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ICT in Psychology Teaching: Formative Evaluations

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This article presents design, development, and evaluation of POSbase in Psychology teaching. POSbase is a highly flexible system that encourages constructive and self-regulated learning. It also allows researchers and instructors to share their teaching materials and experience. POSbase was introduced to undergraduate and to masters students in psychology. We conducted two formative evaluations and implemented improvements between and after the evaluations. Findings from the evaluations show users' positive response toward POSbase as well as requirements for further improvement of the functionalities.

Thousands of college instructors write PowerPoint presentations about the same classical theories and scientific studies. To provide such presentations on the Web so that instructors and students can share them, we have designed POSbase, which stands for Presentations Of Science base. POSbase is a collection of scientific experiments and related information and can be expanded to include experiments from a variety of scientific fields. A pilot version is available at http://posbase.uib.no/posbase and has been featured in different outlets (Mueller, 2005; Netwatch, 2005).

Presentations can be used by instructors for their lecture courses as well as by students to learn from the database (Chen, Reber, Gudem, & Stokke, 2004). The intended target users for POSbase are:

- *Instructors:* Contribute with presentations within their expert domain and share knowledge, use the content for educational needs either by downloading relevant presentations and adapting them to their needs or by using them online.

- *Students:* Use the material for learning by exploring experiments and theories within the field of interest, or for getting indepth information about scientific studies and find important definitions; hyperlinks link the content so that it can be explored in a free and self-constructive way.

The first version of POSbase is online since October 2003. The presentations are downloadable and can be used online. The rest of the article is organized as follows: The next section presents theoretical foundations of this research and discusses related work. We then describe design and development of POSbase, before we present the two formative evaluations and discuss the findings. Lessons learned and future considerations are discussed in the final section.

THEORETICAL FOUNDATIONS AND RELATED WORK

Theoretical Approaches to Multimedia Learning

According to Alessi and Trollip (2001), proponents of constructivist theory suggest that methodologies such as hypermedia, simulation, virtual reality, and open-ended learning environments are of more benefit to learners than traditional methods (i.e., drill). The reason is that these methodologies allow learners to explore information freely: they can apply their own learning styles and use software instead of the teacher as a resource. POSbase is a highly flexible system that encourages constructive and self-regulated learning (Shuell, 2001) and suits the needs of a diverse student population, from beginners at an undergraduate level to advanced graduate students. For example, novices can go through presentations on the psychology of memory and access the links to keywords that explain technical terms. Advanced students, however, may go through the presentations on the topics to be learned, without accessing the terms they already know, and they can leave out presentations on studies that they know.

Mayer (2001) presented a model based on cognitive theory which describes how the human mind processes multimedia. This model assumes that the human information processing system has dual channels for visual and auditory processing (the dual-channel assumption). Each channel has limited capacity for processing (the limited-capacity assumption), and active learning entails carrying out a coordinated set of cognitive processes.

The model has important consequences for the development of interactive multimedia and learning environments. Perception and attention have to be guided in a way that maximizes encoding of information. Alessi and Trollip (2001) presented cognitive principles which should be considered during development because:

1. information (visual or verbal) must be encoded with ease;
2. the position of information affects our attention to and perception of it; and

3. differences and changes attract and maintain attention.

One problem to be aware of in multimedia learning is cognitive overload, when "the learner's intended cognitive processing exceeds the learner's available cognitive capacity" (Mayer & Moreno, 2003, p. 43). Effective instructional design depends on sensitivity to cognitive load, which again depends on an understanding of how the human mind works (Mayer & Moreno). POSbase is built on psychological principles that prevent cognitive overload and optimize learning in students (Mayer & Moreno). Specifically, we take care that visual features and their verbal explanations are as close as possible, that there are no distracting elements, and that information comes, if possible, through both the visual and verbal channels.

Finally, motivation is essential to learning. Cognitive theorists often claimed that learning occurs without the need for extrinsic motivators (Greeno, Collins & Resnick, 1996). Extrinsic motivators are applied from outside the learner, that is, rewards such as grades or money. One problem with extrinsic motivators is that the goal can become the reward rather than learning. In contrast, intrinsic motivators are those that come from within the person, like personal interest (Alessi & Trollip, 2001; Cordova & Lepper, 1996; Reber, 2005). Some aspects for intrinsic motivators are beyond the designer's control, such as personal interest, while some are controllable, such as the level of challenge and relevance to the student. In keeping POSbase flexible, students can choose the level of challenge and the contents relevant to them.

