Notetaking in University Courses and its Implications for eLearning Systems

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Abstract:
This paper presents the results of a study on notetaking in university courses and derives implications for the design of electronic notetaking and annotation systems in eLearning. The study focuses on differences between notetaking with a pen and paper or with a laptop and identifies the reasons for preferring the one or the other. Our findings show that notetaking systems should allow handwritten input, as notes on paper are preferred by the majority of students, mainly because they allow unconstrained free-form handwriting and sketches. Moreover, this paper examines context factors which influence notetaking. For this purpose, a context model for notetaking is presented, which distinguishes the four context types of learner, instructor, content and setting. We identified a significant influence of several specific context aspects and therefore conclude that notetaking systems must be adaptable in order to support notetaking in different contexts effectively.

1 Introduction

Notetaking plays an important role in learning processes and has been proven to be a factor positively related to students' academic achievement [POK05]. This supportive effect encompasses both the processes of recording notes (encoding function) and reviewing notes (storage function) [Kie89].

In eLearning, a growing number of tools have been developed which aim to support student notetaking and annotation. Examples of such systems consist of Livenotes [KWI+05], DyKnow [Ber06], eMargo [GGR+05], AOF [LTZ05] and u-Annotate [CSS+06]. While some of these systems focus on notetaking during the course itself [KWI+05, Ber06], other systems aim at notetaking and review after class [GGR+05, LTZ05, CSS+06]. Most of them include a collaborative functionality and numerous systems allow pen-based input on a Tablet PC in order to simulate the experience of traditional notetaking on paper.

Our current project aims to develop a system for collaborative notetaking, which allows students to annotate the course material with several input modalities. The system will allow both typed input on computer keyboards and handwritten input with electronic pens on digital paper, that consists of ordinary paper sheets, on which a specific pattern is printed. This enables electronic pens to identify their position on the paper sheets, to

capture the user's strokes and to transfer them to a computer. Our goal is thus to close the gap between paper, which still plays a central role in learning, and computers, which are of increasing importance and offer unique benefits not provided by pure paper environments.

The main contribution of this paper is the presentation of a study on student notetaking in university courses. Notetaking in general and more particularly the use of notetaking and annotation software in learning are not well studied [BP05, BK06]. Therefore, we conducted a quantitative study in order to derive implications for the design of notetaking systems in eLearning. These implications provide a basis for the design of a notetaking system in our ongoing work.

Our research was guided by the following main aspects: 1) We evaluated the reasons for the choice of taking notes with a pen and paper or with a laptop. We then assessed the effects of this choice on the notes being taken and on further review and completion activities. 2) Our hypothesis was that notetaking heavily depends on multiple context types. Therefore, we developed a context model for notetaking in university lectures (see below) and evaluated the influence of several specific context aspects. 3) Finally, we assessed note-based collaborative activities.

The context model for notetaking in university lectures is presented in Figure 1. It focuses on the communicative situation in which notetaking in lectures takes place. Following Bühler's organon model of communication [Büh78], we distinguish three central context types (learner - instructor - content) and add the supplemental dimension of the setting surrounding the communicative situation. We then evaluated the influence of several specific aspects of the context types. The learner context type includes preferences and habits, which are personal (and hence on an individual level) or relate to the membership in a social group like gender (supra-individual level). In addition, the influence of two motivational and cognitive factors was assessed, namely the interest in the content and the average grades obtained during previous studies. Moreover, the potential relationship between the ownership of a laptop and the preference for electronic notes was evaluated. In the content type, we analyzed the influence of the course language. The aspect of the instructor's teaching style was not empirically assessed; however, we found a qualitative indice of an influence. Finally, in the setting context type, the study assessed discipline-specific aspects as well as differences between the temporal phases of course review and exam preparation. We did not include a context aspect of tools used for notetaking (i.e. pen, keyboard etc.), since these are not part of the context but of the notetaking process itself. Furthermore, the types and aspects presented herein are not exhaustive. In further work, this framework can be extended for additional types and aspects of context.

The study on notetaking was based on a questionnaire and was conducted in five university lectures which contained several eLearning elements, such as electronic course material, web discussion forums and lecture recordings. In order to investigate discipline-specific differences, we questioned students from computer science and pedagogy. Overall, 408 respondents participated to the study.

The following section will present our method. Section 3 will then detail the results of the study. Finally, Section 4 is dedicated to discussing implications for the design of notetaking systems in eLearning.

