Cloze: Designing an Authoring Tool for Teachers with Low Computer Proficiency

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ABSTRACT

Teachers become increasingly engaged in computer-mediated instruction when they have control over the content. This engagement is critical for the effective use of computers in education. In India, however, two related prevailing conditions limit teacher engagement in computer-mediated learning. First, the low level of teachers' computer proficiency means it takes considerable effort to create digital content. Second, a lack of appropriate content authoring tools significantly increases the time the teachers take to create content. Together, these conditions pose a hindrance to teachers creating digital content and consequently, their disinclination to engage in computer-mediated learning. In this paper, we report on a 34-week field study in Indian peri-urban schools. We identify key issues impeding digital content creation by teachers with low computer proficiency and present an authoring tool, Cloze that successfully addresses these findings. Finally, we discuss general issues associated with designing authoring tools for teachers with low computer proficiency.

Author Keywords

Authoring tools, wizards, content templates, low computer proficiency users, teachers, educational technology

ACM Classification Keywords

H.5.2 User Interfaces; K.3.1 Computers and Education

INTRODUCTION

Developing countries like India are increasingly employing computers in the delivery of education [16,6]. Initiatives by both the Indian government and non-governmental institutions have seen mixed results: an increasing rate of computer penetration in schools – currently at 16% [14] – but no clear sustainable impact on learning [5]. Barrera-Osorio, in evaluating computer-based interventions in education, attributes the ineffectiveness of computers to a "failure to incorporate the computers into the educational process" [6].

The dominant usage paradigm of computers in Indian schools revolves around Computer Aided Learning (CAL) applications [11]. CAL applications are typically self-paced and combine various multimedia elements to guide a student through a particular topic with little or no teacher mediation. For example, to teach fractions, a CAL application would have videos that introduce the student to the concept of fractions. Next, it would guide the student through more advanced manipulations and applications of fractions using games and other interactive elements. This paradigm of use, however, is not always suited for the current Indian education process. For example, in cases where CAL applications are substitutes for teacher instruction, Linden reports that significantly less learning occurs [12]. Furthermore, CAL applications tend to leave teachers out of the learning loop as teachers often have limited control over the CAL content. This creates a gap between the learning content covered in the classroom and that covered with the CAL applications, ultimately leaving the students' curricula needs unfulfilled and limiting the effectiveness of the CAL application.

To bridge this content gap, providing teachers with authoring tools for CAL applications is essential. Additionally, we have observed that teachers become more engaged in the computer-mediated learning process, and develop a sense of ownership and responsibility for this approach to learning, when they have control over content. Unfortunately, digital content creation rarely happens where teachers have low computer proficiency and no appropriate authoring tools.

In this paper, we report observations of key issues affecting computer usage and digital content creation by teachers with low computer proficiency in three Indian peri-urban schools. Building on these observations, we present an authoring tool that successfully employs content templates and wizard interfaces to simplify content creation for CAL applications by teachers with low computer proficiency. Finally, we discuss the implications for designing authoring tools for teachers with low computer proficiency.

MOTIVATION AND RESEARCH GOAL

The MultiPoint project investigated the financial [18] and learning [17] outcomes of enabling multiple students in resource-constrained schools to share one computer, each using his or her own mouse. During the study and related pilots, students collaboratively interacted with CAL applications with pre-packaged content that covered general learning topics such as vocabulary acquisition. To increase
the relevance of the content to the students’ curricula, the teachers expressed an interest in the ability to use their own content with the MultiPoint applications (e.g. add new words to the vocabulary game that would appropriately challenge the students given their learning level). To use their own content, however, the teachers needed to know how to write code – a skill a typical teacher does not possess – as no authoring tools existed for MultiPoint applications.

Thus, the goal of this research was to design an authoring tool that teachers, especially those with low computer proficiency, could use to create content for CAL applications like MultiPoint ones.

In addition to enabling teachers to create digital content for CAL applications, focusing on the type of interactive activities enabled by MultiPoint meant we were considering a good example of integrating computers with pedagogy, as teachers engaging students in their own learning is a proven pedagogical strategy [7], and computers provide a great platform for delivering interactive activities [10].

RELATED WORK
While several content authoring tools aimed at teachers are available (e.g. yTutor [1]), very few have been rigorously evaluated. This section briefly covers related work on authoring tools for teachers and design of interfaces for novice computer users.

Authoring tools like REDEEM [2] help teachers create learning environments from built on their pedagogical principles.