Related Work

Metasites exist that organize teaching materials for all domains, such as the World Lecture Hall at the University of Texas at Austin (http://web.austin.utexas.edu/wlh/), or for specific domains, such as the teaching of social psychology site at (http://jonathan.mueller.faculty.noctrl.edu/crow) or (http://www.socialpsychology.org/teaching). In contrast to these established sites, which present links to teaching materials, POSbase organizes PowerPoint presentations around individual studies that are searchable. This has several advantages: First, if users look for specific studies, they do not have to browse through whole lectures, but can find a study at a click. Second, lecturers who like to compose their lectures of materials from the Web need not take whole lectures, but can download from POSbase the studies they think are relevant for their teaching. Third, the lecture format is often redundant and difficult to find: Lecturers upload their set of lectures onto the Web, and different lecturers upload different materials on the same topic. That is, a single study exists multiple times on the same megasite, but an individual study is difficult to identify because it can not be searched for. In addition, individual lectures often summarize a phenomenon and add one or two examples.

With POSbase, studies can be added so that users can use a variety of studies for the same topic. For example, to illustrate the availability heuristic in psychology (Tversky & Kahneman, 1973; Reber, 2004), lecturers often use one or two examples of this heuristic. POSbase nonredundantly lists eight examples of the availability heuristic which users can search for, and from which they can choose the most relevant ones.

SYSTEM DESIGN AND DEVELOPMENT

The purpose of POSbase is to make scientific studies available as resource on the Web. POSbase consists of a database of different experiments and theories within psychology. It is a flexible system that is intended to be used by novices as well as professionals. The materials can be used for instruction either online or downloaded and adjusted to the particular needs of the course.

Design Rationale

The content of POSbase is designed according to multimedia principles; using both verbal descriptions and graphs (dual-coding theory). The presentations in POSbase contain words and pictures, as well as some animations. Perception and attention are facilitated by presenting a limited amount of information per slide and by emphasizing the order in which it is presented. Related visual and verbal information are as close as possible, for example by pointing to parts of a figure and giving a short description. By providing only one topic per slide and by defining keywords on separate slides, the problem of cognitive overload is addressed.

The use of POSbase is not mandatory for students, but thought as a supplement for those who want to explore relevant information out of curiosity. POSbase contains the same experiments as those in the lectures (relevance) and can therefore be used for repetition or preparation. This might help enhance the understanding of difficult concepts. By summing up important conclusions the content is furthermore arranged to be easily understood. A first version of POSbase also included a discussion forum; transfer of learning could be achieved through relevant discussion provided here.

POSbase is not only a way of presenting information, but also encourages active learning by enabling the user to freely explore the content. The information can furthermore be explored in different ways, from general concepts like memory to specific experiments or vice versa. POSbase is not intended to replace the traditional lectures, but is rather seen as a supplement. Its main purpose is to present information; when used for academic learning it should therefore be combined with techniques for guiding and practising as well as assessment of learning.

Technical Description of POSbase

POSbase is a web-based application. The design and development of POSbase follows the guidelines of agile software engineering methodology which consists of light-weighted, effective, dynamic, and growth-oriented development techniques (Cockburn, 2002). As shown in Figure 1, the backend database is implemented in MySQL. The web pages are written in HTML and served by Apache server. The communications between the database and the web pages are managed by PHP scripts.

The content of the backend database includes fields such as author, year, journal, keyword, and scientific discipline. Each presentation has at least four slides, one for the basic research question and hypothesis, one for method, one for results (often a table or a figure), and one for conclusions. Slides often include links which subsume presentations under certain keywords. These links between presentations allow users surfing from one study to the next. Additional links provide definitions of keywords (e.g., long-term memory), and descriptions of methods (e.g., free recall). In addition, POSbase provides searching facilities. Users can search presentations by author, keyword, and so forth (Figure 2).