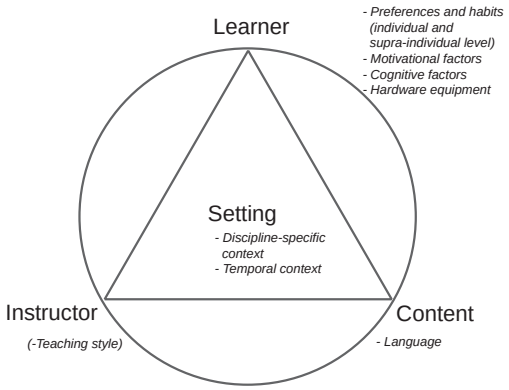

Figure 1: Context types in notetaking and specific aspects assessed in this study.

2 Method

The questionnaire contained 22 closed and open questions related to four topics: 1) notetaking behavior: media used for notetaking, (dis)advantages of those media, types of the notes and the language they are written in; 2) collaboration and team work; 3) course-related information such as the amount of time invested for the course, the personal interest in the topics and the perceived degree of difficulty; 4) personal information about the respondent like sex, field of study, semester and hardware equipment.

The questionnaire was handed out at the end of a university semester in five courses. The participation was voluntary and no compensation was given. We chose four computer science courses, which covered several domains and in which students of different years of studies were enrolled. These courses consist of a first-year introductory course to computer science, a second-year algorithm theory course and two different network courses, which are typically attended in the third or fourth year of studies. In order to allow an interdisciplinary comparison, one course in pedagogy was chosen, in which students of different semesters were enrolled (in average, they were in their forth semester with a standard deviation of 2.8 semesters).

All courses contained eLearning elements. The computer science courses offered a web-based forum for discussions among the students. Two of these courses were recorded and a video including the slides was offered for download after each class. In all evaluated courses, the instructors used PowerPoint slides, which were made available as downloads before the courses. In the pedagogical course, the instructor additionally provided a pure textual script covering more detailed contents as the slides.

Table 1 depicts the number of respondents questioned as well as their gender.

In the statistical analysis, we investigated correlations between items which were five-point scaled and performed χ^2-tests and t-tests to identify significant group differences. All these tests were based on a level of significance of 95 %.

Discipline	Respondents	Female	Male
Computer Science	316	13.8 %	86.2 %
Pedagogy	92	78.4 %	24.6 %
Overall	408	28.8 %	71.2 %

Table 1: Participants of the study.

3 Data Analysis

In this section, the results of the study will be presented along different categories. We will first describe the groups of respondents taking notes. Next, we will detail the media used for notetaking and the reasons of this choice, particularly with regard to the difference between notes on paper or on a laptop. We will then turn our attention to the notes themselves and discuss the languages they are written in. Finally, follow-up activities of notetaking and collaborative aspects will be analyzed.

3.1 Respondents Taking Notes

The proportion of students taking notes during the course considerably varied between the disciplines. While 93.3 % of the pedagogy students took notes, only 62.3 % of the computer science students did. When asked for the reasons for not taking notes through an open question, the largest group of answers to an open question considers the course slides offered by the instructor to contain sufficient information ($N = 16$). Eight respondents indicated that taking notes distracted them from listening.

A significant difference related to the gender of the respondents was revealed in computer science, but not in pedagogy. While 30.0 % ($N = 12$) of the female respondents in the computer science courses did not take notes, a significantly larger proportion of 48.4 % ($N = 121$) of male students did not take notes [$\chi^2(1, N = 290) = 4.702, p = .04$].

When relating these results to the context model, we notice that the decision of taking notes or not seems to depend on the setting and learner contexts, namely on the discipline and on the gender of the respondents. The percentage of students who took notes maximally varied from more than 90 % in the pedagogy course to less than 50 % of male students in computer science.

3.2 Media Used for Notetaking

We further asked the students on which media they take their notes (on empty sheets of paper, on printed versions of the course slides, on printed versions of the course scripts, on laptops and/or other media; multiple responses were possible). Moreover, we examined the use of the course material (i.e. PowerPoint slides, handouts etc.) and searched for

differences which relate to the use of a pen and paper or a laptop. This aspect is of central importance for the design of eLearning notetaking systems, as an electronic system should be able to support the most frequently used media.