Learning content development systems: Applications such as Cognitor [15], Hot Potatoes [3] and Microsoft LCDS [4] primarily focus on designing learning content for e-learning environments. Moreover, such applications tend to target professional educational content creators and do not cater to end-users with limited computer proficiency.

JeLSIM toolkit: The JeLSIM toolkit [21] is a software suite, which facilitates easy creation and customization of Physics and Math simulations. A relevant aspect of the toolkit is that it provides different interfaces based on user computer proficiency. To create identical simulations, a JAVA programmer has access to a programming interface whereas a teacher, without the programming skills, has a graphical interface with visualization objects like graphs that simplify the process of creating a simulation.

Mouse Mischief: Mouse Mischief [13] is single display groupware that extends MultiPoint to support whole classroom formative assessment. Using an add-in to PowerPoint, teachers can create interactive learning activities for whole classroom teaching.

While all the above provide digital content authoring for teachers, none of them specifically consider content authoring for simple CAL applications or evaluate the interfaces for authoring content by teachers with limited computer proficiency.

Another informative related area of work looks at the traits of novice users as distinguished from experts [9]. These traits include, for example, dependence upon system features such as informative feedback that assist recognition memory and aid task completion. Considering these traits will be essential particularly given the computer skills of the participating teachers.

METHODS
We conducted 2 weeks of extensive in-school class observations and semi-structured teacher interviews. The findings from the initial interviews resulted in a 4-month iterative design of an authoring tool and finally, a field evaluation consisting of a 3-month pilot in one school. The following sections describe each phase in detail.

Initial Observations

Teachers
We observed 28 teachers and 3 administrative staff across three peri-urban schools in India. We spoke to mainly grades 6–10 teachers (93%) and two kindergarten to grade 2 teachers. The teachers taught subjects covering: Computers (14%), Languages (25%), Math (18%), Science (10%), Social Science (18%), and other such as Physical Education (15%).

All of the teachers had access to computers in the schools, but they varied on their use and proficiency with the machines. The least proficient (22%) hardly touched the computers, whereas the most proficient teachers (17%) could create PowerPoint presentations with complex animations, and even web pages. The remaining teachers (61%) were adept with certain applications (e.g. Microsoft Word, PowerPoint); however, they only utilized the few features with which they were familiar. On average the proficiency of the teachers rank well below the average skill level of a “digital native.”

While most teachers (90%) held positive views on computer use in education, three teachers (10%) expressed serious doubts. Two of the three intimated that computers have no relevance for their subjects, while one feared that computers devalued the direct interactions teachers have with students.

When teachers spoke positively about computers, they centered on the computer’s ability to grab students’ attention.

\[1^{a} \text{A term coined by M. Prensky to refer to people who have grown up with technology and are fully conversant with computers [19].} \]
attention. They also commented that using visuals helped students understand concepts better and that computers were beneficial in this regard. Four teachers (14%) indicated that computers helped them keep abreast professionally with the latest news in their subject areas.

**Computer Usage**

Computer-mediated lessons largely occurred in computer labs. Teachers would take students to the computer lab for a class period – they avoided splitting a class period between in-class teaching and computer lab time as the transition between the two rooms was time consuming. We observed only three instances of in-class use of a computer/project system: one was in support of student project presentations; another was a kindergarten teacher who showed pictures of sea creatures from a prepackaged application; and the third was a science teacher who interleaved videos of seed germination with regular teaching.

The lab lesson typically took one of two forms: *cal* or *presentation*. In the *cal* form, students interacted with *cal* applications. During the course of the lesson, the teacher was hardly involved, apart from answering a few questions or keeping order. We often observed some teachers leaving the students alone and only returning after the period was over. During a typical school week, students participated in 2-4 *cal* mode lessons.

In the *presentation* form, teachers introduced new topics via PowerPoint or showed videos or pictures related to a topic already covered in class. In this mode, the teachers were more engaged, interleaving teaching with visualizations of concepts or projected problem questions that the class to worked through together.

This latter mode did not occur often: 25 out the 28 teachers reported doing such presentations about two times in six months, with the rest reporting a rate of twice a month or more. Teachers noted that a major hurdle limiting the *presentation* form of computer use is the time required to gather materials and author the presentations.