The POSbase portal includes three interfaces with respect to three types of users: students, contributors, and administrators. For the students, POSbase provides with a common forum to look for experiments and relevant literature (Figure 3). It will also give the students the opportunity to discuss and comment on the content of the database (experiments, definitions, links, literatures, etc.). Contributors include professors, lecturers, and researchers in cognitive psychology who want to share their presentations with colleagues. They can use POSbase to upload their own presentations, to download others' presentations,

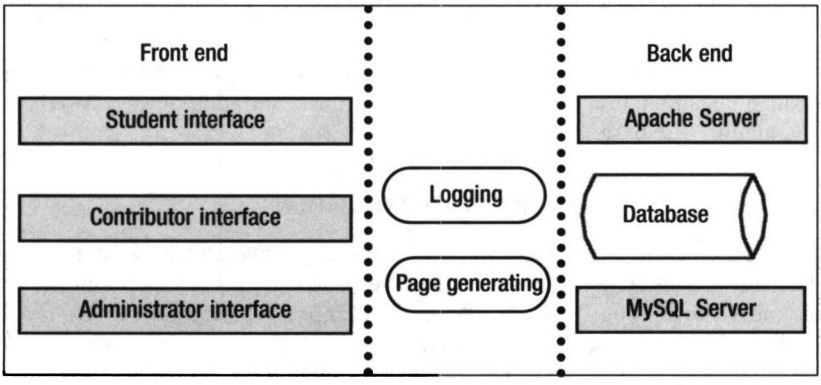

Figure 1. POSbase system architecture

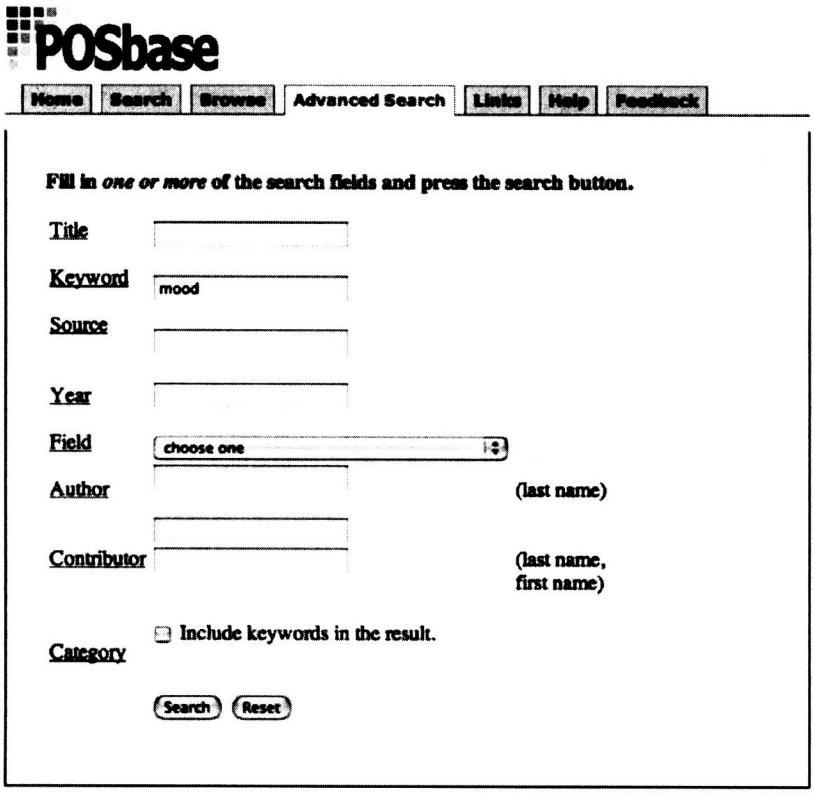

Figure 2. POSbase search interface

to search relevant experiments and literature. Administrators in POSbase are responsible for setting up the user accounts and managing the database.

For system administration and our study, POSbase kept an anonymous record of users who log on/off. This information, combined with the data from a questionnaire, observations of system use, and interviews, is used for evaluating POSbase.

FORMATIVE EVALUATION

In this section we present experimental design, data collection and analysis, and preliminary results of a study we have conducted with POSbase in cognitive psychology teaching. We conduct formative evaluations (Wottawa & Pult, 2001) in order to further enhance the functionality of POSbase.

