Designing a Pen-based Flashcard Application to Support Classroom Learning Environment

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Abstract
Pen-based Flash Cards Application ("application") offers the flexibility of handwritten input while benefiting a wide set of users to increase their memory retention. It is particularly useful in learning mathematics where typing the material using a keyboard can be difficult. In this study, we describe the observations and major findings in a two-year case study in an eighth-grade geometry class. We found that this application may enhance teacher-student interaction, increase autonomy in students for self-guided learning, and encourage collaborative learning.

Keywords
Pen-based UIs and Education, User-Centered Design / Human-Centered Design, Pen and Tactile Input

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design

Introduction

Recently, pen-based applications have been successfully used in classroom settings [1], and several web based flashcard programs and numerous intelligent testing algorithms were studied in context of language training [2]. Most of them are text based and do not provide an easy and effective way for users to create and study the cards. In 2007, we created a pen-based Flashcard application to provide users an easy way to create the cards, a timesaving way to study the material, and an enjoyable way to increase memory retention.

The application was initially designed for individual learning. However, after deploying it in a classroom, we discovered its potential use as a collaborative learning tool. In this paper, we discuss our design methods, major findings, refinements made based on user feedback, and their impact on students and teachers as well as its contribution to CHI community.

Iterative Design Methods and Findings

In this study, we 1) observed how students use physical flashcards to study; 2) created and deployed the application in a classroom setting and conducted contextual inquiries of its use; 3) gathered the cards created by the teacher and the students; and 4) conducted interviews and surveys to enhance the application.

Designing by Observing Users

In the initial phase of this research, we observed that many students sorted the cards each time they studied. They found this process cumbersome, but necessary since their familiarity with the material changed over time due to learning and forgetting the material. To match the real world experience of creating physical flash cards and reviewing them, we developed two views: authoring view and game view in this application.

In the authoring view [figure 1], users can create cards. We found that it was important for the users to have a view of the cards that they have created so far. So, we created thumbnail view [Figure 1] of the cards so that users can easily view and organize them.

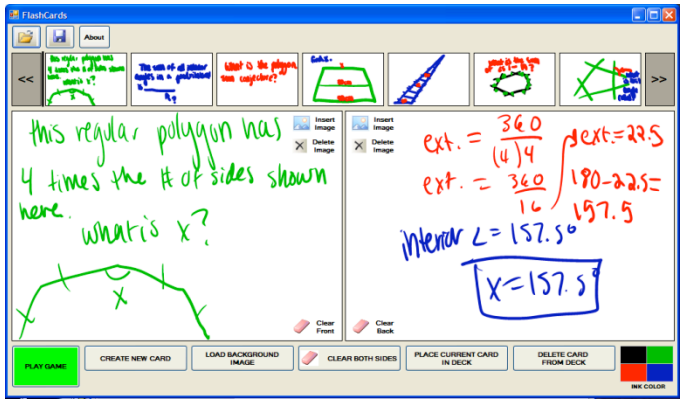

Figure 1. Authoring view of the application. It shows actual cards that an eight-grade geometry student created.

Deployment in a Classroom

We deployed the application in an eighth-grade geometry class in all girls' school in Pennsylvania, USA. Each year, there were 9 to 15 students enrolled in this class. We conducted contextual inquiries to understand how this application is used in the classroom setting. We found that there were two main ways that the users utilized this application: the teacher creates the cards in advance and reviews them with the students using the game feature; and the students create the cards individually for self-learning.

