

Collage: A Presentation Tool for School Teachers

Saurabh Panjwani, Aakar Gupta, Navkar Samdaria, Edward Cutrell
Microsoft Research India

Kentaro Toyama*
University of California, Berkeley

Abstract— We present *Collage*, a software application designed for classroom presentations for school teachers in the developing world. An in-depth investigation of teaching practices in several schools in India led us to believe that a simple tool that enabled the display of images and textbook materials while facilitating blackboard-like interactions would be very helpful for these teachers. Collage is a simple media viewer with a small number of features that enables teachers to prepare lessons with little overhead and then present them in classrooms with maximum flexibility. The tool was piloted in three schools in suburban India for use in real-world classroom teaching. All teachers who used Collage uniformly praised it, and students' learning of visual concepts seemed to improve through it. Interestingly, some teachers continue to use the tool now for their own teaching needs and have spontaneously shared it with colleagues from other schools.

Index Terms—Computers, education, presentation, software.

I. INTRODUCTION

"We need something that helps students visualize things and [that] works as a blackboard at the same time."

- Teacher, Govt. school, Bulandshahar, India

The use of computers and digital projection systems is becoming increasingly common in schools across the world, even in developing regions. As the costs of projection systems fall [1], and the technology becomes more accessible to schools, it is imperative to understand how software and content could be best designed to utilize such technology in classrooms. The question is particularly pertinent for K-12 (i.e., primary/secondary) education: despite the steady rise in technology's penetration in K-12 schools, research on its effective utilization inside the classroom is practically non-existent.

While there could be many creative uses for such technology, our focus here is on one aspect – designing software tools to help *teachers* present digital content to students in a K-12 classroom. To the best of our knowledge, there is no software application that has been designed specifically for this purpose, although general-purpose tools – like Microsoft PowerPoint – seem to be extensively used in classrooms at all levels. Today, over 6 million teachers use Microsoft PowerPoint for classroom instruction across the world, out of which at least 250,000 reside in India alone [2],[3]. Still, there is very little research on the effectiveness of PowerPoint as a classroom presentation tool in K-12 schools.

* Address all correspondence to saurabh.panjwani@microsoft.com

In this paper, we describe a new software tool called Collage, which was specifically designed for making digital presentations in K-12 classrooms. Our target environment for this tool constituted schools that are equipped with a minimal amount of computing hardware (e.g., a shared PC and projector) and the requisite infrastructural requirements; the number of schools of this variety, even in the developing world, is now steadily rising.

We created Collage through a two-phase process involving close interaction with teachers in our target environment. The first phase was an in-depth exploration of current practice in eleven technology-equipped schools in India, wherein we investigated the classroom needs of teachers as well as their mode and extent of technology usage. Our exploration culminated in a set of four design principles which were then used in the second phase to implement our tool. The implementation involved a participatory design process: teachers in one school experimented with intermediate versions of the tool in their classes and provided ongoing feedback. This phase lasted nine months, after which the tool was piloted in two additional schools in suburban India.

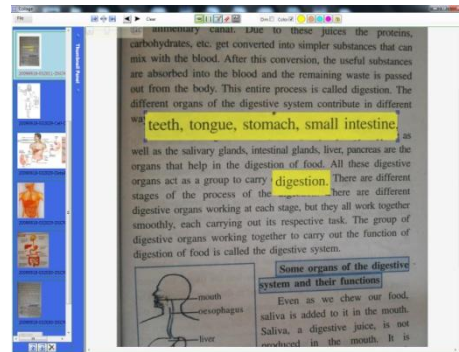


Fig 1: A screenshot of Collage.

In overall design, Collage is quite different from general-purpose presentation tools. Instead, it resembles a media viewer that can display digital images, videos and scanned copies of textbooks and other paper materials. What differentiates it from traditional media viewers is that Collage enables users to interact with digital content—particularly content derived from paper—while it is being displayed. For example, teachers can use Collage to highlight and annotate different parts of a textbook, to overlay media elements on a textbook page and to arbitrarily switch between a textbook page and multimedia files *as they are presented to students*. Besides meeting teachers' requirements for presenting classroom lessons,

Collage is designed to reduce the effort involved in authoring presentations ahead of class.

The teachers who used Collage in our pilot schools report a strong preference for the tool over PowerPoint, the only other presentation software they are familiar with. Their feedback indicates that Collage is not only easier to learn and use, but also offers greater flexibility for presenting material to students. In addition, both teachers and students rate Collage as being significantly better-suited for displaying visual content in the classroom than PowerPoint. An important measure of their approval is the fact that some teachers have continued using Collage in their classrooms after the pilot observation period was over.

A key contribution of this work is the idea of using scanned versions of paper materials in preparing classroom presentations. To the best of our knowledge, this has not been investigated thoroughly in prior work in the research literature, even for developed-world education. Our users report several advantages of this technique and state that Collage is well-suited to exploit these advantages. Preliminary research in one of our pilot schools also shows that intermingling textbook-based content with digital multimedia, as facilitated by Collage, can improve students' retention of visual concepts, plausibly due to improved mental association between such concepts and textbook content.