A key observation here was that the *cal* mode, although it was the most common form of computer usage, did not support good interactive learning: teachers were hardly involved the learning process. The teachers felt frustrated by this: a few viewed the *cal* mode as the “children only playing games,” and a loss of valuable time that they could have used to cover more content in the classroom. Those who found *cal* applications useful still expressed a desire to specify the content the students interacted with, especially for the self-assessment applications. The teachers wanted control over the content so that they could be as involved in the learning as they are in the *presentation* form.

**Digital Content Creation**

Teachers authored three main types of digital content: administrative documents (e.g. lesson plans), worksheets, including quizzes and PowerPoint presentations. The teachers mainly used the presentations to introduce new topics or show images related to the week’s lesson topic. The worksheets were used for end-of-lesson assessments.

On average, the teachers created and used 2-3 worksheets a month and two PowerPoint presentations in a 6-month period. While most teachers took an average of 3 hours to prepare a 45-minute lesson, teachers with low computer proficiency took upwards of 6 hours spread over several days. These teachers attributed this time sink directly to their slow typing speed. We also observed that most teachers would gather information and have the computer lab managers create their presentations for them.

A key observation here was that very few teachers (18%) created new content from scratch during our observation period. They all relied heavily on their textbooks and other curricula materials as sources (some from the Web) for their digital content. Some teachers did adapt and add to the content as they copied it, but most created slides or worksheets that were exact copies of the textbook content.

**DESIGN GOALS**

From the observations and interviews, we identified three key issues related to computer use and content creation:

- Although some teachers found the CAL applications useful, the lack of control over content frustrated them and sometimes led to them disengaging from the learning process. This could place students at a risk of not learning [12].

- Low computer proficiency resulted in long content authoring times. Consequently, this limited the authoring of digital content.

- Teachers rarely created content from scratch, but instead relied heavily on existing content.

The goal was to address the first issue by designing an authoring tool that allows teachers to create content for CAL-like applications. This would further engage them in that type of learning process, thus resulting in a more productive use of the computing resources [12].

Considering the teachers’ computer proficiency levels, the issue of authoring time, and the teachers’ reliance on existing materials, we set the following goals for the authoring tool:

- It should have a simple, intuitive user interface.
- It should require very little of the teacher’s time to generate an activity.
- It should provide the ability to integrate textbook and other curricula materials to support the teachers’ existing practices.

**DESIGN AND PROTOTYPING**

From the design goals, we developed a prototype authoring environment for interactive activities.
Methodology
The design process was highly iterative. We spent the first month building an initial prototype. The remaining 3 months consisted of iterative improvements based on feedback from in field-testing with teachers and two formal usability tests involving seven teachers.

First Prototype
The initial prototype supported the creation of the following interactive activities – we established these based on observations of the activities teachers engage in with their students, which we could easily replicate on a computer:

- **Labeling**: given a piece of text or an image, students provide labels for different parts of the text or image.
- **Matching**: given two lists, students match elements from one list to elements in the other.
- **Identifying**: given an image or text with a list of labels, students have to select the labels that match the areas of the image or text the teacher specifies.
- **Quizzes**: a set of questions with or without answer options that the teacher poses.

The key concept behind this prototype was to use a wizard (see Figure 1). Wizards are user interfaces designed to walk one through complex task completion by sub-dividing the complex task into smaller specific ones [8]. Thus, this sought to enable simple, guided content entry for the teachers.

To allow for easy manipulation of the graphical elements of the interactive activity, we initially adopted the visual-slide metaphor from PowerPoint, with which the teachers were already familiar (See Figure 2).

**First Prototype: Creating Content**
Each activity had its own input wizard for content entry. Thus, for example, to create a quiz activity, a teacher would click on the ‘Quiz’ button in the toolbar.

This would launch a wizard (Figure 1) where the teacher would add their questions and options. After the teacher completed the wizard process, the system automatically added the quiz content to the current slide (as shown in Figure 2). On the current slide, the teacher could then edit any text, change the position of UI elements (e.g. buttons, timer), clear the contents of the slide, save or delete the slide.

**Feedback**
The wizard input interface was well received; however, the visual-slide metaphor posed teachers difficulty. First, the fact that the first thing they saw was a blank canvas proved a bit confusing – they were not sure what to do because they did not yet have an expectation of what to create for an interactive activity.

Second, by providing an interface that allowed the editing of graphical elements (e.g. buttons), the tool had the teachers working at a low level of UI manipulation. For example, when they made mistakes in the content, the teachers found it difficult to edit the text on the generated buttons. The inconvenience was such that they would start an activity all over again instead of fixing the incorrect text on a button.

