback, CLP is designed to support students working on higher-order open-ended tasks that most current systems do not employ. Current wireless polling systems, for example, are limited to posing close-ended questions such as multiple-choice, matching, and true-false. CLP's interface for Tablet PCs grants students the freedom to generate solutions from scratch, rather than forcing them to select from a predetermined set of options. The general workflow of the system is as follows:

1. Instructors create electronic “notebooks” of pages ranging from simple questions to complicated word problems. These notebooks are distributed to each student’s Tablet PC.
2. Students answer the questions and wirelessly submit their solutions to the teacher.
3. The software system uses artificial intelligence techniques to automatically interpret and aggregate the answers when possible, enabling instructors to view a summary of in-class student work.
4. The instructor views the results and adjusts the lesson accordingly. He or she also has the option to select students’ solutions to display anonymously to the class using a projector. Such displays can be used as the basis for class discussion.

If integrated into a classroom properly, CLP has to the potential to make learning more efficient by keeping the students engaged and the instructors better informed.

## **2.2 Problem**

In past classroom trials, CLP team members have noted that some students would benefit from being able to view all of their past submissions for a specific page. The need stems from a couple different scenarios. The first case is when a student attempts to solve a problem in multiple ways. As an example, assume a student has submitted a correct response for the current page. She realizes, however, that she would like to try to solve it using a second method. In order to do this, she erases the correct answer she submitted and starts over from scratch. After trying to solve it using this method, she realizes that she would rather stick to what she did the first time. Unfortunately, she has already erased her past submission with no way to recover it, forcing her to completely redo her previous work.

The second case occurs when some students finish their work more quickly than others. Oftentimes after they submit their answers they proceed to erase their work to prevent their classmates from copying off of them. Other students erase their work to give themselves space to doodle while they wait. Since CLP currently does not store any information for a given page other than what is currently on it, there's no way to recover the work of these students. If later pages in the notebook make references to the original one, students who changed or erased their work no longer have anything useful to which they can refer.

## **2.3 Original State**

In the original state of the system, there was no way for students to view or edit their past submissions to the teacher. If students wanted to go back in time to a previous version of a specific page, they had to do it by manually undoing any changes they had made. This process was both difficult and inefficient, especially if the entire page had been erased. My project provides a useful tool that enables students to easily view and interact with previous versions of their work.

# **3 Solution**

## **3.1 Backend Design**

In order to make the submission history work, I had to adjust how CLP handled submissions as they came in. There were basically two potential approaches to being able to populate a student's history. The first involved retrieving the submissions from the instructor. Since all the submissions are already aggregated and saved on the instructor's machine, it would be feasible to gather a specific student's work for a given page from this collection. The second option was to

create and store a copy of the page on the student's machine every time a page was submitted. This option would allow the history to be populated locally rather than over the network. At the cost of creating extra copies of the same object, the second method proved to be cleaner, more reliable, and easier to implement.

## 3.2 Frontend Design

With the history data being supplied by the backend, my feature needed to provide an intuitive way to allow students to access it. There were a few key design concerns that needed to be addressed (see Figure 1):

1. Ease of use: Due to the young age of the target users, the feature had to have a clear purpose and only require simple actions to use.
2. Screen Real Estate: The new user interface components needed to be large enough to allow the students to easily use all of the features, yet still remain compact to avoid inhibiting their ability to use the application's other tools.
3. Styling Consistency: In order to maintain a uniform looking application, the new components had to look and feel like other similar features, e.g., displaying submissions for teachers or listing notebook page thumbnails.