II. RELATED WORK

A. ICT for classrooms

The idea of using computing technology as a teaching tool is not new and computers with digital projectors have been used in K-12 classrooms for at least a decade [4]. There has been considerable research on the benefits of equipping schools with computers, ranging from impact assessment of technology immersion in schools [5],[6] to providing laptops to all teachers in a school system [7]. There is much ongoing debate on the value of equipping schools with ICTs and there are several works which particularly criticize schemes which call for replacing traditional tools (like textbooks, blackboards) with computing technology [8]. Linden, Banerjee, Duflo and others from the Poverty Action Lab [9],[10] study questions around technology usage in developing-region schools and provide evidence suggesting that ICTs are ineffective substitutes to teacher-led instruction in these schools, even where teacher capacity is limited. They do, however, report some instances of ICTs playing a positive role in *complementing* already-effective classroom activities.

A specific classroom technology that has attracted considerable interest in the developed world is the interactive whiteboard (IWB) [11]. Even with their prevalence in developed-world schools, research on the design of presentation software for IWBs to suit existing teaching practice seems limited. In contrast, Collage was designed while taking teachers' preferences into

consideration. For reasons of cost and scale, it has been tested with a standard data projector, but it is also compatible with IWBs that use Windows.

There has been some research on the design of software authoring tools for teachers [12], but most of this work has been carried out in developed-world contexts. Authoring tools provide flexibility to teachers in terms of choosing content but they also place more demand on their time. One of the design goals of Collage was to make content preparation easy for teachers; as such, an authoring component was excluded from its design. (Teachers instead rely on pre-prepared content like textbooks, hand-drawn diagrams, web-based materials to prepare presentations.)

There is also a rich body of research on designing appropriate software for *students*, for the purpose of self-directed learning or development of skills like story-telling, programming and communication. This paper uses a different model of technology-aided learning, wherein a single unit of hardware is shared across a large number of students in a classroom and interaction with content is mediated by a teacher. Such a model may be more fitting for developing-world classrooms, where access to technology is scarce and student-computer ratios are high, although a precise cost-benefit comparison of the two models is beyond the scope of this paper.

B. Presentation Tools for K-12

The use of digital technology is prevalent in K-12 classrooms in the developed world, and is on the rise in the developing world as well. Presentation tools commonly used in the K-12 classroom range from general-purpose slideware technology like PowerPoint and Apple's Keynote software [5] to a variety of media viewers [5],[7],[11]. Based on current knowledge [2],[3],[5],[13],[11],[14] it seems safe to assume that PowerPoint is the most-heavily utilized software presentation tool in today's K-12 classrooms. No data on utilization and effectiveness of other presentation software seems to be currently available.

C. Presentation Tools for Higher Education

There has been some work on designing special-purpose software presentation tools for the undergraduate classroom. Perhaps the most notable amongst these is the work on Classroom Presenter (CP) [15],[16]. Collage bears a resemblance to CP, though there are some key differences. First, the context is very different – our focus is primarily on K-12 classrooms where the teacher has limited computer skills. Second, CP is designed mainly to support digital inking on PowerPoint slides, whereas our goal is more general – we wish to support existing pedagogical practices in K-12 classrooms. Third, CP operates only on PowerPoint slides, whereas our tool accepts anything that can be represented as a digital image. Finally, CP supports various multi-user interactions (e.g., a facility for capturing student feedback and one for distance learning) which our system currently lacks.

D. Presentation Tools that Integrate Digital and Paper

The idea of using paper content in electronic presentations has been considered in past work. The visualiser [9] is a tool that allows instructors to digitally project paper-based content (from textbooks, hand-made slides and notes) in real time and provides basic functions like zoom and perspective variation. This technology is becoming increasingly prevalent in developed-world school and university classrooms [9]. Even with its advantages over overhead projectors, the visualiser is limited in that it does not support integration of paper with digital multimedia.

Other techniques that incorporate paper in digital presentations include the use of barcoded paper for slide navigation [17] and of interactive paper for real-time annotations [18]. Both techniques were designed for use with PowerPoint and neither underwent a teacher-centric participatory design process.

Finally, there is considerable literature on combining paper and digital media for different applications in development e.g., microfinance [19] and healthcare [20], but none, to the best of our knowledge, has applied this idea to classroom presentations.

E. Presentation Tools and Pedagogy

Studies of the pedagogical benefits of software presentation tools are currently limited to PowerPoint-based instruction for undergraduate instruction. Experiments have shown that the use of PowerPoint slides can increase students' engagement levels when compared with instruction using overhead projectors and chalkboards, but the difference in learning outcomes is often insignificant [14]. Studies have also shown that the learning benefits of presentation software can be greatly improved by enabling post-instructional access to the content of the presentation [21]. There is some research evidence that the use of PowerPoint in K-12 education can be enjoyable for teachers, but, compared with the use of blackboards, it does not lead to a noticeable change in students' learning outcomes [22].

There is also work that argues against the use of PowerPoint for teaching and/or learning. The arguments range from criticisms of specific features of the tool [23],[24] to attacks against its overall design [23]. Many claim that PowerPoint suppresses teachers' spontaneity and reduces interactivity in the classroom [23],[25]. We know of no study comparing the pedagogical value of PowerPoint with that of other presentation software.

