

Extending and Evaluating a Collaborative Note-Taking Application: A Pilot Study

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Abstract. Taking notes during lectures helps students filter information, record key points, clarify ideas and be more actively engaged in learning. This is particularly important in face-to-face lecture-based scenarios supported by slides, when students need to complete instructor handouts with their personal notes in order to facilitate understanding and foster involvement. In order to offer an alternative for handwritten notes or generic note-taking apps, we developed a mobile application with pedagogically grounded functionalities, called EduNotes, which allows students to collaborate with their peers during the note-taking process. In the current paper, we present an extension of the platform with a web version, which supports the simultaneous presentation of the lecture slides alongside the notes, together with a more advanced note management functionality. Both EduNotes versions were successfully used in an experimental study involving 38 students, which is reported in the paper.

Keywords: Note-taking · Collaborative learning · Lecture-based instruction

1 Introduction

Note-taking is an important process in education, by means of which students record key ideas and concepts [11]. Beside the role of "external memories", notes lead to an "internal storage" by contributing to memorization [3, 7]. Note-taking helps students personalize knowledge construction, building connections between the newly received information and their existing knowledge [12]. Furthermore, it fosters active engagement during lectures [14] and encourages reflection and filtering of the lecture content [3].

The traditional lecture-based scenario, in which teachers deliver lectures supported by slides, is still a very popular instructional approach. In this context, even if students are provided with the presentation slides, they still need to take their own notes to facilitate understanding and higher-order learning [1, 16]. Indeed, studies show that provision of partial or guided instructor notes that students can complete with their personal notes is the best approach, offering a scaffold for student note-taking, but still encouraging attendance, attention and engagement [4]. One solution is to provide handouts that students can take notes on, but this is paper-wasting and not very practical; furthermore, students cannot easily share their notes or collaborate with their peers. A

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Z. Kubincová et al. (Eds.): MIS4TEL 2020, AISC 1236, pp. 179–186, 2021. https://doi.org/10.1007/978-3-030-52287-2_18

better solution would be to provide an approach for digital note-taking and note sharing between students. In this context, we designed and implemented a mobile application for note-taking during lectures, called EduNotes, which was presented in [13]. Its advantage over general-purpose, commercial mobile apps for note-taking [10] is represented by the functionalities dedicated for lecture use in classroom settings. First of all, the tool is integrated with the lecture process by enabling students to take notes associated to each lecture slide; furthermore, it supports social interaction and collaboration between learners, by providing functionalities for note sharing, commenting, tagging or rating. In addition, question notes can outline the areas where the lecture is too vague and facilitate the process of clarification, while the option to answer peers' questions has the potential to increase learner engagement [13].

EduNotes mobile application was well received by the students [13], so we decided to extend it with a web version, which allows the simultaneous presentation of the lecture slides alongside the notes. In addition to classroom use, this web application is also suitable for after-class use, allowing the students to manage the notes taken and download all lecture notes associated to the slides.

To the best of our knowledge, no other similar educational platform provides both a mobile and a web version. Indeed, the landscape of existing note-taking systems specifically designed for education is quite limited [13]. A notable example is Tsaap-Notes [16], a web-based application for collaborative note-taking which offers the following main functionalities: posting/deleting/replying to a note, marking a note as favorite, adding hashtags to notes, accessing all existing notes; teachers can also add "notes as questions", in order to assess the current level of understanding of their students. Another example is GroupNotes mobile application [15], which gives students the possibility to jointly take digital notes during a lecture; color codes are used to differentiate between each learner's contribution and students take various roles within a group: note-taker, reviewer, commentator and questioner. In addition, some earlier initiatives for educational note-taking, designed for PDAs, have been proposed in [8, 17].

On the other hand, the literature includes also a related but distinct class of social annotation tools [6, 9], which allow adding notes, comments and highlights to an electronic resource that can be subsequently shared; examples include [2, 5, 18]. By contrast, EduNotes focuses on the process of taking notes during face-to-face lectures, in class-room settings, and not on document annotation. The platform provides a wide range of pedagogically grounded functionalities and has several advantages over similar systems: a simple means for associating notes to lecture slides, flexible sharing options, advanced filters, live notifications, note rating feature, file attachment option as well as different note types (including lecture summary, questions for peers and associated best answers) [13].

In this paper, we aim to introduce the web version of EduNotes, as well as evaluate the usability and usefulness of both versions of the platform, by means of a pilot study. The first objective is covered in Sect. 2, which describes EduNotes web application in terms of functionalities and architecture; the second objective is covered in Sect. 3, which reports on the experimental study conducted with 38 computer science students. The paper ends with conclusions and future research directions.