According to Flagg (1990) the main reason for performing formative evaluation is to assist the decision-making process during all the stages of

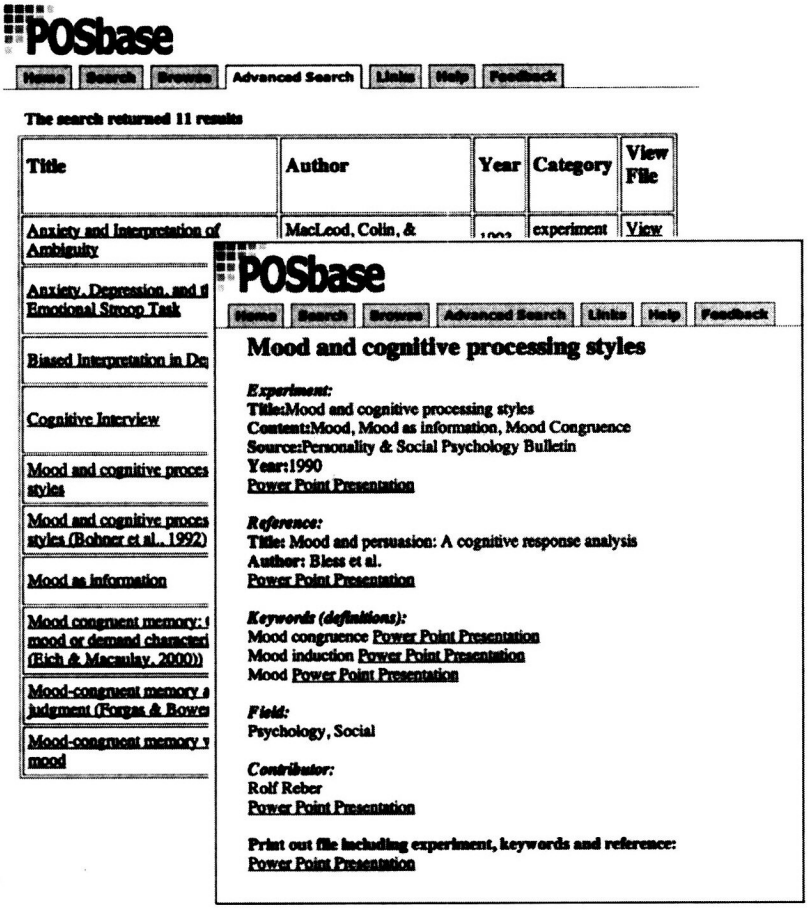

Figure 3. POSbase search result

the development of an educational program. The purpose is to improve the program. Both Preece et al. (1994) and Flagg (1990) recommended the combination of different methods often called triangulation. According to Flagg this is the most common approach to increase the likelihood of credible findings in formative evaluation. Methods can furthermore be used both qualitatively and quantitatively, as both Grønmo (1996) and Silverman (2001) argued. They also point out that quantitative and qualitative approaches are not mutually exclusive, but can be combined. To strengthen the overall validity of the study, Grønmo recommended a combination of different analyses (qualitative and quantitative). This also strengthens the confidence in the results because one can assume that they are not due to the peculiari-

ty of the methods employed. In our formative evaluation, we followed those principles by collecting case log, questionnaire, interview, and observation. Case log and questionnaires were quantitative in nature, interview and observation qualitative.

Experiment Settings

We have conducted two evaluations of POSbase. The first evaluation was in October 2003 and the second in February/March 2004. Both evaluations were conducted with one introductory course and one advanced course. Between the two evaluations some improvements were implemented based on the findings from the first evaluation.

POSbase was evaluated in two courses in the Department of Psychology at the University of Bergen in fall 2003. One was an introductory cognitive psychology course with 316 first-year students; the other was an advanced cognitive psychology course for 36 third-year students who had basic knowledge about cognitive psychology. In spring 2004, POSbase was also evaluated in two courses. One is an introductory cognitive psychology course with 881 first-year students; the other is the same advanced course as in fall 2003 with the same number of students.

In the beginning of each course, there was a training session in which POSbase was introduced to students. The project team demonstrated the various functions of POSbase and how they could be used. Both courses lasted three weeks. Presentations from POSbase were used in the lectures, more or less as lecture notes, and questions and related information were posted on the discussion forum. Students used the discussion forum to share information relating to the use of POSbase and the course content.

