About the Application of a Next-Generation Interactive Whiteboard to Teacher Education

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Abstract: Interactive whiteboards (IAWs) are an integral part of 21st century learning environments. In this submission we present a new technological approach to the implementation of an interactive whiteboard based on HD equipment. In specific, the proposed whiteboard system architecture utilizes state of the art components for a high definition rear projection. In the main part, we will analyze educational aspects of the usage of whiteboards based on a small survey. This discussion will be based on first experiences in teacher education using the system.

Keywords: Interactive Whiteboard, Rear Projection, Teacher Education, Full HD, Math Education, Interactive Geometric Software

1. Introduction

Interactive Whiteboards (IAWs) have been proposed for a long time as an effective tool in classrooms. There have been a number of initiatives to further the installation and use of such systems at schools in Europe. There have already been perceived advantages in the use of IAWs in mathematics teaching in the United States (Bailey and Chambers 1996). This was also shown by Greiffenhagen (2000) and Glover and Miller (2001). Also, IAWs are an integral part of learning environments of the 21st century (OECD 2006).

The idea to build a classroom as it could exist in 20 years has been our motivation to look for an improved whiteboard technology. Current IAWs used in school improved in functionality over the years, but still, since several years the same technologies for projection and interaction are used. Further, these technologies have some deficits concerning image resolution, contrast, and interaction. As well, projection from the front leads to occlusion of the presentation, which is due to the thrown shadow of the teacher. In addition, nowadays media sources comply with modern digital standards that do not automatically integrate into analog systems.
The Lernlabor system integrates a state of the art Full HD 1080p rear projection with digital image processing that supports all different kinds of digital and analog electronic media. To our knowledge, our system is currently unique in Europe. In the following, we will discuss the system architecture and several system features. We also provide first results from application in educational settings.

2. The Lernlabor System

![Rear projection placed in our Lernlabor. Student works with Cinderella.](image)

The system we built is based on a 270 cm x 150 cm large rear projection. An additional anti-reflective glass pane protects the translucent silver screen behind against scratches made by input devices or other sharp objects.

For projection a cineo 3+ 1080 video projector from projectiondesign is used. It provides full high definition resolution of 1920 x 1080 pixels at 60 Hz (Full HD, even better). All video signals from any resource are processed by a crystalio II scaler from pixel magic. It provides best quality for up-scaling minor quality video signals.

Of course, in a couple of years, several interactive panels of that size with the given resolution will exist, that provide a similar picture quality. At the moment, they do not. That is why we decided to use a projection device, but with the goal to build a system, that looks and feels like a giant interactive monitor panel.

Effective and intuitive interaction is crucial for Interactive Whiteboards. In our system we integrated mimio interactive from mimio for pen based interactions. It
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Combines ultrasound and infrared signals to track the position of the pen for high accuracy. The device comes in combination with mimio Studio, a software toolkit providing several functionalities for interactive presentations. It provides a host drawing tool and a gallery, to create entire presentations. Any of mimio Studio’s drawing and editing tools can be used to markup applications and web pages. All annotations are automatically saved for later editing, printing, or exporting. Also, a lot of interactive tools support to direct the attention of an audience. A spotlight tool allows you hide the entire screen, except for a region you wish to focus on. A reveal tool can be used to progressively reveal bullet points and information in any application.

Currently, we are also experimenting with the integration of a Nintendo Wii as a haptic interface into the system. We expect interesting application scenarios for using this device in the area of simulation and training.

As mentioned above, we integrated several other media technologies into the system. However, since our system does not correspond to an integrated consumer product, adequate tools for media control are not provided from the shelf. In our approach, we made sure that control of all components is possible via a dedicated local web-server. This provides us with the possibility to develop a media control solution based on web-technologies. From an interaction point-of-view, it is possible to control all media components both, from the dedicated media presenter system (in our case a MacPro workstation from Apple) and from all connected mobile devices.

![Image](image.png)

Figure 2: The system can be controlled via the web interface with an iPod or any other web-capable devices

In specific, we utilize an Apple iPod touch as a local media control interface for the lab. By the way it does not matter, whether the iPod is used or any other web-capable device like laptops etc. (see Fig. 2).
Using a Full HD projection device, the Lernlabor system provides improved resolution and 16:9 aspect ratio. Hence, the projection is proportionately wider than standard XGA-resolution. This matches better with the size of known not-interactive white- and/or blackboards. As well, presented content can be distributed more over the width of the projection, what makes it easier also for smaller people to use the system. All parts of the projection screen are better accessible. Another crucial aspect is resolution. A higher resolution leads to clearer projected images. This should improve the perception of the presented information. Also, because the image quality advances the analog quality of a blackboard, user’s acceptance of the IAW should increase.