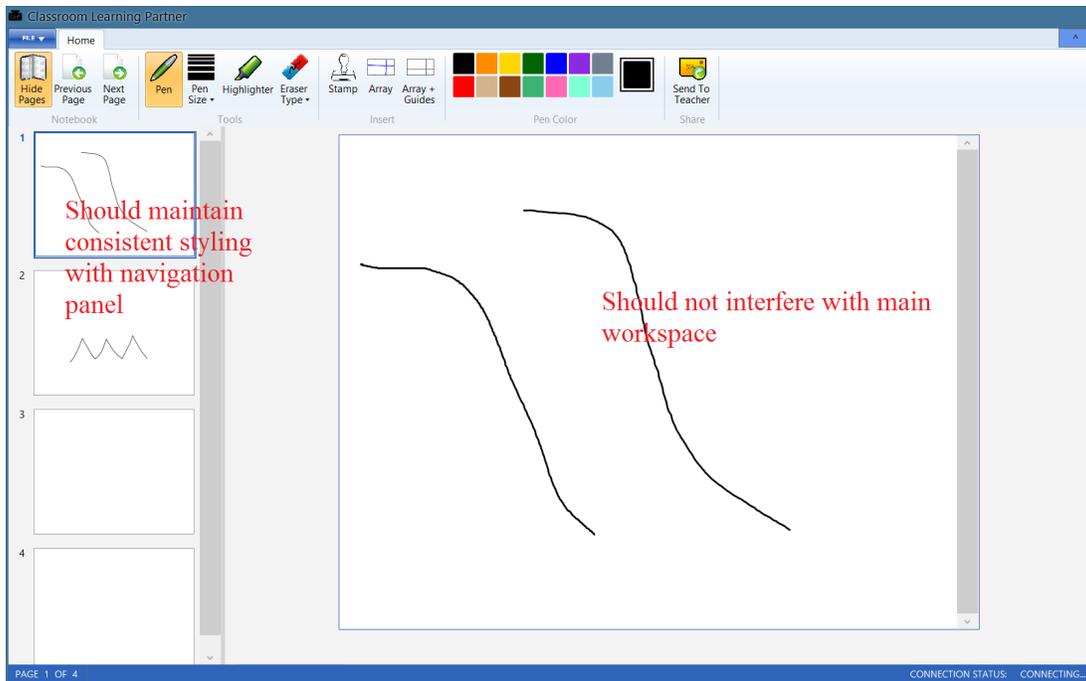


Figure 1. Screenshot of old user interface highlighting areas of concern.

The solution that best adhered to these criteria was one that used a collapsible tray to hold thumbnails of the past submission pages. It would be straightforward to use, take up very little space when collapsed, and would be consistent with other elements of the interface.

## 4 Implementation

### 4.1 Overview

After implementing the necessary changes to the backend, the student notebook objects now contain a dictionary mapping each page in the notebook to an array of submissions for that page. When the student submits an answer, a copy of the page is created and stored in this dictionary. If the student wishes to view past submissions for a given page, the corresponding list is loaded from the notebook and passed to the interface to be displayed.

On the frontend, there is now a button at the bottom of the student user interface that opens up the history tray. (See Figures 2 and 3.) This tray holds the thumbnails of the past submissions for the current notebook page in addition to a thumbnail for the current page (set in a fixed location at the left side so that it is easy to spot). Students can select any of these thumbnails to bring up the associated page in the main editing panel.