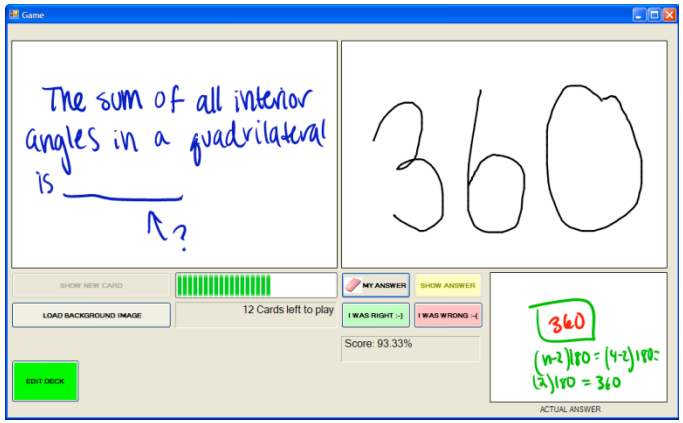

Figure 2. Game view of the application. The question is shown on the left panel, a place to write the answers is on the right, and the actual answer is shown on the bottom right.

The teacher suggested that sequentially reviewing the cards is important in learning new material since the knowledge of previous material is essential in learning subsequent material in math, whereas using the smart algorithm is beneficial for reviewing learned material. Also, the teacher requested an ability to easily share the cards amongst the students to encourage collaborative learning, and the ability to add images as the teacher already had the preformatted figures and graphs in .jpg and .gif formats.

Card Gathering, Interviews and Surveys

We collected cards created by the users and interviewed them after they have been using the application for a semester. We found that almost all of the students had been using the application on their own for other classes such as biology, chemistry, music, art, and foreign languages and found its use beneficial. They also used it for activities such as doodling and writing quick notes. Many students had this application open constantly when they used their Tablet PCs, which led them to use it more often for academic use as well. One student noted that "since I have it up all the time, I quickly make a card when a good question comes to my head."

At the end of the second year, we also conducted an anonymous online survey. It gave us an opportunity to hear from the students what they did not share during the interviews. We found that at least half of the students were concerned about the free rider problem in collaborative learning. Free riders are people who benefit from others' contributions without contributing themselves. However, they were still willing to share the cards with their classmates since they can "make sure that [they] are on the same page." Students also were weary that classroom collaboration tends to be time consuming due to the differences in opinions, so some preferred studying alone.

Refinement Based on User Feedback

We iteratively updated the application after analyzing the observations, contextual inquiries, interviews, and survey results throughout the study.

In the context of learning geometry in a classroom setting, an ability to insert image files, and learning the card contents first in the original order then in the smart-order were the most crucial needs. The current version of the application now includes these features. These helped the teacher to use the application interactively with the students before and after his lessons.

Furthermore, to provide an easy way to share the cards with other students, we created a Google Group where students upload their cards. From an earlier study, we found that merging the cards from four to five students was enough to include 80~100% of the study material [3]. So, by merging the individually created cards, then

distributing the merged cards back to the students, they could benefit from collaborative learning aspect without the free rider problem.

Impact on the Teacher and Students

The students were eager to use the application. They felt superior or more advantaged by using the application that their peers did not have. One student summarized the feelings of many saying "it was a funner way to study than using the dry textbooks." The flexibility of the application for non-academic use increased the likelihood for them to use the application for academic use.

The teacher was delighted that using this application increased students' participation in the class, encouraged students to study on their own, and supported them to learn from each other by sharing the cards. He stated that students are more engaged in the class as its game feature promotes more two-way interactions between the teacher and the students compared to traditional lecturing.

Contribution and Conclusion

In this study we enhanced a pen-based application to encourage collaborative learning in a geometry classroom. We found that a majority of students were concerned about the free rider problem, but it did not stop them from willingly sharing the cards with each other.

We also found that 1) to support collaborative classroom interactions, the application needs to support both the teacher's teaching methods and the students' learning needs; 2) providing flexibility for non-academic use increased students' autonomy in using the application for academic use; and 3) while we support collaboration, we also need to support customized, individual learning through mechanisms such as smart learning algorithms.

Overall, this study illustrates a successful deployment of a relatively new technology – pen based application – in a classroom setting. We discovered implications for the design of such applications for collaborative use within the complex social setting of schools, teachers, and students. Further studies in larger classrooms and in different subject areas would advance our knowledge in designing and enhancing the application and other such educational software.

Acknowledgements

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