III. INITIAL FIELD EXPLORATIONS

Before designing Collage, we conducted an investigation of current practices in K-12 schools in India, with a specific focus on the use of instructional technology. We visited 11 schools (nine public, one private, one semi-private) in and around two cities in India, Bangalore and Pune. The medium of instruction in all but one public schools was the primary local language of the region (Kannada in

Bangalore, Marathi in Pune); the remaining three schools were English-medium. We interviewed 24 teachers in these schools and conducted 21 classroom observations.

Since one of our goals was to understand how teachers used or might use technology for instructional purposes, we worked closely with partners (NGOs and corporate social responsibility initiatives) who had experience providing technology support to schools. All public schools in our sample were identified with the help of these partners. The remaining two were reached through personal contacts. This sampling process naturally created a bias towards technology-equipped schools but such schools were indeed the focus of our research.

Each school in our sample had a computer lab with at least 6 computers. The private school had the most computers (40, with a student population of 700). Availability of additional hardware varied: 6 of the 11 schools possessed a digital projector meant to be shared by all teachers; the private school had two such projectors and 5 had one. The remaining 5 schools did not have a projector, but all had a TV with at least a 21" screen. Seven schools were equipped with a digital camera, 3 had a digital scanner and 2 had access to the Internet.

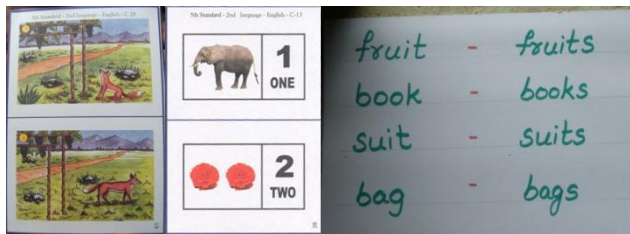
The teachers we spoke with came from a diverse set of backgrounds: they spoke at least 5 different languages, and their teaching experience ranged from 2 to 26 years. Teachers taught a variety of subjects including language, mathematics, science, social science, environmental science and computers. There were 13 secondary school teachers (grades 8-10), each holding a bachelor's degree in education (B. Ed.) and sometimes even a master's degree. The remaining were primary and middle school teachers (grades 1-7), with a bachelor's degree in some discipline, typically followed by a diploma in education. Teacher salaries were in the range of USD 150 – USD 400 per month. Sixteen teachers were female, the rest male.

The interview sessions were one-to-one, open-ended conversations with the teachers, lasting at least an hour each. We queried teachers on a number of topics including their approach to content and preparation, their teaching styles, their usage of PCs and their views on the applicability of PCs for classroom teaching. We attempted to make classroom observations as unobtrusive as possible, and abstained from interacting with students or teachers. Two out of the classroom observations were of technology-enabled classes. In sum, the interviews and observations accounted for at least 50 hours spent in the field.

A. Findings

One of the key findings from the study was that teachers in our sample schools made extensive use of paper-based equipment in their classes and during class preparation. Most of the tools teachers used in class (besides the chalkboard) were made of paper and included things like textbooks, student workbooks, posters, flash cards and occasional handouts. Teachers treated the content of

textbooks as the main source of information: every teacher prepared his/her classes using the content of the textbooks, and 11 out of 21 classes we observed made explicit use of textbooks both by the teacher and the students. A common phenomenon we observed in all the public schools was the use of paper-based flash cards as presentational aids (figure 1). During class, teachers often held a flash card in hand and walked about the class to facilitate visual access or circulated the card around the classroom. Some classrooms had posters pasted on the walls, which were reportedly also used as presentational aids.



(a)



(b)

(c)



(d)

Fig. 2: (a) Flash cards are commonly used in Indian public schools. Oftentimes, teachers make their own flash cards using paper and color pens. (b) A quizzing device made by a public-school teacher using cardboard. (c) Teachers use textbooks not only for class preparation but also during instruction. (d) The blackboard is the most heavily used presentation tool in all schools we visited.

The blackboard was the single most important presentation tool used by teachers: 19 of the 21 observed classes used it. Teachers used the blackboard in a spontaneous manner, each adopting a unique style to create content on it while teaching. They wrote on it almost exclusively by themselves – in only 4 classes (out of the 21 that we observed) did students write on the blackboard during instruction. As reported by the teachers, at least 90% of all classes in the schools used blackboards, on average.

1) Technology Usage

Schools used computers primarily to promote student self-learning and sometimes for teaching specific computer skills; these activities always took place in a dedicated computer lab. In the two cases of computer-based teaching we observed, teachers taught a group of 30-40 students using prepared PowerPoint slides. The nature of these classes was very different from the blackboard-based classes we witnessed e.g., all interactions between the teacher and students were oral in nature and did not involve any real-time creation of written content; in one class, even students did not take notes. The PowerPoint slides were heavy on text animations, often accompanied by sound effects. PowerPoint-supported classes ran faster than regular ones and teachers seemed to perceive them as a way to revisit portions of the curriculum that had been covered in regular classes while maintaining student engagement.