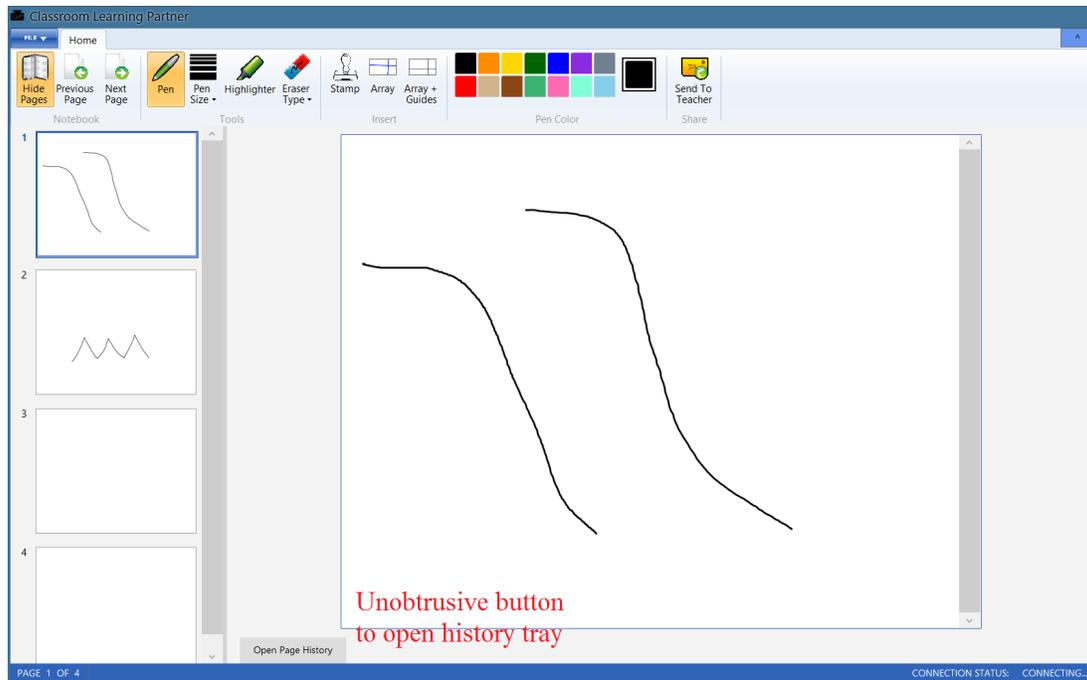


Figure 2. Screenshot of new interface showing discrete button for opening page history

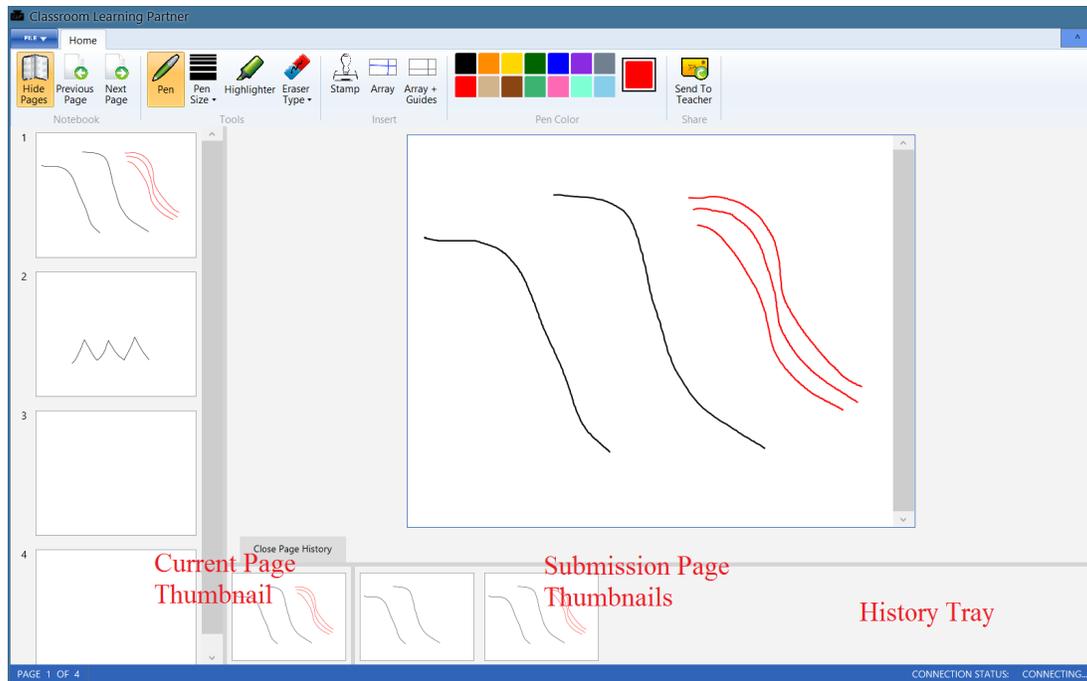


Figure 3. Screenshot showing open history tray with sample submissions

This design satisfies each of the requirements laid out earlier. A simple button to open and close the tray, in addition to familiar looking thumbnails, makes it easy for students to use the feature with little help. The consistent styling of the tray and the thumbnails inside keep the interface looking uniform. Finally, the ability to collapse the tray when not in use ensures students do not lose valuable workspace when constructing their answers.