2 EduNotes Web Application

EduNotes web version was designed as a complementary tool for the Android-based mobile version, which was presented in [13]. The mobile application is well suited for taking notes in the classroom, when teachers give lectures supported by slides and students use their smartphones for adding and sharing notes with peers. The web application can also be used for distance learning, as well as at home, for individual study, as it allows the simultaneous delivery of the lecture slides alongside the notes.

Both versions provide several functionalities for the students, such as creating, visualizing and sharing notes. Thus, the learner can write a note associated to a slide and add specific tags or file attachments; the note can be private, public, or shared with a specific peer or group. The student can also create a summary note, which is associated to the whole lecture and condenses its key points, facilitating recap and comprehension [3, 14].

Collaboration between learners is also supported by EduNotes: they have the option of starting from an existing peer note, mark it as favorite, add comments and ratings. In addition, students can ask and receive help by posting notes of type *question* and providing answers; this helps to clarify parts of the lecture, while also increasing learner engagement. Finally, students receive live note updates and notifications and can visualize all personal and public notes, search, filter and sort them based on various criteria.

In addition, the web version of EduNotes is centered around the lecture slides, which are provided alongside the notes, as shown in Fig. 1. This is more intuitive for the students, who can thus visualize the slide content while writing or reading the notes. Furthermore, there is a synchronization option, which allows the student to keep its current slide always in sync with the one presented by the lecturer. Moreover, the learner can download all lecture notes associated to the slides. This makes the web application also suited for after-class use, providing students with the annotated lecture slides, based on the notes taken in class.

From a technical point of view, extending EduNotes with a web-based client was facilitated by the flexible service-oriented design. The back-end consists of REST services implemented in PHP, which run on an Apache web server¹ and interact with a MariaDB² database server; more details regarding the system architecture can be found in [13]. The web front-end is based on JavaScript and consists of 3 modules: 1) the GUI module containing the HTML layouts; 2) the Service Invoker module that manages all interactions with the REST API; this module also handles all response objects received from the REST API and it is implemented using AngularJS³; 3) the Updates Manager module that handles both incoming and outgoing real time update messages.

¹ https://www.apachefriends.org.

² https://mariadb.org.

³ https://angularjs.org/.



Fig. 1. EduNotes web version: note-taking bar (dotted blue area) next to the associated slide (dashed red area)

3 Experimental Study

We conducted a small study with 38 students from the University of Craiova, Romania, in order to test our EduNotes platform. The experiment took place over the course of three weeks, during a summer practice assignment for second year computer science students. The teacher delivered three presentations on Java programming for a clientserver application; these included several code examples, which were explained verbally by the instructor, while students could use EduNotes in order to write down the explanations when needed. More specifically, learners were asked to use the web version for the first presentation, the mobile version for the second presentation and the version of their choice for the third presentation. 31 of the students tested both the web and mobile versions, 6 students used the web application exclusively (as they did not have an Android-based mobile phone) and one student used the mobile application exclusively (as he did not bring his laptop to the classroom). For the third presentation, when students could choose the version they preferred, most of them (37 out of 38) selected the web version; according to the learners, this choice was largely motivated by the fact that they already had laptops readily available for the practical programming activities; otherwise, if only mobile phones had been available, the mobile app would have provided a suitable alternative. At the end of the three weeks, the students were asked to fill in several questionnaires regarding their experience using EduNotes, as detailed next.

First of all, we were interested in learners' perspective on collaborative note-taking in general. Thus, the majority of the students liked the idea of taking lecture notes digitally (over 86%), of sharing lecture notes with peers (over 83%) and of viewing peers' lecture notes (over 89%).

Subsequently, we wanted to gauge learners' satisfaction with EduNotes tool in particular, based on the opinion survey proposed in [13]; 37 students gave their opinions regarding the web version and 32 students regarding the mobile version. In particular, learners were asked to answer the following questions on a five-point Likert scale:

- Q1. It was easy for me to use EduNotes
- Q2. I read the notes shared by my peers in EduNotes
- Q3. The note-taking process with EduNotes was quick
- Q4. The note-taking process with EduNotes was not distracting
- Q5. The note-taking process with EduNotes made me pay more attention to the lecture
- Q6. Overall, I was satisfied with EduNotes app
- Q7. I would like to keep using EduNotes in the future
- Q8. I would like to use EduNotes in other courses.

The results are summarized in Fig. 2 for EduNotes web application and in Fig. 3 for EduNotes mobile application.