Teachers' desire to use computers for instruction and the actual usage never matched. Every teacher we spoke to said that he/she would like to be able to make more frequent use of computers for teaching than they currently did. Six of the 24 teachers said they had never used a PC for instruction, even though they had access to one. Only 4 out of the 13 teachers who had access to a projector reported using it more than 4 times a year. One teacher said that she would like to use the school projector once a week, but admitted that she had not done this even once in the past year.

This low utilization of technology by teachers was rarely due to unavailability of functional hardware or the difficulty of sharing it (though these were cited as reasons, too). The main reasons teachers given to us were: lack of proficiency in using computers; and lack of time to prepare content.

The first reason was often more critical. Most of the teachers had very limited access to computers in their everyday lives (only 7 had a PC at home), and as such, were not confident technology users. One issue that affected their comfort level with PCs was their lack of expertise with typing: 13 out of the 24 teachers explicitly stated that they were dissatisfied with their typing speed and 9 out of the 13 teachers with experience using PowerPoint stated that typing was a deterrent for using it in the classroom. Language was cited as a barrier to developing comfort in typing: all schools had English keyboards, but none of the teachers were native English speakers.

Lack of preparation time emerged as the other main reason for the low use of PCs in classrooms. A majority of the teachers expressed a desire to be able to prepare and present content to students, but complained that they could never find enough time to do this regularly. Thirteen out of the 24 teachers interviewed were familiar with PowerPoint (typical through IT training programs) and told us that they liked to use it for instructional purposes. But only 2 of these admitted to have made more than 4 PowerPoint presentations for their students in the past year. In a separate survey of 41 school teachers across India (mostly from public schools), we found that teachers who use PowerPoint

spend an average of 5.5 hours preparing a *single* PowerPoint slide deck for a 40-minute lesson. This is more than 10 times the amount of time they reported spending on preparation for regular classes. As one teacher commented:

I don't use PowerPoint in class, [although] I used it in my company where I was employed earlier. Time factor is the main reason for us.

2) *Computers as Visualization Tools*

Ten of the schools we visited had received CDs with multimedia content from different vendors. Teachers were divided on their opinions of these CDs: some expressed unequivocal liking for such content, particularly for content developed for self-aided learning, while some complained that it was difficult to modify the content at will. One teacher said that despite having received multimedia CDs as donations, he was creating his own digital image collection using computing resources at an Internet cafe.

When asked about their motivation to use technology for instructing students, teachers universally stated that computers are useful to help students visualize curricular concepts. This was evident in the PowerPoint presentations we witnessed: Over 75% of the slides teachers used in these presentations contained at least one picture and the use of text was minimal (at most 33 words in a slide)¹. At one school with recently-acquired digital projector and laptop, teachers stated that they would use the new equipment only to show pictures to students. There were at least 8 teachers in our sample who, despite not having access to the Internet at school, reported to have spent time in cyber cafes only to gather images for their classes. One of these reportedly spent 2 hours in a café to download pictures for a single PowerPoint presentation. All but 3 of the teachers who had used PCs for presentations reported to have got their visual materials off the Internet. The rest used multimedia CDs.

B. *Design Principles for a New Presentation Tool*

Based on information gathered during our field visits, we defined the following design guidelines for a software presentation tool for our target teachers:

1. **Keep it Simple:** The tool should be easy to use and the time required to prepare presentations should be minimal. Utilization should not require mastery of typing skills. All components of the tool should be implementable on a standard PC (with cheap input devices) and a projection device.
2. **Display Images:** The tool should facilitate display of multimedia, in particular, digital images.
3. **Exploit Paper:** The tool should help teachers exploit paper-based content that they already use in everyday classes, which, in particular, includes content from curricular textbooks.

¹ We analyzed more than 10 PowerPoint slide decks made by teachers in the schools we visited and observed a similar pattern in all these decks. Even the text that was used borrowed heavily from textbooks, sometimes verbatim.

4. **Blend with current practice:** The tool should enable teachers to emulate the blackboard-based pedagogy that they are comfortable with. This could be done through the use of appropriate input devices and an appropriate software interface.²

We remark that some of these principles (e.g., “blend with current practice”) are recurring themes in various strands of ICTD research, not only in education. Still, their application to a specific task of building a presentation tool for teachers is, to the best of our knowledge, novel.

IV. THE TOOL

We designed Collage while carefully adhering to the above design principles. At an abstract level, Collage is a media viewer which enables users to view images and videos on a digital display and to interact with such content as it is being viewed. The intended usage is in a classroom where a teacher presents digital content to students on a shared display and renders explanations about the content by exploiting the interactive capabilities of the tool. Text is intended to be presented primarily by digitizing printed materials or hand-written notes. Collage provides several features to enable such paper-based content to be intermingled with digital multimedia as it is presented.