Figure 3: Due to the high resolution of our system handwriting is much smoother and our IAW is a coequakull alternative to a blackboard.

Another goal of our system design was to allow for collaborative scenarios in educational settings. In our case, this means that more and more students are equipped with their own laptops or mobile devices. We wanted to support seamless use and interaction with the students’ systems. For this, we integrated also a wireless presentation device for receiving video signals from any personal computer or notebook that is located in the laboratory (see Fig. 4). Students can submit their video signal to the system to present their results or ideas they developed on their personal device without having to mess around with video cables. In the future, we would like to adapt specific applications from the field of education and training to allow for more advanced collaborative scenarios.
3. Application and Experiences

Currently, we are using the IAW in several classes and seminars for students in different subjects of teacher education and in media-related subjects. First informal evaluations with students and teachers participating in the seminars confirmed that most of the design goals for the HD Interactive Whiteboard were in fact achieved. These include:

- More flexible application and educational settings compared to traditional Interactive Whiteboards due to the higher contrast ratio and the much lower interference with environment lighting, thus reducing need for darkening and therefore for adapting the environment.
- More intuitive use based on the back-projection that solves the problem of obscuring the projection and having to move around those areas of the screen for interaction. In addition, the higher resolution and the better response to pen-based I/O also clearly increased usability and acceptance of the system.
- The provided interaction technologies, especially the wireless transmission of video signals, allowed for new and more flexible settings in the classroom with integration of students’ laptops.

Using IAWs for mathematics has already been firmly established. In April 2008, we started a seminar dealing with the "application of personal computers to math education". In this seminar we are concerned with Interactive Geometry
Software (IGS) (in this case: Cinderella (Kortenkamp 2002)) but also spreadsheets, HTML, and interactive worksheets.

A good example can be this scenario: We used PDF-documents as worksheets, where variation tasks of a triangle were given. Sketches of the construction were part of the worksheet. Only one task was presented on the screen using the reveal tool in mimio Studio. In annotation mode, students should draw in their ideas concerning changes of specific intersections while modifying the construction. After doing so, the problem should be solved directly using an IGS (Cinderella). Afterwards, the IGS construction and the hand drawn sketches were presented next to each other. Doing so, the drawn assumption could be checked against the IGS results. This session gave the impression, that students highly accept our next generation IAW.

In general, the students dealt with the system in an intuitive and open-minded manner. To validate this and get scientifically well-grounded results, we accomplished a small empirical study based on a questionnaire. In the following we will discuss the findings.

3.1 Methodology

The survey was integrated within the seminar and done in the first half of the overall period. After a period of seven weeks it was repeated. (Dates: 28.05.2008 and 16.07.2008). Unfortunately, we have comparable test data sets only of five test persons, who were present at both dates.

In the section before we presented several different usage scenarios. Also, a lot of different use cases can be imagined that occur during the workaday life at schools or universities. Currently, one of the most controversially discussed topics in teacher’s education in Germany is student’s media literacy. Hence, the questionnaire has been created to collect data concerning the subject’s literacy concerning media and computers in general. It was developed to be used especially students off education and teachers.

For quantitative analysis, particularly we dealt with two batteries of questions, first those concerning computer skills, and second experiences with computers in general. The students had the possibility to quote their accordance to a given statement on a scale of one (no accordance) to six (absolute accordance). The answers have been digitalized by an expert and controlled trough another two persons. For qualitative reasoning, we discuss frequent free-text items dealing with the application of computers for education in school. We also want to mention applied quality criterias:

Objectivity: Because of the standardized questionnaire, the objectivity of realization as well the objectivity of evaluation can be estimated as high. Objectivity of interpretation cannot be assured completely due to the fact that some interpretations had to be made with regard to the evaluation of the Lernlabor.

Reliability: Test-retest reliability is not a criterion here, because delta values have been used for interpretation. Also, due to the research design no parallel test
reliability can be stated. But, the inner consistence of results can be graded well, because comparable aspects have been queried using different items.