Figure 2 below shows the percentage of notetakers on single media or on combinations of several media. Both in computer science and pedagogy, traditional notetaking with a pen and paper clearly outperforms notes on a laptop. In the computer science courses, 77 % of the respondents took their notes exclusively on paper. This group consists of three subgroups of roughly equal percentages which took notes either on empty sheets of paper, on printed course slides or on both of them. 8 % made an exclusive use of a laptop, while 15 % indicated to prefer cross-media notetaking, which combines notes on a laptop with notes on empty sheets of paper or on printed course slides.

The context factor of the discipline proved to be an influential factor of the context model, since laptop use differed largely between the disciplines. In the pedagogy course, laptop use was almost not existent. 98 % took their notes exclusively on paper. The two largest groups (about 45 % each) took notes either only on empty sheets of paper or combined them with printed slides or the printed course script. These findings confirm results of other studies on the choice between paper and laptops [OS97, Obe03], which, however, did not assess notetaking during courses but during overall reading processes and moreover constrained the participants to use a specific software for notetaking.

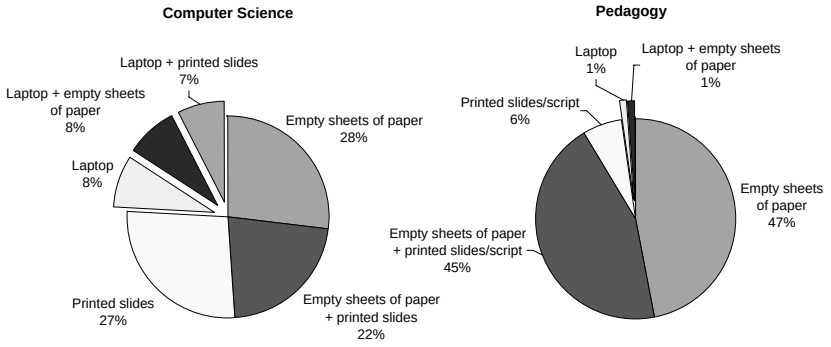

Figure 2: Combinations of media used to take notes on.

It is worth noting that the percentage of students taking notes on a laptop was small even though 78.6 % ($N = 180$) of the notetakers possess a laptop. Only 19.6% ($N = 35$) of the students owning a laptop took notes on this device. The hardware equipment, one of our context factors, does therefore not seem to be relevant.

A gender-specific difference was found in the computer science courses, but not in pedagogy. While 77.8 % ($N = 42$) of female respondents took notes on printed lecture slides, only 56.1 % ($N = 69$) of male respondents did so [$\chi^2(1, N = 150) = 4.336$, $p = .05$]. However, we found no significant gender-specific difference in the use of laptops.

Comparing different computer science courses, we found that in one course (algorithm theory), the respondents made a significantly higher use of empty sheets of paper (76.4 %,

$N = 42$) than the remaining respondents (52.3 %, $N = 58$) [$\chi^2(1, N = 166) = 8.927$, $p = .004$]. In this course, the instructor frequently drew sketches and diagrams on the blackboard which were not contained in the slides. We assume that this specific teaching style combined with little free space on the slides led to the heavy use of paper sheets.

Taking a closer look on laptop users, we asked them about the software they took their notes with. Responses fell under two categories of almost equal frequency: Software that allows to annotate the electronic course slides (e.g. Adobe Acrobat) ($N = 16$) or word processors and text editors ($N = 17$). Four students indicated to use both annotation and a word processor, three students annotated on a tablet PC and two students employed a specific software for creating mindmaps. These data show that the repartition between annotating printouts and taking notes on blank sheets which we identified for paper notetakers is approximately reflected by notetaking on laptops. The main device for the input of electronic notes is the keyboard, since only few students own a Tablet PC (1.2 %).

The prominent position which course material provided by the instructor holds in student notetaking is reflected in the general use of course material as well. Figure 3 depicts the mean frequency of course material use indepentently of notetaking. This chart indicates that the most frequently used media are course slides and the textual script.