To illustrate the content preparation model underlying Collage, we walk the reader through a typical usage scenario. Suppose that an eighth grade biology teacher, Raghu, wishes to conduct a class on “*The circulatory system*” using Collage. His school is equipped with a digital camera/scanner, a PC running Windows with Collage installed on it, and a digital projector or a TV capable of displaying the visual output of the laptop. Suppose that Raghu has access to the Internet, either through school resources or a cyber café. To prepare for class, Raghu first collects a set of relevant digital images. He digitizes some pages from the textbook chapter on the circulatory system and some from a reference book that he commonly reads before his classes by photographing or scanning them, whichever is easier³. Raghu could potentially draw diagrams of parts of the circulatory system on paper and digitize these diagrams in the same manner. If these resources are not sufficient for his purpose, he goes to the Internet and downloads relevant images he finds through a search engine. If time permits, he downloads some videos on the circulatory system from commonly-used websites like YouTube or else, takes a video from a multimedia CD donate to the school.

² Some may question this guideline, given recent skepticism surrounding current teacher-led styles of instruction. Due to the lack of any unanimity on this subject and given the long history of the teacher-led instruction in schools, we chose to focus on adapting our intervention to such practice.

³ A digital camera or scanner was present in all the schools where we tested Collage. While photographing paper may not yield the best image quality, it is a more flexible and efficient approach for this purpose.

Each image or video collected by Raghu in this manner is referred to as a *page* (an analogy to textbook pages). Raghu stores all his pages in a single folder on the school PC. He then plans out the tasks he would conduct while presenting his materials to the students. At this point, Raghu feels the need to modify his page collection and adds a few more pages to the folder. Once the page collection is finalized, Raghu orders the pages by *renaming* each of them with a unique numeric label – pages which are meant to be displayed earlier are titled with smaller numbers and those to be presented later with larger numbers. After ordering the pages, Raghu is set for class.

Note that during class preparation, Raghu types very little text on the laptop (he does this only to search for and download Internet content), nor does he use a digital authoring tool to create content, as he would normally do if he was presenting content using PowerPoint.

Right before class, Raghu connects the PC to the projector with the help of his students, runs Collage, and “loads” his image collection and videos for viewing through the tool. He presents the content to his students, freely switching between different pages by clicking on the respective thumbnails (just like in a standard image viewer). While displaying a page, he conducts the tasks he had planned around that page and uses Collage’s interactive features. We next describe these features in detail.

A. Features to Support Interaction

In Collage, every feature that supports interaction has been designed while giving careful attention to teachers’ preferences and classroom requirements. Over a period of 9 months, we worked closely with 3 teachers in one school, soliciting feature suggestions and feedback on different concepts as we planned and implemented them. The iterative design process culminated in the following feature set:

1. *Zoom*: While presenting pages, teachers can zoom into or out of them using a physical zoom-bar and a scroll-wheel shortcut. Collage also supports dynamic zoom on digital videos i.e., teachers can zoom into or out of a video while it is playing. This feature is particularly important for improving access to text on the computer projection.
2. *Rectangle selection*: This enables teachers to identify rectangle-shaped regions inside pages through a click-and-drag process and to arbitrarily resize and move the region thus identified⁵. Such selections are referred to as *page elements*. These can be colored differently from the page they are derived from (see figure 3) and portions of the page behind them can be “dimmed” for increasing contrast. Rectangle selection is meant to help teachers highlight regions in a page (e.g., words or

⁵ The original page remains intact, while a fresh copy of the selected region is created as a layer on top of it. This is similar to one specific implementation of rectangle selection in Microsoft Paint (but not the default one where the selected region is “etched out” of the canvas.

phrases in a textbook page can be highlighted) and to attract students’ attention to such regions using options of coloring, background dimming and resizing. Indeed, this was a feature recommended to us by a teacher.

3. *Digital inking*: Users can annotate images using free-form input from the mouse or equivalent hardware. In our experiments, we used a graphics tablet and stylus attachment for assisting in ink interactions because this combination provided a good tradeoff between usability and cost [26].

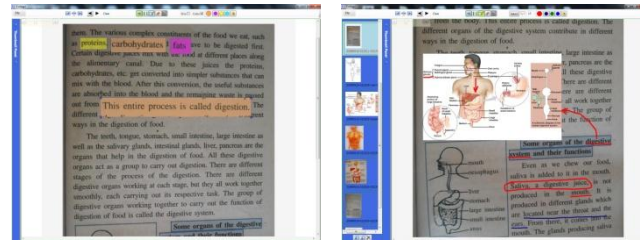


Fig. 3. The left figure illustrates the rectangle selection feature; the right one illustrates page overlay and inking.

4. *Page overlay*: Users can overlay a page on top of another page using a simple click-driven interface. Multiple pages can be overlain on a single page and the overlaying pages can be either digital images or videos.
5. *Occlusion*: Users can draw an occluding rectangle on top of a page, allowing for the progressive revelation of information, much as transparencies are incrementally displayed in overhead projectors. (See figure 4.)
6. *Textboxes*: Teachers who are proficient at typing can create and modify textboxes on the fly. Text in the textboxes can be resized, colored and justified.
7. *Saving a deck*: Teachers can save a collection of pages along with any digital annotations or drawings created on them. Saved page decks can later be opened as a unit.
8. *Whiteboard*: This is a distinguishing feature of Collage, enabling teachers to create content in real time in a dedicated portion of screen. (See figure 5.) Teachers can split the screen vertically into two parts, the left part displaying pages as before while the right part – the *whiteboard* – can be used for creating fresh content. Teachers can write notes, transfer page elements or entire pages from the page viewer to the whiteboard and vice versa. All features implemented for the page viewer are also available in the whiteboard. Though trivial in retrospect, the whiteboard was responsible for much of the creative activity we observed in our field evaluations. It became a real-time content creation zone for teachers where they could assemble elements from different pages, insert entire pages, perform annotations and organize content in different orientations based on the immediate needs of the lesson. The spontaneity with which teachers used this feature in class was reminiscent of the way collages are created on paper, whence the name for our tool.