## 4.2 Issues

While implementing the new feature there were, of course, some unexpected issues. Most of them were minor problems that required nothing more than simple bug fixes. There was one issue, however, that required some design thought. The problem stemmed from a student's ability to select a thumbnail from both the navigation panel and the history panel. Due to the consistent styling of these two components, it would often be difficult to determine which page was actually being displayed in the main workspace. (See Figure 4.)

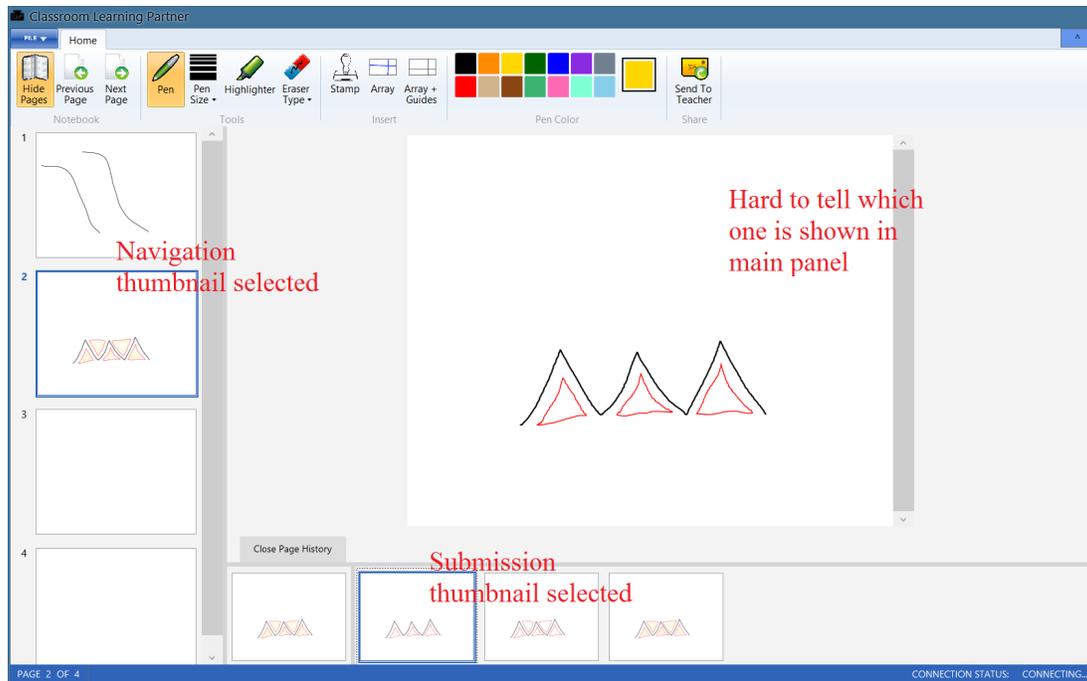


Figure 4. Screenshot showing ambiguity of selections

When a thumbnail is selected, a blue border is placed around it. Since the two panels are independent from one another, however, the application allows one selection from each list. This independent selection makes it impossible to tell which page is being displayed without examining the actual content. In order to combat this, there were a couple of options. The first was to somehow tie the two lists together so that there could only be one selection between them. This option proved to be overly complicated to implement. The second option involved indicating the list from which the selection was chosen. In order to implement this option, I changed the default selection border color for the history panel (to orange) and added a colored border around the main page. The color of this new border corresponds to the panel containing the page. Figures 5 and 6 illustrate this change.