Research Questions and Methods

Through the evaluation, we wished to be able to answer questions about the following three aspects: (a) Frequency of use. For example, how many students used POSbase? How often did students use POSbase, and when did they use it? (b) Usability issues of various functions provided by POSbase. (c) User satisfaction. We asked students for the subjective opinion about POSbase and its usefulness (Table 1).

To answer these questions, we used questionnaires, observation of system use, interviews, and system logging to collect data. The questionnaire included mainly closed-ended questions and scales, based on the guidelines from Shneiderman (1998, pp. 132-145) and Remenyi, Williams, Money, and Swartz (1998, pp. 150-159). It was furthermore divided into several categories to capture detailed information relating to these questions. With the questionnaires we hoped to gain an overview of the students' experiences with POSbase. With the interviews, on the other hand, we hoped to gain a deeper understanding of the data collected by questionnaires.

Table 1
Research Questions

Description	Examples of Subquestions	Methods
Frequency of use	- How many students used POSbase? - How often did they use POSbase? - When did they use it?	Log Questionnaire
Usability	Usability of: - Search - Navigation	Questionnaire Observation Interview
User satisfaction	Subjective opinion about: - Functionality and usefulness - Contents - POSbase combined with traditional lectures	Questionnaire Interview

The questionnaires were distributed on the last lecture of the courses. Therefore, only those students who were present received the questionnaires. To compensate, we also distributed the questionnaire in electronic form to the course mailing list. For the interviews, we recruited for volunteers by email and during the lectures. Through the log we kept track of how many users there were, and how often they used the system.

A large part of the questionnaire was based on Questionnaire for User Interaction Satisfaction (QUIS), developed by Chin, Diehl, and Norman (1988). It measures the user's subjective rating of the human-computer interface. These ratings are based on scales from 1 to 9, with adjectives on both ends that are always positioned so that the scale goes from *negative* on the left to *positive* on the right. Subjects could cross an additional box if the question was not applicable; these data were coded as missing values and did not enter data analyses. Chin, Diehl, and Norman evaluated this questionnaire and found that the reliability was quite high, Cronbach's alpha=.94.

Due to the fact that many of the students who were present in the lectures had not sufficiently used POSbase to answer the questionnaires, we did not get as many answers as we had anticipated. Therefore we sent out an electronic questionnaire, identical to the former, to reach those students who had not been present in the lectures.

To get a better understanding of the students' experiences with POSbase (problems and advantages) we conducted interviews with some of the student from each course. There were seven subjects from the undergraduate level and seven subjects from the graduate level. Before the interview started the subjects were asked to perform some predefined tasks to observe the user interacting with the system. These tasks were alike for all students and

consisted of searching and finding two experiments and two keywords. The interviews were semi-structured; we had an interview guide to capture the important issues, but the questions were open-ended and encouraged the respondents to tell their own story and experiences. When the answers were vague or ambiguous, we asked additional questions to clarify statements. Each interview lasted approximately 20 minutes. They were audio taped with a minidisk recorder and later transcribed for analysis. The interview guide was mainly designed to capture issues concerning user satisfaction and elaborate on why they were satisfied or dissatisfied with different features. For example, one issue was how the respondents got started using POSbase. After this initial question, subjects were asked for the reasons of their answer, for example, if they answered that it was difficult, they were asked why. Then, the interviewer asked what was difficult, and what was easy. We aimed at a deep and comprehensive understanding of usability and user satisfaction of POSbase.

Data Analysis and Results

First we describe how many students used POSbase, and how many users participated in the two evaluations. Then we come to the results; as there were only few differences in single questions between Evaluation 1 and Evaluation 2, and no differences when questions were summarized into scales, we report the scores combined over both evaluations and report single questions where there are differences. To get equal numbers of participants across the analyses, we replaced missing values by the question mean.

We report results in the order of the research questions to be answered: First, frequency of use of the system, then usability of the different functionalities, and finally user satisfaction. For each question, we first report quantitative results, including group differences, and then illustrative examples from the interviews. We observed only few gender differences, which may be due to the large number of t-tests employed; they are not reported here. Level of significance was set at $\alpha = .05$

Subjects in the two evaluations. The number of subjects that participated in the first evaluation is shown in the upper half of Table 2. The numbers show that there was a higher percentage of advanced students (15 of 36) who used the system compared to the undergraduates (85 of 316). In Table 2 we see that there are fewer observations than interviews. During the first interviews we did not have access to an online computer. When this was resolved we also conducted observations.