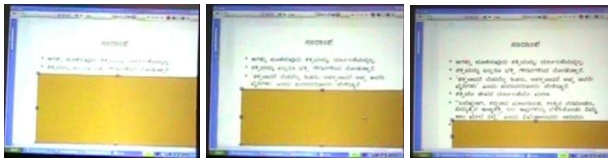


Fig. 4. The occlusion feature being used in a literature class.

B. Features that were excluded

It is worth mentioning some features that we implemented in Collage but eventually eliminated due to lack of sufficient uptake from the teachers. We partially implemented the option of hyper-linking parts of pages with each other and with external resources (e.g., linking a word inside a textbook with a media file). Such features are common in other presentation tools. In our case, hyper-linking gained absolutely no traction with the teachers – the time required to set up hyperlinks prior to class was much too high for the potential benefit during class and the random-access model of our image viewer appeared to be sufficiently convenient. We also implemented a feature to automatically detect word boundaries inside pages with textual content and click-facilitated selection of words. (In absence of good OCR tools for Indic scripts, we were compelled to program this from scratch.) This feature could not match the accuracy and flexibility of simple rectangle selection.

V. USAGE AND EVALUATION

Over a period of 3 months, Collage was deployed for classroom instruction by 6 teachers (3 female, 3 male) in 3 schools (2 public, 1 private). All 3 schools were in Bangalore and among those visited during the initial field explorations; one of them was used during the iterative prototyping phase.⁶

The teachers who used Collage come from varied backgrounds, but their experience with technology is comparable. All teachers have basic familiarity with computers and have used Microsoft Office applications in the past. Access is a common problem: only one of the six has a computer at home and only one (a computer lab instructor) reportedly uses PCs for more than 5 hours a week. Teachers reported to have used PowerPoint for instruction at least 4 times prior to our intervention, although proficiency levels varied; the computer lab instructor was, ostensibly, the most proficient and frequent user of PowerPoint.

Training these teachers to use Collage required very little effort: we spent at most 2 hours per teacher, and this included sufficient practice time for each. One challenge we encountered was building familiarity with the graphics tablet, which none of the teachers had used prior to our

⁶ Besides these 6 teachers, 8 other teachers have interacted with the tool during training sessions, but did not yet try it in the classroom. The reasons for this are still not known, but it is clear that follow-ups were critical for the six who *did* use it in classes. More follow-ups would have likely helped with the other 8.

intervention. Teachers requested extra time to practice with the tablet, and could not gain sufficient confidence in using it in just 2 hours. However, 5 of the 6 teachers *did* use the tablet in their very first class, which suggests that hesitation to try the new piece of hardware in front of students was not a barrier.

A. Usage Patterns

We observed, video-recorded and analyzed 18 different classes, totaling more than 15 hours of real classroom usage. Our research team assisted teachers in acquiring content through the Internet for most classes, although the identification and selection of the content was always done by the teacher. Teachers conducted classes largely on their own; our team provided setup support and helped resolve occasional technical glitches.

While teachers used Collage in a variety of ways, there is one theme we consistently observed in these classes: teachers' behavior borrowed from their practice in regular blackboard-based classes and with very little effort they were able to perform activities using Collage which they would normally perform using the blackboard. To illustrate this point, we highlight three key usage patterns we found in the classes we observed.

1) Usage Pattern 1 – “Mix as you teach”

Perhaps the most consistent theme we noticed was a tendency to “mix” different forms of content as they taught using Collage. There are two provisions in Collage which facilitate mixing of content – the whiteboard and the page overlay feature – and at least one of these features was used in 17 out of the 18 class we observed.

The whiteboard, in particular, was heavily utilized. In an analysis of 12.6 hours of usage data, we found that teachers use this feature an average of 5.03 times an hour (window of opening and closing the whiteboard). Each teacher invented his or her own unique style of using the whiteboard. One science teacher often used it to display words and phrases extracted from textbook pages alongside relevant images (figure 5(a)). The same teacher sometimes assembled key words from the text to form a “word wall” as shown in figure 5(b). A similar word-walling activity (figure 5(d)) was performed independently by an English teacher who reportedly creates word walls on the blackboard in regular classes. Another English teacher used the whiteboard to display a scan of his hand-written notes, as he displayed a textbook scan on the left.

One literature teacher used a particularly interesting style: as he taught a chapter from the textbook (displayed in the page viewer), he generated a glossary of words for the students on the whiteboard, as shown in figure 5(c). In classroom observations prior to our intervention, we had noted that he created similar glossaries on the blackboard in regular classes, although there, he was compelled to do it without a textbook scan on the side.