Thus, although the wizard was successful, the visual-slide metaphor introduced unexpected difficulties for content editing. Consequently, we redesigned the tool from a PowerPoint-like interface to a wizard-only approach (see Figure 3). This meant a teacher only provided the content for an activity and did not have to handle the nuances of manipulating UI elements. Field-testing confirmed that the teachers did not miss the slides and preferred the new approach.

**Second Prototype: Improving Navigation in the Wizard**
Having lost the visual slides, further feedback suggested we pay more attention to the design of the navigation through the wizard to keep the teachers from getting lost.
For example, the prototype divided parts of a task over multiple screens to simplify content entry for the teachers. For instance, in the quiz activity, the first screen provided general instructions; the next screen would ask for the quiz question; the following screen would require entering all the choices and the final screen would allow the teacher to mark the correct choices.

A usability test, however, revealed that splitting one task over too many screens presented an undue cognitive load for the teachers, as it required them to keep mental track of too much information. We rectified this successfully by bringing all elements of a single task together on one screen: for example, in creating a quiz activity, a teacher specifies the question; the choices; the correct option; and the timer value on the same screen (see Figure 3). Further iterations over the wizard interface concept resulted in a simple, intuitive interface that required little time to enter content for generating an interactive activity.

Third Prototype: Introducing Content Templates
The next set of iterations focused on allowing teachers to create digital content from existing content. The key concept was to add a content template feature. Content templates are activities with pre-populated curricula based content, which a teacher can modify to their liking and use instead of creating an activity from scratch (See Figure 4).

This feature allows textbook makers or curriculum developers to create content templates with their materials and make them available to the teachers, thus saving the teachers the time and effort needed to transfer the textbook content for digital use. The field-tests of the content template feature were successful, with teachers requesting a feature that would also save their own lessons as templates, thus allowing other teachers to reuse and build of their creations.

Final Prototype
The final prototype of the tool, which we named Cloze, combined two key features that enabled the tool to cater to the needs of the target teachers. The wizard interface provided appropriate instructions and feedback – effective for novice users [9] – that allowed teachers to create activities in a simple, intuitive and timely manner and content templates enabled the teachers to create activities from existing content, thus both saving them time and matching their natural methods of content creation.

To create an activity, a teacher could select either an existing content template or a new lesson. This would bring them to an 'Activity Selection' screen where they could pick an activity to create (see Figure 5).

3 The name was derived from the Cloze Method [20].
Once an activity is selected, the teacher moves through the wizard for that activity, providing the necessary content. When the teacher saves the activity, students can then interact with it (see Figure 6).

Satisfied with the stability and usability of the tool, we conducted a field study to validate its efficacy.

FIELD STUDY
The goal was to develop an authoring tool for teachers with low computer proficiency. To ensure that we had achieved this goal, we ran a pilot where we left the tool in a school for 3 months and evaluated its impact based on observations, interviews and logged usage data.

EVALUATION PILOT
To evaluate Cloze, we installed it on nine computers spread across two computer labs in one school. We then provided a two-hour long course, including practice sessions, for 10 teachers on how to use Cloze. The following sections describe the pilot and its outcome in more detail.

Method
The version of Cloze installed on the machines included a log feature to track the edit history of the activity lessons teachers created. In addition, we also visited the school every two weeks to have informal interviews with the teachers and collect the logged data.

Log Data
The log files for the created lessons contained the following: the lesson name, the author of the lesson, the number of activities in the lesson; the name of the machine it was created on; and a timestamp for when the file was created. If the file was edited after the creation date, a note with a timestamp and information on the changes were appended to the file.

Informal Interview and Observations
We visited the school every two weeks to collect data and observe how the teachers were using the tool. During this time, we engaged in several informal interviews with the teachers to get a sense of what they thought of the tool and collected feedback for improvements. In cases where the log files showed interesting activity, we followed up with the teachers to get a better understanding of the context.

Results
The log data collected indicated that five different authors created twelve lessons over the three-month period. One teacher created eight lessons, three of which were on behalf of two other teachers who were not part of the original teachers who received training. Two of the authors were computer lab teachers and the others where English, Math, and KG teachers.

The remaining five teachers who did not use the tool at all reported time constraint as the reason. Further inquiry revealed that they were mainly interested in using Cloze for quizzes during class, but this required them to move their students back and forth between the labs where the computers are situated and the classroom. The time involved in the shifting process was significant enough that they found printing or writing questions on the blackboard a more suitable option.

