

EduNotes – A Mobile Learning Application for Collaborative Note-Taking in Lecture Settings

Elvira Popescu¹(✉), Constantin Stefan¹, Sorin Ilie¹,
and Mirjana Ivanović²

¹ Computers and Information Technology Department,
University of Craiova, Craiova, Romania
{popescu_elvira, ilie_sorin}@software.ucv.ro

² Department of Mathematics and Informatics,
University of Novi Sad, Novi Sad, Serbia
mira@dmi.uns.ac.rs

Abstract. Note-taking activities are encouraged in teaching as a mechanism for information retention, review and consolidation, as well as for promoting active engagement with the lecture. Traditional pen-and-paper approaches limit the possibility of note sharing and collaboration between students. An alternative is offered by mobile applications for note-taking, which capitalize on the wide availability of smartphones. In contrast to generic note-taking apps, in this paper we propose a mobile application specifically conceived for educational settings, called EduNotes. Students can write notes associated to a specific lecture slide and share them with peers; they can also tag, rate, add to favorites or comment on notes. Additional features include live notifications, as well as advanced search, filtering and privacy options, which help reduce the overhead of note management. The paper also reports on a successful pilot study involving the use of EduNotes in real classroom settings.

Keywords: Note-taking · Mobile learning · Collaborative learning

1 Introduction

Note-taking plays an important part in lectures, with a high proportion of students taking notes during a course [1, 14]. Recording information and aiding reflection are the two main functions fulfilled by note-taking [3]. Notes act as “external memories”, but at the same time they contribute to the memorization process, leading to an “internal storage” [3, 5]. Taking notes also has a generative effect, by helping students build connections between the information received (lecture content) and their existing knowledge [9, 17]. Notes do not simply transcribe teacher’s talk but also include concept explanations, questions about difficult topics, implications and conclusions [17]. Through notes, students condense information, remember key points of a lecture, clarify ideas and build a better understanding of the subject [12].

In addition, taking notes increases the level of engagement during lectures, helping students become more actively involved in the learning process [12] and focusing

attention on the sorting and coding of the lecture content [3]. Sharing notes with peers is also quite common, leading to an exchange of ideas and interpretations, which fosters cognitive conflict and social learning [17]. Collaborative note-taking further contributes to learner engagement and knowledge building [14].

The most popular note-taking practice still remains the traditional pen-and-paper method, followed by the use of a word processor [1]. Sharing approaches in case of hand-written notes are quite limitative, e.g., by lending the original copy, by photocopying the notes or by digitizing them via mobile phone camera. Dedicated note-taking applications are seldom used, since they are not integrated with the lecture, making note access and retrieval more difficult. In addition, sharing and social interaction with peers are not adequately supported, so students feel these existing applications do not provide the required educational functionalities [1]. Hence there is a clear need to simplify and encourage digital note-taking, note sharing and exchange of ideas between students.

Given the overwhelming popularity of smartphones, especially for the younger and more educated population [10], providing a dedicated mobile application for note-taking during lectures appears useful. In contrast to general-purpose, commercial mobile apps for note-taking [8], our idea is to provide a dedicated application for lecture use in classroom settings. Based on various studies reported in the literature [1, 17], as well as our personal teaching experience, we extracted several functionalities desired by the students for such a note-taking mobile application. First of all, the tool should be integrated with the lecture process by enabling students to take notes associated to lecture slides; furthermore, it should support social interaction and collaboration between learners, by providing functionalities for note sharing, commenting, tagging or rating. Easy note retrieval, by means of advanced search and filtering options, is another desired functionality.

Starting from this set of requirements, we designed and implemented an innovative mobile learning application which aims to support students in the note-taking process during lectures. The name of the application, *EduNotes* (which can be read also as *EduNotes*), blends together its two main features: on one hand the *Educational* role of the app, and on the other hand the inherently small size of the notes, given the mobile device constraints (inspired from the *micro*-blogging tools).

The rest of the paper is structured as follows: Sect. 2 presents an overview of related work, Sect. 3 describes the *EduNotes* application in terms of functionalities and architecture, Sect. 4 reports on the experimental results of using the app in real classroom settings, and Sect. 5 outlines some conclusions and future research directions.