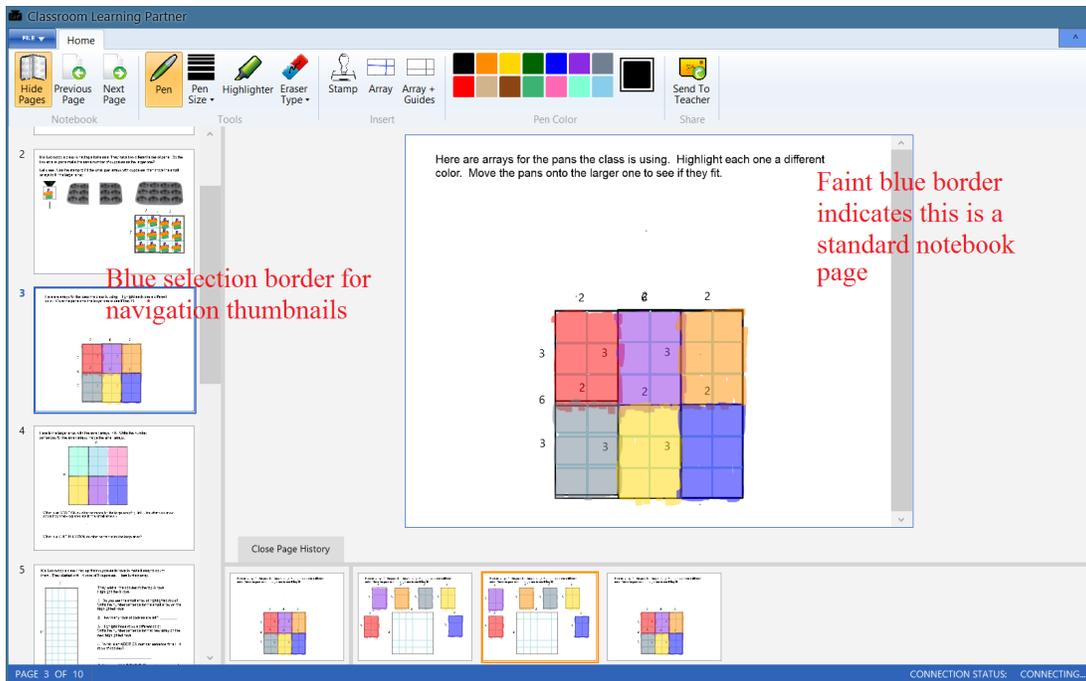


Figure 5. Screenshot of actual student work showing navigation page selection

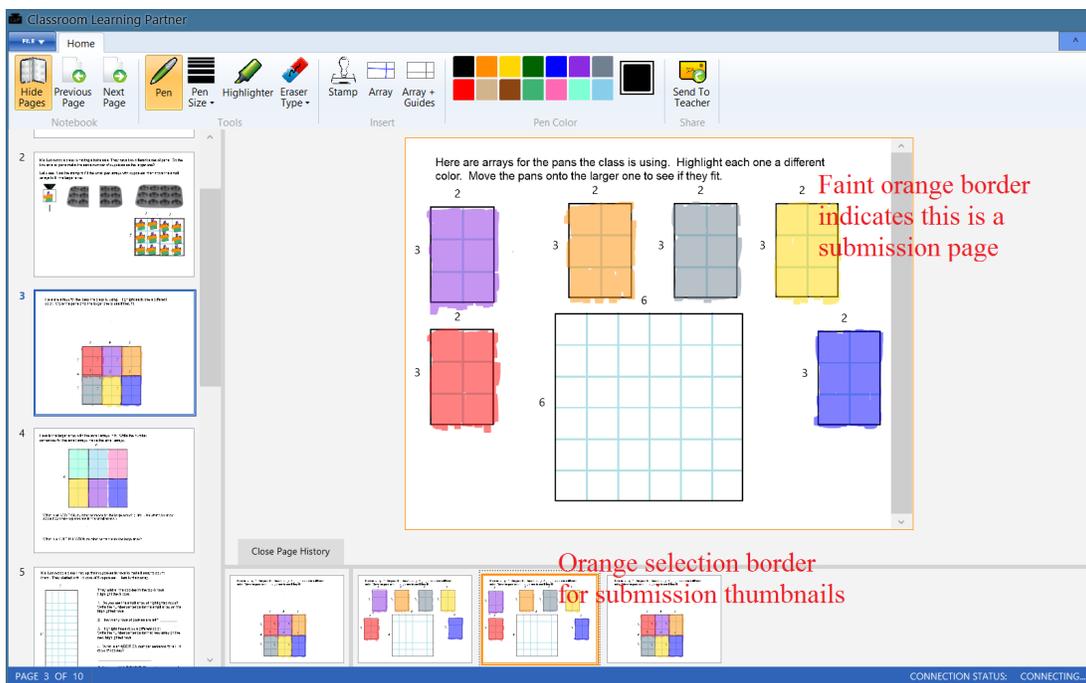


Figure 6. Screenshot of actual student work showing submission page selection

This solution provided a clean, simple way to indicate to the students whether they were looking at a standard page or a submission page.