All the activities created were quizzes, except for two, which were image-labeling activities. One quiz activity was a derivative of a pre-existing one, with some questions removed and others added. On average, the quizzes contained 10 questions, with an average of four options.

Of the 10 quizzes, seven consisted of content from textbooks and other supplemental materials. The other three contained new content created by the teachers. The two image-labeling exercises came from curriculum materials, but used pictures obtained from the web.

Although the number of lessons seems small, conversations with the authors revealed that over the same 3-month period, they had only created an average of two other digital activities or presentations.

The authors used three different computers – two of these were the primary workstations of the computer lab managers and had projectors connected. The logged data also included several uncompleted lessons started by various teachers not part of the original training group.

During the bi-weekly visits, the teachers we spoke with provided many more ideas for features. We implemented two – a reading comprehension activity and a grade viewer.

Discussion
In this section, we discuss the key results from the pilot. We cover the following topics: (1) ease of use of Cloze (2) content creation patterns and (3) the choice of interactive activity.

Ease of Use: Informal interviews and observations of the teachers showed that the teachers found the interface and interactions intuitive, particularly for quizzes and image labeling activities. A computer lab teacher reported getting more requests from colleagues to create digital quiz activities for them after word spread that the creation
process was now faster and easier. Additionally, the math teacher reported that Cloze allowed her to focus on only entering content and not "fretting over the formatting issues" involved in creating a PowerPoint presentation. The wizard interface significantly reduced the time and effort needed to create and administer quizzes in her class.

Creation patterns: The pattern of content creation matched with what we observed in the initial interviews: teachers built off existing materials. Most of the activity content came from textbooks and one teacher created a new quiz by adapting an existing quiz created by another teacher.

During the course of the pilot, the school acquired access to an online question bank. Following that, three of the five active users repeatedly asked, "can you also hook the program up to Asset [the online question bank], so we don't have to keep copying and pasting?" This further confirmed the teachers' reliance on pre-existing content and underscored the utility of Cloze's content template feature in simplifying the process and reducing the time required for the teachers to create content.

Choice of interactive activity: One unanticipated outcome was the lack of variety in the activities created. Even though Cloze supports four different types of interactive activities, 10 of the 12 lessons created were quizzes. This correlates with the pre-Cloze environment where quizzes were also the most common interactive activities. This outcome, in part, speaks to the conservative nature of teachers when it comes to content creation: they replicate what is most familiar to them.

Overall, the pilot re-emphasized the teachers' natural tendencies for content creation and demonstrated that Cloze aligned well with these tendencies and made content creation easier and less time consuming for the teachers.

Implications for Designing Authoring Interfaces for Teachers with Low Computer Proficiency

In this study, we observed and demonstrated that providing a simple, intuitive wizard interface that supports easy integration of existing content makes it easier for teachers to create digital content. Below, we provide three considerations for designing authoring tools for low computer proficiency teachers.

Provide simple interfaces: Very few teachers are interested in environments that require significant typing, programming or manipulation of UI widgets (e.g. buttons). The handholding, only-content-needed, nature of a wizard interface is best suited for teachers with low computer proficiency.

Provide content-primitives: Teachers prefer to assemble content from various sources when creating content. Making it easy for teachers to integrate existing content, particularly those they often use, greatly simplifies the content creation process and time required.

Incorporate the pedagogy: Teachers use tools that align well with their pedagogical methods, experience, and comfort levels. Even though we provided different types of activities, teachers mostly created quizzes, as this was already part of the school's pedagogy. Integrating pedagogical practices in the design of content authoring tools provides an incentive for a teacher with low-computer proficiency to utilize the tool.

Overall, we find that the above three factors do lower the barrier for digital content creation by teachers with low computer proficiency. However, given that the study was limited to one particular group of teachers, we caution against generalizing our results beyond this group. Nevertheless, there are grounds to suspect that these findings will apply to a broader set of low computer proficiency teachers.

CONCLUSION

The effective use of computers in learning requires teachers to be engaged in the computer-mediated learning process. This engagement occurs when teachers have control over content creation. In this paper, we present Cloze, an authoring tool that successfully meets the unique needs of teachers with low computer proficiency to simplify digital content creation for them. Through 34 weeks of field study and a pilot, we observe that such teachers prefer to work off existing content, rather than from scratch; and that these teachers perceived Cloze to be intuitive, but made limited use of its features. Additionally, we discuss the implications for designing authoring tools for teachers with low computer proficiency.

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