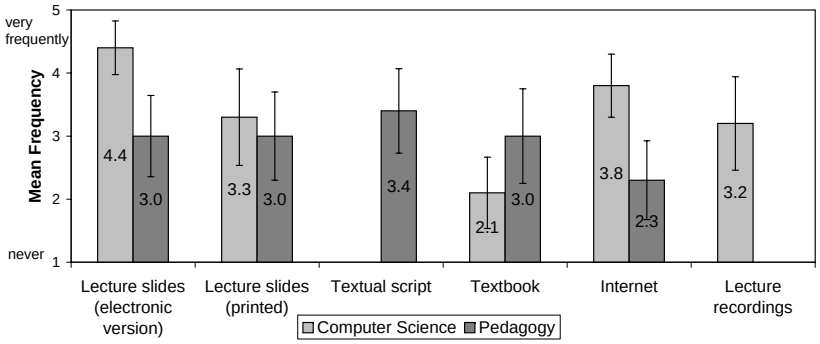

Figure 3: Use of course material (independently of notetaking). Standard deviations are indicated by the error lines.

3.3 Advantages of Different Media

Besides assessing the distribution among different notetaking media, we aimed to gain information about the reasons for choosing those media as well as the advantages respondents associated with paper or electronic notes on a laptop. This aspect is of general importance for eLearning systems which aim to transfer activities traditionally relying on paper to a computer. Therefore, students were requested to judge the importance of several advantages of paper and electronic notes on a five-grade scale. In addition, we posed an open question, in which we asked the students to explain why they preferred the specific

media they took notes on.

The results of the quantitative question are depicted in Figure 4. They show that the free-form flexibility was regarded as the most important advantage of notes on paper. This is followed by the fact that paper can be easily transported. As far as electronic notes are concerned, all proposed advantages were rated almost equally. When investigating differences between the advantages of paper and laptops, we found that long-term archivability was rated significantly more important for laptop than for paper notes [$T = -5.935$, $df = 234$, $p = .000$]. Similarly, good readability of typescript is rated significantly more important than good readability on paper [$T = -5.907$, $df = 230$, $p = .000$].

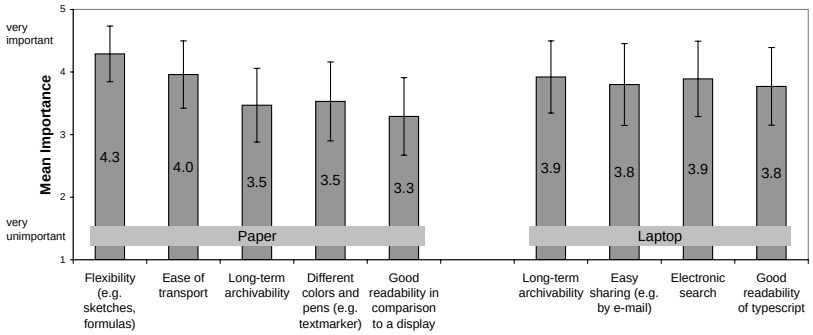

Figure 4: Advantages of paper and electronic notes.

Students taking notes on paper regarded most advantages of paper as significantly more important than students taking notes on a laptop and vice versa. However, both groups highly rated the flexibility of free-form notes on paper, which thus seems to be of great importance even for laptop notetakers.

The responses to the open question indicate some additional important factors. Students taking notes on a laptop valued that notes can be more easily modified ($N = 4$) and offer a cleaner appearance ($N = 2$). Two respondents stated to prefer electronic notes because this way, they do not have to print the slides. Two further students noted that a laptop allows them to keep the information in one place. On the other hand, 20 respondents stated that notetaking on paper is easier and faster than notetaking on a laptop.

The responses also indicated reasons for preferring annotations on course material or notes on blank sheets of paper. Annotations on printed course slides are regarded as advantageous, since these allow to establish a direct reference to the context by taking the notes on the place they refer to ($N = 27$). 24 respondents particularly valued that they do not need to write everything down on the slide, but only add additional information of importance. On the contrary, blank sheets of paper are favored because they allow to create an own structure and to note own ideas more individually ($N = 12$). Moreover, in contrast to course slides, they provide sufficient free space ($N = 5$). Three students indicated to combine notes on paper and on printed course slides in order to separate their own ideas from additional information given by the instructor.

3.4 Language of the Notes

A further aspect of our context model is the language in which the notes are taken. This aspect must be considered if an eLearning system includes further analysis of textual notes like handwriting recognition or summarization and recommendation of relevant notes.

Even though German stays the most used language, the language in which the course is held largely influences the languages of the notes. The percentage of respondents who indicated to often or very often use the German language varied from 36.7 % ($N = 14$) in courses held in English to 95.0 % ($N = 207$) in courses held in German.