The number of subjects that participated in the second evaluation is shown in the lower half of Table 2. We had only four volunteers from the advanced students to interview and none from the undergraduates.

Table 2
Subjects in the First and Second Evaluation

Time	Course	Students	Users	Questionnaires	Interviews	Observations
First	Evaluation					
	Undergraduate	316	85	23	7	3
	Advanced	36	15	8	3	2
	Total	352	100	31	10	5
Second	Evaluation					
	Undergraduate	881	91	23	0	0
	Advanced	36	12	8	4	4
	Total	836	103	31	4	4

Reliability. To check the consistence of the measurements, we did reliability analysis for the scales in the questionnaire from both evaluations. We looked at the reliability for usability, user satisfaction, the combination of these and for the overall aspects. The alphas, along with the questions, are shown in Table 3.

The internal consistency of the scales was very high, and is excellent for the purposes of our study.

Frequency of use. On average, respondents reported to use the system between two and three times and to use it for about 10 minutes in each session. We asked students about the frequency of use of functions they did not necessarily have to use: Help pages, discussion forum, and links between presentations. On a 9-point-scale ranging from 1 (never) to 9 (always), students gave the following answers (Table 4).

As can be seen, help pages were rarely used, in contrast to discussion forum and links within PowerPoint presentations. There were no significant differences between introductory and advanced students. A significant difference between the two evaluations was obtained on how much they had used the discussion forum; it was less used in the second than in the first

Table 3
Reliability of Questionnaire

Aspect	Questions	Alpha
Usability	8-12, 20-22, 24	0,78
User Satisfaction	7A-D, 27-31	0,84
All aspects	4, 7A-D, 8-12, 20-22, 24, 27-31	0,89

Table 4
Frequency of Use of Functions

Function	Mean	Standard deviation
Help pages	1.82	1.68
Discussion forum	3.08	2.81
Links within presentations	4.92	2.84

evaluation, $M_{eval1} = 3.97$ and $M_{eval2} = 2.19$; $t(60) = 2.66$, $p = 0.01$. This result is probably due to the fact that the lecturer did more to encourage students to use the discussion forum in the first semester.

Usability. *Questionnaire:* For the evaluation of functions, we summarized single questions into categories. Summary evaluations for search, navigation, help pages and discussion forum can be seen in the first section of Table 5.

In sum, usability of the discussion forum, the links, the pages, and the search options was satisfactory.

When comparing all the answers from the two evaluations, the only significant difference found concerning usability was on the question "Getting back to the previous page was; difficult (1) – easy (9)": $M_{eval1} = 5.46$ and $M_{eval2} = 6{,}72$; $t(60) = 2.20$, $p = 0.031$. This might indicate that some of the changes we

Table 5
Usability and User Satisfaction ($N = 62$):

Category		Evaluation
Usability	Navigation (5)	5.22 (1.44)
	Search (4)	5.91 (1.63)
	Help (1)	4.20 (0.93)
	Discussion forum (3)	5.98 (1.14)
User Satisfaction	General reaction (4)	5.10 (1.41)
	Content relevance (5)	6.54 (1.58)
Content Evaluation (6)		.69 (.20)
Content Usefulness	New topic	.27 (.44)
	Replacement	.10 (.30)
	Repetition	.60 (.49)
	Supplement	.68 (.46)

Note: Number of questions in parenthesis after category; standard deviation in parentheses after mean evaluation.

made helped improve navigation within the HTML-pages, as the search result was not lost when entering the PowerPoint presentations. There were no other significant differences about usability to support this assumption.

Usability of the discussion forum can not be compared because there were too few users in the second evaluation. This is probably due to the fact that the advanced students were encouraged by mail and in the lectures to use it, and their lecturer had also posted some problems for them. This was not done with undergraduate students.