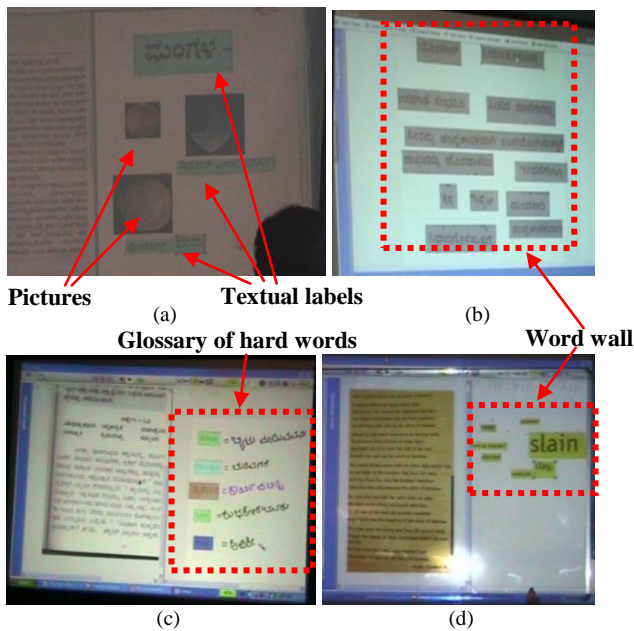


Fig. 5. Teachers invented their own pedagogical styles of using the whiteboard facility in Collage. The language of instruction in the classes shown by (a), (b) and (c) is Kannada, the local language of Bangalore.

2) Usage Pattern 2 – “Clean the board, don’t save it”

An equally consistent theme we observed was that teachers tend to erase the contents of the whiteboard after filling it. In Collage, teachers have the choice to transfer contents of the whiteboard into the page viewer but they never did this, choosing instead to erase them completely. The only time teachers did *not* erase the whiteboard was at the end of the class i.e., the last whiteboard page was not erased. There is a remarkable resemblance between this behavior and the manner in which teachers treat the blackboard. Interestingly, the behavior did not replicate itself for ink annotations on main pages, which were often preserved until the end of class. (This is in line with observations around persistence of ink in other presentation systems [15].)

3) Usage Pattern 3 – “Rework your plan as you teach”

A third theme was that many page transitions were between non-consecutive pages: more than half (56%) of all page transitions corresponded to non-consecutive pages in the page sequence. This is surprising on one hand, given that teachers took care to order their pages before going to class, but it also fits their natural inclination to improvise and switch contexts as they teach [27]. During regular classes, teachers tended to go back and forth between various portions of the blackboard without explicitly “planning” for it.

B. Feedback

To help us understand the costs and benefits of using Collage, we collected qualitative feedback from the 6 principal users of the tool and conducted a preliminary examination of students’ perception of Collage

presentations. We assessed teachers’ and students’ perceptions of Collage vis-à-vis their perceptions of PowerPoint which is the only other presentation software they were familiar with. Feedback was collected over a series of post-class informal interaction sessions in which researchers posed different questions about users’ perceptions of the tool.

1) Ease of Learning

All teachers in our sample reported that Collage is easier to learn than PowerPoint. This was somewhat expected, given the smaller feature set of Collage, and the fewer modes of operation (no separation between authoring mode and presentation mode). One teacher, who had reportedly spent 3 months training high school students in PowerPoint usage prior to his teaching assignment, said:

I think anyone can learn it in one day. But PowerPoint, I think, a person would take 15 days to learn.

2) Flexibility of Presentation

Consistent with our classroom observations, all teachers reported that Collage affords them significant flexibility when presenting digital content, and enables them to digitally mimic actions they perform in regular classes. When asked about their preferences for features, teachers voted in favor of *whiteboard*, *rectangle selection* and *inking*, the *whiteboard* being the most favored. An example comment:

I thought I could use the whiteboard spontaneously [in class], even though I had not pre-prepared [what to use it for].

Another benefit touted by several teachers is the ability to be spontaneous while teaching, simultaneously “mingling” different types of content.

Collage helps me correlate two types of information. [I can show] pictures on one side and equations on the other side. I can show videos alongside textbook pages. This kind of mixing of different materials helps children learn better.

This facility seems to be a unique facet of Collage, and neither PowerPoint nor the blackboard seems to afford teachers such flexibility. It also seems to have an interesting bearing on students’ perceptions and learning behaviour.

3) Ease of Preparation

Teachers consistently reported that one of the key benefits of Collage was the efficiency of preparing presentations: 5 out of the 6 teachers believed that they could prepare lessons faster using Collage than PowerPoint, and 1 teacher was neutral. One teacher, who continues to use Collage autonomously today, comments,

Earlier I had to spend at least two hours making PowerPoint presentations; with Collage, I can do it in 20 minutes.

Teachers attributed the savings in time to two factors – the lack of effort required to prepare and format slides, and the efficiency gained by scanning paper materials.

What I like is that we need not spend time making slides (cutting, pasting, slicing etc.) in Collage. Everything can be shown raw. . . . In PowerPoint, you need to make a lot of .. you know .. formatting changes [before going to class]. Here, the only job you need to do is scan the page. And you can directly work when you are teaching in the class.