An important finding was that a significant proportion of students combined notes in two or more languages. This percentage corresponded to 60.2 % of the respondents in computer science and to 26.8 % in pedagogy.

3.5 Review and Completion of Notes

Respondents who took notes were asked how frequently they review and complete their notes after class and when preparing the exam. These results allow to estimate in which phases an electronic notetaking system would be used. Mean values are depicted in Figure 5. (Results for exam preparation relate only to the computer science courses, since in the pedagogy course, no final exam took place.) The results show that, in contrast to the wrap-up phase after class, where scores are rather low, students become more active when preparing the exam. The context factor of time thus seems to influence notetaking.

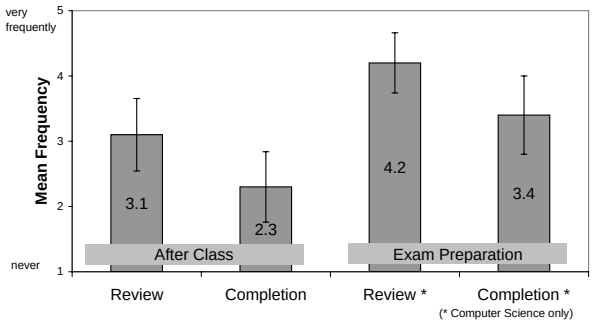

Figure 5: Frequencies of follow-up activities for notetaking.

No significant differences were found between laptop and paper notetakers. However, taking a closer look on the group which took notes on paper, our data indicate that annotations relate to more frequent follow-up activities than notes on empty sheets of paper: In review after class as well as in review and completion before the final exam, mean frequencies of respondents annotating printed course slides or the course script were .4 to .6 points higher ($p < .006$) than of students taking notes on blank sheets.

3.6 Note-based Collaboration

Collaborative notetaking is supported by most eLearning systems for notetaking. They allow either to collaborate by synchronously taking notes on a shared set of documents (e.g. [KWI+05, Ber06]) or by asynchronously sharing notes in threaded forum-like discussions (e.g. [GGR+05, LTZ05]). In order to additionally assess collaborative behavior in university courses, we asked the respondents to indicate their collaborative activities which make use of their notes.

54.4 % ($N = 135$) of the respondents who took notes during class indicated to use them for collaborative work. The most important point (71.1 % of this group) consisted of using the notes as a basis for group work and discussion with other students. 51.1 % compared their notes for completion with those of others. 45.9 % gave their notes to other students or used those of others, e.g. in case of illness. Collaborative use of notes does not seem to relate to a specific medium on which respondents took their notes.

We found a relationship between collaboration and the frequency of note review and completion. Respondents using their notes collaboratively review them more frequently after class ($M_1 = 3.3$ [$SD = 1.0$, $N = 134$] vs. $M_2 = 2.7$ [$SD = 1.1$, $N = 92$]) [$T = -4.142$, $df = 224$, $p = .000$]. Alike, this group completes them more frequently after class than non-collaborative notetakers ($M_1 = 2.4$ [$SD = 1.0$, $N = 129$]; $M_2 = 1.9$ [$SD = 1.0$, $N = 91$]) [$T = -3.671$, $df = 218$, $p = .000$].

4 Implications for Notetaking Systems in eLearning

The goal of this study was to derive implications for eLearning and the design of notetaking systems which support students in university courses. These implications will be discussed in this section.

Support of handwritten input

Our study shows that in university courses, taking notes with a pen and paper is considered to be easier and faster and therefore preferred to a laptop by the vast majority of students. Important factors for the choice of paper consist of the flexibility of free-form notes and the easy transport. For the majority of the respondents, these advantages are not outrivaled by those of electronic notes on a laptop which mainly consist of electronic search, long-term archivability and editing functions. According to the results of this survey, this also seems to apply to computer science students, who are generally more familiar with new technologies.

Therefore, our findings indicate that a laptop is not the most adequate device for taking notes in courses. Instead, handwritten input should be supported by an eLearning system. However, no recommendations for the choice between traditional paper and Tablet PCs, which allow handwritten input, can be given, since only 1.2 % of the respondents possess a Tablet PC.