Fig. 2. Percentages of students' answers on the opinion survey regarding EduNotes web version

As can be seen in the figures, students' opinions were very similar regarding the two versions of EduNotes. According to Q1, most of the students found the applications easy to use; the majority of learners chose to read the notes shared by their peers (Q2). The note-taking process was deemed quick (Q3), not very distracting (Q4) and helpful for paying attention to the lecture (Q5). All in all, most students were satisfied with both versions of the platform (Q6), and willing to continue using them (Q7), also for other courses (Q8).



Fig. 3. Percentages of students' answers on the opinion survey regarding EduNotes mobile version

Overall, the results improved compared to the pilot study in [13]; this can be explained by the fact that the mobile application was then in beta version, so students' experience was negatively impacted by the small bugs which were still present at the time.

Subsequently, students were asked about the ease of use of each of the main functionalities provided by EduNotes; results are summarized in Table 1. As can be seen, all functionalities were perceived as easy or very easy to use by the majority of the students, for both versions of the platform. Writing summary notes and adding notes to favorites were found easier in the web application, while searching for notes and setting note privacy were found easier in the mobile application. Adding tags to notes was the least used functionality, not being tried by a quarter of the students.

As far as the usefulness of the functionalities is concerned, positive results were also recorded, with the majority of the students perceiving them as helpful or very helpful. Taking notes and viewing notes shared by peers were considered the most useful features, while adding tags to notes was reported as the least useful.

Finally, students were asked to provide suggestions for improving EduNotes, as well as additional functionalities that they believe would be useful. The features proposed by the learners include: an option for downloading lecture slides on the mobile version, a larger note-taking sidebar in the web version, text highlighting and drawing tools associated to notes.

Table 1.	Student perceived ease of use	e for EduNotes	main function	alities; for each	functionality,
the first li	ne includes percentages of ans	swers for the wo	eb version and	the second line	for the mobile
version (h	nighest values in boldface)				

Functionality	Did not use it	Very difficult	Difficult	Neutral	Easy	Very easy
Take note	2.70%	0.00%	0.00%	16.22%	32.43%	48.65%
	6.25%	0.00%	3.13%	9.38%	21.88%	59.38%
View notes shared by	0.00%	5.41%	0.00%	5.41%	24.32%	64.86%
others	0.00%	0.00%	0.00%	9.38%	21.88%	68.75%
Search note	10.81%	0.00%	0.00%	21.62%	27.03%	40.54%
	3.13%	0.00%	3.13%	12.50%	40.63%	40.63%
Ask question	10.81%	5.41%	0.00%	13.51%	27.03%	43.24%
	12.50%	0.00%	6.25%	12.50%	25.00%	43.75%
Write summary	2.70%	2.70%	0.00%	24.32%	29.73%	40.54%
	6.25%	0.00%	9.38%	21.88%	34.38%	28.13%
Rate notes	13.51%	5.41%	0.00%	13.51%	10.81%	56.76%
	15.63%	0.00%	3.13%	18.75%	15.63%	46.88%
Add note to favorites	16.22%	5.41%	0.00%	10.81%	18.92%	48.65%
	21.88%	0.00%	6.25%	18.75%	15.63%	37.50%
Add tag	24.32%	8.11%	0.00%	13.51%	18.92%	35.14%
	25.00%	0.00%	6.25%	18.75%	18.75%	31.25%
Set note privacy	21.62%	10.81%	2.70%	10.81%	16.22%	37.84%
	15.63%	3.13%	6.25%	12.50%	31.25%	31.25%
Add reply to note	13.51%	5.41%	2.70%	13.51%	21.62%	43.24%
	15.63%	0.00%	3.13%	9.38%	37.50%	34.38%
View note replies	8.11%	5.41%	2.70%	10.81%	32.43%	40.54%
	3.13%	0.00%	6.25%	12.50%	28.13%	50.00%

4 Conclusion

We presented a web application designed to support collaborative note-taking in lecturebased settings. The tool was developed as an extension of the mobile app introduced in [13]. Both versions of the platform were well received by the students, as evidenced in a pilot study involving 38 participants. From the instructor point of view, we noticed that students need consistent encouragements to be more actively involved with the lecture and take more notes; furthermore, a positive class climate is needed to foster students' confidence in sharing their notes with peers. Clear guidelines for digitally taking notes in a collaborative way and initial scaffolding are also important for ensuring the success of the process. As future work, EduNotes could be extended with a module dedicated to the instructor, for monitoring learners' notes and activity; furthermore, the features suggested by the students could be integrated in the platform. In addition, the system could be used on a larger scale, in various course contexts, and more in-depth analyses could be performed to investigate the impact of collaborative note-taking on the learning process.

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