Interviews: The interviews showed navigation and help pages need improvement. Navigation problems were mentioned several times in the interview. For example, students did not know which presentation they entered when switching between different presentations. The problems with orientation and navigation are well-known within hypermedia systems (Alessi & Trollip, 2001, pp. 155-165), and some of the students expressed the feeling of getting lost: *"sometimes when I entered a presentation, I could not quite find out how to prevent from going in a circle"* (interview subject 2), or: *"We forget where we started and why we started there"* (interview subject 8).

PowerPoint does not support features such as navigation bars across different presentations. Therefore users become confused when they want to know in which presentation they are. Some of the students also mentioned during the interview that it was difficult to get back to the original presentation, after having followed several links: *"there was one time when I clicked myself far away and I was not able to get back again, so I just closed the window."*

From both evaluations the problem with navigation and orientation seemed particularly profound. We tried to find alternative solutions to this problem after the first evaluation, by embedding PowerPoint presentations in our own pages (the ilayer-tag). We abandoned this because it did not improve the navigation, but worsened the layout. Users could still not see what presentations they had entered and in what order. We were therefore not able to improve the navigation within the PowerPoint files. We tried, however, to improve the navigation within the HTML-pages by adding labels to the hyperlinks in the search result and opening the PowerPoint presentations in new windows from the search result. Now the users would always have the result list available.

A feature not asked in the questionnaire, but mentioned in the interview was the fact that PowerPoint presentations were difficult to print. As each study and each keyword is a single presentation, there are several files to print out, in contrast to lecture notes which are often downloadable as one file: *"When printing, it can be difficult to get the right sequence of the presentations. A printout file would be useful."*

Printing out the lecture notes was mentioned as a problem many times during the first evaluation, but not mentioned at all in the second evaluation. After the first evaluation we made printout files to make it easier for the stu-

dents to print out; this might be the reason for why it was not mentioned.

Generally the students found the search process quite easy. Most students reported that they preferred simple search when searching for content. What was difficult was to know what to search for. Some difficulties that were reported in both evaluations were getting an overview over the content in POSbase. Several students expressed that it was difficult to know what could be found in the database, and that they therefore did not know what to search for. This could be solved either by arranging the content by lectures (as many of the students wished for) or by categories/topics within science. The reason why we did not arrange the content by lectures is that this differed from advanced to undergraduate courses; moreover, POSbase is not only intended to be used by different courses, but also by other people interested. We could have made another kind of overview available, but this turned out to be too time consuming. It was also reported that they would have preferred an alternative to search. After the second evaluation, we added a browse option to facilitate navigation.

Observations: Neither questionnaires nor interviews revealed any problems with keywords. However, observation during the first evaluation showed that students had problems finding a specific keyword. After the evaluation we therefore changed both simple and advanced search to include keywords in the search result. In the second evaluation the students seemed to have no problems finding out how to use "categories" to search for keywords.

User satisfaction. *Questionnaire:* We finally assessed how the user felt toward POSbase. We therefore assessed a general reaction measure, consisting of four questions, and a relevance of content measure, consisting of five questions; the response scale for these questions ranged from 1 to 9, the higher value denoting a positive evaluation. In addition, six dichotomic content evaluation questions and four dichotomic questions about the usefulness of POSbase were asked. A positive response was scored as 1, a negative evaluation as 0. We summarized content evaluation into one category, but report each single usefulness question because there were substantial differences between single questions. The four questions of this latter category were: Useful to learn new topics, to replace traditional lectures, for repetition, and as a supplement to traditional lectures. The results are shown after the usability categories in Table 5.

No significant differences between introductory and advanced students emerged. By and large, respondents were satisfied with the system, with the contents, and they found it useful as a tool for repetition and as a supplement to traditional lectures. Students could not think of POSbase as a replacement for traditional lectures or as a tool to acquire new knowledge on their own. There was a marginally significant difference between the two evaluations: Participants of the second evaluation gave higher scores to the question "Do you think you will continue to use POSbase: not at all (1) – very much (9)": $M_{eval1} = 5.08$

and $M_{eval2} = 5.94$; t (60) = 1.69, $p = 0.097$. Students in the second evaluation were somewhat more positive to use POSbase in their further studies.