Support of both annotations and notes on blank pages

This study indicates that a system for notetaking should allow both to annotate course material provided by the instructor and to take unstructured notes in a blank region. Annotations in textual handouts or presentation slides allow a close association with the course by directly referring to the adequate position within the material. Furthermore, students can concentrate on noting important points, since not everything must be noted. On the contrary, unstructured notes in a blank region of the screen or on blank sheets of paper offer the benefit of not constraining students to closely follow the structure provided by the lecturer. Instead, a restructuring can be made and a personal view on the relations between pieces of information can be expressed. These transformation operations have proven to increase the effectiveness of learning processes in other findings [BP05]. In this respect, DyKnow [Ber06] offers an appropriate support as students can both annotate the slides provided by the instructor and take unstructured notes in a separate blank frame. Windows Journal supports both modes as well. However, most other current eLearning notetaking systems only support annotations.

Provide enough free space for annotations

With regard to annotations, several respondents stated that the free space available on the slides for annotations was too small. Instructors should thus provide enough room on paper handouts for annotations. In this respect, electronic systems have the potential to clearly outperform paper-based annotation since they can dynamically adapt free space for annotations on the screen, hide and filter annotations on demand or display them in a separate frame (e.g. [LTZ05]).

Support of several languages

Furthermore, our results indicate that students tend to combine several languages when taking notes, especially if the course is held in a language other than their native one. Hence, systems for handwritten input which use handwriting recognition techniques must correspond to this more complex situation and offer support for several languages at the same time. A system in which the user must choose one single language to be recognized (e.g. Windows Journal) does not seem appropriate.

Support of collaboration

According to the results of this survey, a significant proportion of respondents use their notes for collaboration. Hence, collaborative functionality should be included in eLearning systems. This can be especially beneficial in distance learning settings, where a personal exchange of the notes is not possible or more difficult to realize.

Adaptability to the specific context

Our findings indicate that notetaking in university courses should be studied along several context types (see Figure 1). We showed that in the learner type, both individual preferences and supra-individual factors have a significant effect on notetaking. In addition,

influences of the setting, such as discipline-specific and temporal factors, were revealed. However, personal interest in the content and average previous grades of the respondents do not seem to influence the choice of a notetaking medium and the frequency of follow-up activities or collaboration. In the two remaining context types which concern instructor and content, only a small contribution could be made since both the teaching style and the content of the course are difficult to assess in a questionnaire. Nevertheless, context influence of the language and of the teaching style was revealed as well.

In summary, our study showed that notetaking behavior largely depends on a complex multitude of context aspects. Notetaking systems must account for this dependency. Therefore, they must be adaptable in their central functionality (like support for annotations vs. notes on blank pages, input modality, types of the notes and collaborative features) to fit the different user needs and teaching styles in specific context situations.

5 Conclusion

The study presented in this paper examined both the differences of paper and electronic notes and the influence of several contextual factors in notetaking. Based on these findings, implications for the design of eLearning notetaking systems were derived.

We showed that numerous key characteristics of traditional notetaking with a pen and paper are comparable with those of electronic notes on a laptop. No differences between the two groups were found in the types of notes taken, in the frequency of later review and completion as well as in collaborative activities.

Nevertheless, in university courses, most students prefer notetaking on traditional paper to electronic notes on a laptop. This also applies to computer science students. Main reasons for this choice are the easy transport as well as the advantage of easily taking free-form notes on paper. About two thirds of the students who took notes on a laptop simultaneously took notes on paper. This seems to indicate that the support of handwritten free-form notes is a key aspect for a successful introduction of electronic notetaking systems in university courses.

Furthermore, a model of context types which influence notetaking was presented and the influence of specific context aspects was proven. Amongst others, the study identified an influence of personal habits, of the discipline in which the students are enrolled and of their gender. An eLearning system for notetaking must comply with this complex multitude of context dependencies. Therefore, it seems indispensable that such systems are highly adaptable to fit diverse user needs and teaching styles in specific context situations. This is even more important as the literature shows that small changes in the system design can have large effects on notetaking processes [BK06].

Future work could make a contribution to refining the context model. A question of great interest consists of evaluating the influence which specific media types (such as text, pictures, diagrams, tables, videos) used in the courses have on notetaking and more specifically on annotations. Furthermore, the dynamics of collaborative notetaking could be taken into account by introducing a fifth context type, the interaction history. Once note-

taking systems allow a tightly integrated support of both paper-based and electronic input, future work should also evaluate this combined use. This would lead us a further step forward in understanding how traditional tools can be effectively integrated into electronic systems.

Acknowledgments

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