## **5 Results**

On May 2<sup>nd</sup> and May 3<sup>rd</sup>, the CLP team went into two 4<sup>th</sup> grade classrooms to test out new features, including the new history panel. These visits gave me a chance to observe students using the feature and take notes on how successful it was. It seemed very intuitive for them. Finding the button to open the panel was easy, and selecting their previous submissions was straightforward since it was consistent with selecting thumbnails from the navigation panel. One student commented that the feature was “very cool” after accidentally deleting something and being able to recover it using the history. In another case, a student was able to preserve an answer that would have otherwise been lost. (See Figures 7 and 8.) For this example, the teacher asked the students to answer two questions on the blank pages at the end of the notebook. One student, however, used the same page for both submissions; i.e., he submitted his answer to the first question, erased it, and then wrote out his answer to the second on the same page. Prior to the history panel, his first submission would have been lost to him.

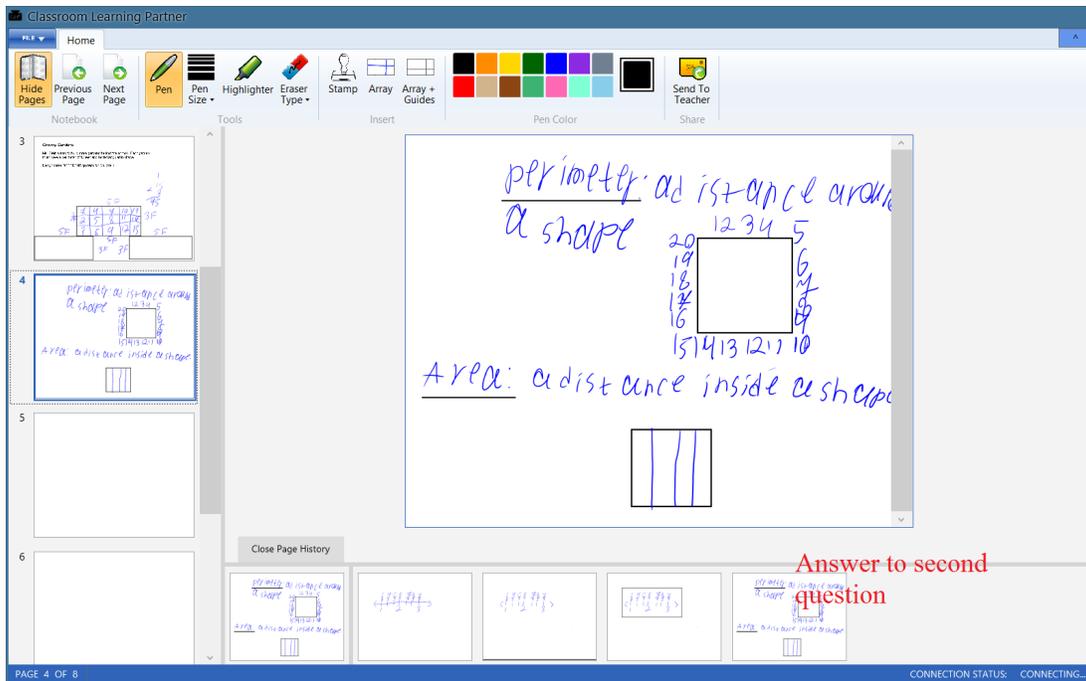


Figure 7. Screenshot showing student's answer to second question

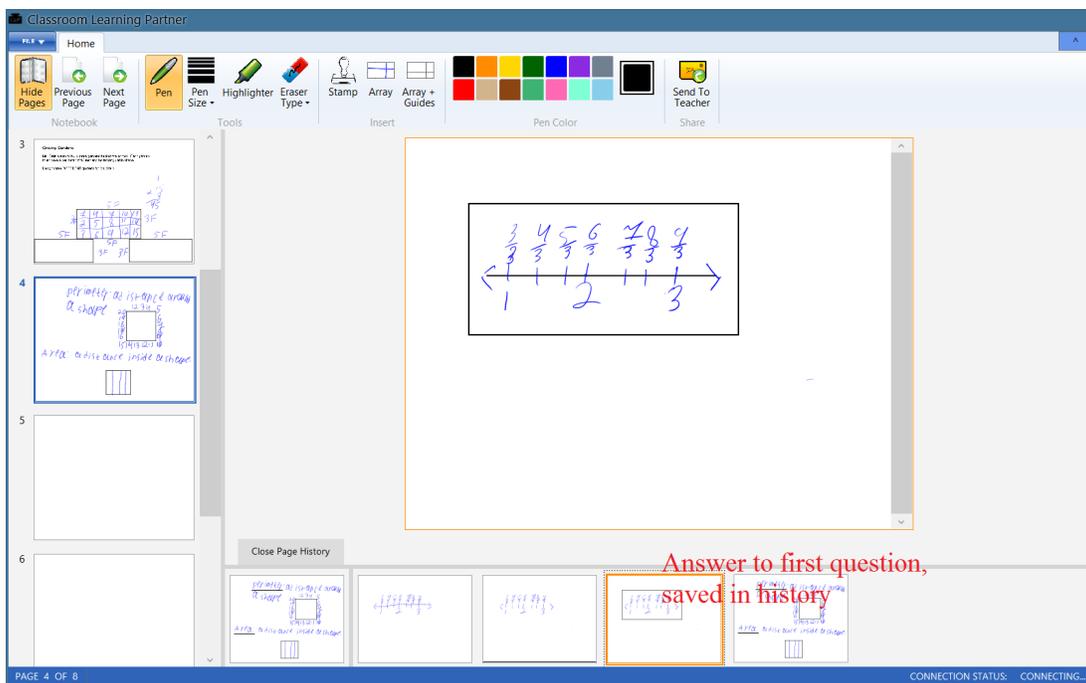


Figure 8. Screenshot showing answer to first question, preserved in the history

Overall, I was satisfied with how the submission history performed in the classroom and was happy with students' reception of it.

## **6 Future Work**

### **6.1 Saving vs. Submitting**

In future iterations of the history panel, it may be better to migrate to the idea of allowing students to create save points of their work. This option would allow students to have multiple versions of a page without having to submit all of them. Since students dislike submitting answers they know are incorrect, saving without submitting might encourage them to try out different approaches. If they do not have to worry about the