Validity: As well, external and internal validity can be graded well. The questionnaire has been used successfully to survey media literacy several times already.

![Figure 5: Delta values depending on questions and subjects.](image)

### 3.2. Quantitative Analysis

Fig. 5 shows the changes in abilities concerning the computer depending on questions and on subjects. Analyzing the data concerning the different questions major differences can be found. The most important results are:

The trend of question #2 ("Working with computers is very simple": -0.4) is slightly negative. Supposedly, this can be ascribed to the unfamiliar complexity of the used software products and hardware built-in in the Lernlabor. This kind of interpretation has been supported by answers to the questions #4 ("Obviously I have problems using the most programs so far": +0.4), #5 ("Computers frighten me": +0.4) and #22 ("I think computers are much too complex": +0.4).

At the same time, the sureness of the test persons increased during the period between both surveys. This can be interpreted from the increasing values for question #3 ("I’m very unsure about my competences concerning computers"): -

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1 Translation of german question: “Ich finde das Arbeiten mit Computern sehr einfach”
2 “Ich habe anscheinend Schwierigkeiten mit den meisten Computerprogrammen, die ich zu benutzen versucht habe”
3 “Computer machen mir Angst”
4 “Computer sind viel zu kompliziert für mich”
5 “Ich bin sehr unsicher über meine Fähigkeiten mit Computern”
0.2) and question #12 (“I’m very sure in my abilities to use computers”\(^6\): +0.2). Also, there is a positive trend of readiness to the application of computers in school, because the test persons started to confirm that computers can support learning (question #7 “I think, computers hinder learning”\(^7\): -0.4; question #20 “Some programs simplify learning definitely”\(^8\): +0.4; question #24; “Computers are good tools for learning”\(^9\): +0.2).

3.3. Qualitative Analysis

In this section we want to examine in how far the test persons changed their view on the application of information technology during the seminar. Hence, it has to be pointed out, that at the beginning the students named geometry to be a good topic for applying computers. At the second survey the number of appropriate topics increased: spreadsheets, functions, interest calculation and also interdisciplinary projects together with physics, biology or chemistry have been added.

Further, from no statement can be inferred, that the participants of the seminar would have a negative stance on the application of computers in school. Rather, the analyzed questionnaires suggest that the student’s point of view has changed due to their experiences with the technology. One test person pointed out, that technical problems and temporal effort can argue against the use of computers, even though it would make sense. Another one noted that there were no arguments against it and the quality of teaching would depend on the combination of conventional and digital elements. However, a third test person was really skeptical against applying computers: drawing and constructing with a set square would be important for gaining knowledge. But we think, especially in this context the use of the interactive whiteboard should support the process of manual construction. An often oral expressed opinion has been that the advantage of the application of system not only has been visualization of data and elements, but also, even more important, interaction.

4. Summary and Conclusions

In this paper we presented the design of an HD Interactive Whiteboard based on rear-projection technology. With our HD Interactive Whiteboard system with rear-projection we were able to proof that high-end video components are getting within reach nowadays, both in terms of availability of suitable components and in terms of price. Especially the higher degree of resolution and contrast as well as

\(^6\) “Ich bin sehr sicher in meinen Fähigkeiten, Computer zu nutzen”
\(^7\) “Ich finde, dass Computer beim Lernen behindern”
\(^8\) “Einige Computerprogramme machen Lernen eindeutig einfacher”
\(^9\) „Computer sind gute Hilfsmittel beim Lernen“
the availability of new interaction devices may provide the necessary increase of quality to achieve higher acceptance of such systems and, in future, a higher distribution in the classroom. It is clear that the HD rear-projection solution might be too complex to make their way into schools. However, HD LCD systems are also in development and we expect corresponding large flat panel technologies in the near future. However, today HD rear-projection technology is almost ready for being used in a wider degree in educational settings.

Of course, our survey was just a first step to get well-grounded results. First of all, we have to continue this work and gain more data. But, although there were no direct questions concerning the application of the rear-projection whiteboard, we can conclude from our experiences from the seminar, that there is a huge motivational effect influencing the students. Also, the whiteboard supports the visualization of geometric tasks due to the combination of working digitally and manually at the same time.

During the seminar we got the impression that has been confirmed by the survey: The Lernlabor system gave our students the possibility to collect experiences with a medium that is currently not yet available at German schools and after a short period of reluctance, they used it gladly and gainfully.

References