Within the content relevance category, we compiled a measure of ease of content in order to assess potential cognitive overload (see upper third of Table 6). Advanced students found the contents significantly easier than introductory students, t (60) = 2.01, $p = .049$. Further evaluations need to assess cognitive overload directly by tests of retention and deep understanding (Mayer & Moreno, 2003). Despite finding POSbase more difficult, the undergraduate students found it both more interesting, t (60) = 2.43, $p = 0.018$, and more informative, t (60) = 2.97, $p = 0.004$. Moreover, interestingness correlated with relevance of information, r (62) = .375, $p = .003$; the correlations to ease were not significant.

Finally, we checked whether there were any relationships among frequency of use, usability, user satisfaction, and content evaluation. The resulting correlations are presented in Table 7. Frequency of use was significantly related to user satisfaction and positive content evaluation, but not to usability. Usability, user satisfaction, and positive content evaluation were significantly interrelated.

Interviews: The interviews bolstered the quantitative findings that the students appreciated many features of POSbase, especially the possibility to go through presentations of experiments or to look up keywords. *"I think it is good that examples of experiments are shown ... we can learn a lot from that"* (interview subject 1). *"The best, I think, was to be able to look up key terms"* (interview subject 8).

Table 6
Content Evaluation

Question		Undergraduate students	Advance students
Ease	Difficult	.20 (.40)	.01 (.04)
	Easy	.38 (.48)	.59 (.49)
	Average Ease	.59 (.37)	.79 (.25)
Interestingness	Interesting	.40 (.49)	.15 (.34)
	Boring	.05 (.21)	.19 (.40)
	Average Interestingness	.68 (.28)	.48 (.29)
Information Relevance	Informative	.71 (.45)	.35 (.48)
	Irrelevant	.00 (.00)	.06 (.25)
	Average Information Relevance	.85 (.23)	.64 (.29)

Note: To get the respective average scores, the scores for difficult, boring, and irrelevant were reversed. Standard deviation in parentheses after mean evaluation.

Table 7
Intercorrelations of Frequency of Use, Usability, User Satisfaction, and Content Evaluation

	Usability	User satisfaction	Content evaluation
Frequency of use	.183	.367**	.324*
Usability		.793***	.618***
User satisfaction			.669***

Note: *: $p < .05$; **: $p < .01$; ***: $p < .001$.

LESSONS LEARNED AND FUTURE WORK

In this article, we presented our experience with POSbase in psychology teaching. As can be seen, the system serves unique functions as a supplement to textbooks, as a tool to get indepth information about experimental studies, and as a source to look up key terms. The search and browse functions provide students with opportunities to learning according to their interests, which supports constructive and self-regulated learning. The careful design of the PowerPoint slides based on multimedia design and psychological principles helps prevent cognitive overload. Moreover, informal inquiries of psychology instructors suggest that POSbase is a meaningful tool that will both enhance quality of teaching materials and substantially reduce the teacher's preparation time.

Despite the positive attitudes toward POSbase in general, some functions need to be enhanced, and the results of our formative evaluation will guide this further design and development. Some improvements are already implemented based on the feedback from the evaluations. We have solved the printout problem mentioned in the interviews by adding a printout function; students now can print out all the related presentations with one click. In addition, keywords are shown as search result, in addition to experiments. This enables students to begin with a superordinate concept, such as "perception" or "memory," and to proceed to individual studies from these topics. Finally, in order to improve the navigation and encourage active learning, we have added a browse option as an alternative to the search function, which facilitates surfing the database without specific target study or keyword in mind.

We are currently investigating how we can further improve the navigation in POSbase so the students can easily orient themselves within POSbase. One idea is to build a concept map for psychology studies. With this map, studies can be linked to each other and to keywords; for each study and each keyword, there is a link to the respective PowerPoint presentation. Experiments with students could assess the incremental utility of the concept

map. It will be of special interest to observe the utility in terms of navigation through the database and in terms of additional informational value because the links between studies can be seen more easily.

So far, POSbase has been used for psychology, mainly social and cognitive psychology, and will be used in other scientific disciplines. It has also been featured in several outlets, most prominently in the NetWatch section of *Science* (Netwatch, 2005), and has been accessed more than 59,000 times from more than 110 countries from October 2003 to August 2006; most of the hits were registered after POSbase had been featured in the "Teaching Social Psychology Newsletters" in February 2005 (Mueller, 2005). Today, there are more than 160 studies and more than 110 keywords in the database, mainly in cognitive and social psychology, and there are first submissions from external contributors.

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