One teacher strongly voiced his dislike of typing and how avoiding it contributed to time savings in Collage presentations,

The hardest part in PowerPoint for me is typing. Typing is boring for me, too. In Collage, there is no need to type.

Another described how the idea of scanning paper materials was useful for science presentations,

I like the idea of scanning diagrams I make on paper. It would take me ages to draw these drawings in PowerPoint.

The efficiency gains achieved by scanning paper materials are possible when using PowerPoint as well, but teachers seem to prefer to do it with Collage. In a preliminary field experiment, half of the teachers in our sample taught two different classes on the same topic. They used Collage in one class and PowerPoint in the other (order of classes was counter-balanced) and scanned materials were used by them in both. All three teachers stated that displaying scanned paper content was preferable in Collage because of the greater real-time interaction capabilities it offers.

4) *Suitability for Display of Visual Materials*

Another comment we consistently heard was that Collage is better suited than PowerPoint to display image and video content during classroom instruction. Teachers attributed this to the real time interaction afforded by Collage:

In Collage you have rectangle selection and whiteboard and we can write with the pen [stylus] in the whiteboard. In PowerPoint, [this is] not possible. [Image overlay] is a good option. It is not there in PowerPoint.

Even students perceived Collage to be well-suited for viewing multimedia in the classroom: in a within-subjects study with 44 tenth-grade students, subjects reported that it is easier to comprehend images if they are displayed through Collage than when this happens through PowerPoint. As justification, some students stated that in Collage, presentation of pictures “along with teachers’ notes” was “nice”. Students were neutral about other dimensions of comparison between the two tools.

In another controlled experiment, we found evidence that the practice of intermingling visual content with scanned textbook pages in digital presentations (as done by Collage) improves students’ retention of the visual content. It is

plausible that such intermingling helps students build associations between the visual content they are exposed to and the content of their textbooks, which aids in retention. (Details of the experiment are reported in [28].) Similar findings have been reported in the context of individually-viewed multimedia content (on PCs and on paper) [29], but in the context of shared viewing in a classroom setting, there does not seem to be any work prior to ours.

C. *Limitations of Collage*

One concern about Collage that teachers voiced was that it constrains a teacher’s movement during instruction, forcing her to be near the computer throughout. Although such a limitation is applicable to tools like PowerPoint as well (PowerPoint presentations involve mouse-driven interactions), the criticism is perhaps more valid for Collage because certain interactions are simpler to conduct in other tools. For example, moving from one slide to another in PowerPoint is manageable with a position-independent mouse click, which can be conducted using a remote control. But, given the need for frequent transition between non-sequential pages in Collage, such a transition technique, if applied here, may not be universally acceptable.

The increased ease and efficiency of preparing content in Collage could compromise quality: scanned hand-written notes may not be as presentable as formatted text in a digital slide and may require more work if edited. The computer lab teacher at one of the schools pointed out this trade-off:

It may be easier to make presentations by scanning hand-written notes but typing gives you better quality. The text can be edited, too. If I have time, I will type.

Perhaps unsurprisingly, this teacher had the most daily interactions with computers in our sample.

VI. CONCLUSION

Collage is a presentation tool designed specifically for supporting instruction in K-12 classrooms. Teachers in suburban India who have used the tool provide consistent positive feedback on its content preparation model and the delivery styles it facilitates. Though research on Collage was conducted in fairly under-resourced Indian schools, we believe that the lessons we have learnt are applicable in more privileged environments as well. We have made the tool available for free download at: <http://research.microsoft.com/en-us/um/india/projects/edulab/collage.html>

Collage affords several benefits to teachers, but its regular usage in classes is limited by teachers’ ability to rapidly acquire preferred multimedia content. During our pilot, we found that teachers spent a significant amount of preparation time (up to 50% in some cases) downloading images from the Internet. We are currently considering ways to alleviate this problem for teachers.

Our evaluation of Collage is in a preliminary stage and it is possible that some of our findings were influenced by novelty. Whether the optimism around the tool displayed

during the pilot can be sustained in the long run still remains to be seen.

In at least one school, the signs are positive. Both the Collage users in this school are using it without our visiting them (at least 8 cases logged), and they have trained other colleagues at their school and two friends from a neighboring public school in its usage. In the other pilot schools, usage without our encouragement is still absent. In one of these schools, a virus disrupted computing services right after the pilot. In the other, usage seems to be steered by the choices of the computer lab instructor, who has an inclination for PowerPoint and assists other teachers in using it. Neither the issue of preparation time nor that of computer inefficacy seems to constrain this teacher.

Several questions remain open for exploration. It will be useful to quantitatively evaluate the advantage Collage seems to offer in terms of preparation time and compare that with preparation time that other tools demand. It is worth exploring the extent to which the increased interactivity in Collage presentations slows down progress of the class, and the extent to which this slowdown is unacceptable. It is also worthwhile to investigate simple and cost-effective ways to integrate student feedback into Collage. Finally, the role Collage plays in improving students' learning of *curricular* content is still unclear and a careful investigation of this question is necessary before we scale up deployment.

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