teacher seeing their work, they might be more willing to experiment at the risk of being wrong. On the other hand, hiding student work undermines the concept of providing feedback to the teacher, so this solution may not be the best solution for the future. Classroom testing with students and teachers will help us investigate the trade-offs between saving and submitting.

### **6.2 Teacher/Student Feedback**

A potential extension of this project is to incorporate the idea of direct feedback on submissions; i.e., a teacher (or fellow student) would have the ability to write comments on a submission and send it back to the original author. The history panel could be adapted to hold these responses. This feature seems a good way to encourage more interaction in the classroom and is likely to be pursued in the near future.

## **7 Conclusion**

The addition of a student submission history to the CLP software improves the usability of the system in classrooms. It keeps students more organized by providing them with a list of their

previous work. It also can make them more efficient by helping them avoid redoing lost work. Finally, it encourages them to experiment with different approaches by allowing them to always go back to an earlier solution. Overall, I think that CLP's classroom success grows more and more with each addition such as this one. Hopefully it can become a routine part of many classrooms rather than being limited to our test classrooms.

## 8 Acknowledgements

I would like to thank my 6.UAP advisor, Kimberle Koile, for giving me the opportunity to work on this project. The project was stimulating and being able to interact with the kids in the classroom made everything so rewarding. I can see why she is so dedicated to making an amazing application to help these kids out. Under her guidance and enthusiasm I am confident that CLP project will one day have a big impact on the current education system.

## 9 References

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