2 Related Work

Several initiatives regarding educational note-taking tools have been proposed over the past few years. Some of them belong to the class of social annotation tools, which allow adding notes, comments and highlights to an electronic resource that can be subsequently shared [7]; examples include [2, 4, 16]. By contrast, the focus of our paper is on the process of taking notes during face-to-face lectures, in classroom

settings. Few initiatives have been reported in this respect: some used existing services [17], while others built dedicated systems from scratch [13, 14], as detailed next. In addition, some earlier initiatives, designed for PDAs, have been proposed in [6, 15].

Valtonen et al. [17] present an experimental study of using the *general-purpose Qaiku*¹ *micro-blogging platform* for taking notes in a university course; 12 students were involved over 8 lecture sessions, in a course on pre-primary education. A total of 367 notes were produced, classified in 5 categories: reproducing lecture content; summarizing lecture content; connecting key concepts; developing lecture content; questions arising from lecture content. While students' attitude towards sharing notes was generally positive, the Qaiku platform was considered unsuitable for the task, mainly because it separated notes from the lecture slides; furthermore, due to a lack of appropriate ordering and filtering, the list of notes became large and sometimes confusing; the necessity to include graphic and video material was also pointed out by the students.

Shen and Reilly [13] introduce GroupNotes, a *mobile application* that a group of students can use to take digital notes during a lecture. Each note can be jointly edited by the group members, in its individual editor window. Color codes are used to differentiate between each student's contribution to the same note area and a content synchronization solution is proposed in order to keep the consistency of all students' notes. Group members can be assigned different roles in order to capture every aspect of the lecture: note-taker (who records notes for the entire lecture), reviewer (who reviews and rectifies notes), commentator (who comments on the notes), and questioner (who develops questions about the notes). However, the subsequent note retrieval and management process is only superficially addressed and no experimental validation of the application is reported in the paper.

Silvestre et al. [14] describe Tsaap-Notes, a *web-based application* for collaborative note-taking. The main functionalities offered by the system include: posting a new note, deleting a note, replying to a note, marking a note as favorite, adding hash tags to notes, accessing all existing notes. Furthermore, teachers can add "notes as questions", by means of which they can quickly assess the current level of understanding of their students. An initial experimental study involving 40 students showed that these interactive questions promoted learner engagement; furthermore, students reported a good overall experience using Tsaap-Notes.

As can be seen, the landscape of existing mobile note-taking systems specifically designed for education is quite limited; in this context, we propose EduNotes, a native mobile application, with a wide range of pedagogically grounded functionalities. Unlike similar systems, our app provides 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). A detailed presentation of EduNotes is included in the following section.

¹ <https://en.wikipedia.org/wiki/Qaiku>.

3 EduNotes Prototype

3.1 Student Functionalities

EduNotes is conceived as support tool for students in a traditional lecture-based scenario, which is still a very common instructional approach. Teachers deliver lectures supported by slides and students use their smartphones for taking notes and sharing them with peers.

Three types of notes are envisaged: basic note, summary and question. Each note can be associated to one of the lecture slides or to the whole lecture. The summary note is unique per lecture and its role is to allow students to recap and condense the information, recording key points [12] and facilitating comprehension [3]. Notes of type question are meant to outline the areas where the lecture is too vague and facilitate the process of clarification [17]. The practice of asking and answering peers' questions has the potential to increase learner engagement [14]. Furthermore, once a question is answered satisfactorily (as marked by the question initiator), the most useful reply becomes available to all peers.

Whenever a student tries to write a new note, EduNotes compiles a list of public notes that are similar in content (the search and note creation functionalities are merged). This feature enables students to easily post comments and corrections if a peer already took a note on the subject. If the existing note is already complete enough, the student can mark it as favorite or rate it using a five star system. This mechanism helps reduce the overhead of note management.

The overall list of student functionalities includes:

- Create notes
 - Write a note associated to the current lecture slide or to the whole lecture
 - Set note privacy (public / private / group / peer)
 - Tag note (with the option to use either a predefined tag or a user-created tag)
 - Write lecture summary
 - Include attachments to notes (mobile camera images or documents in any format from the file system)
- View notes
 - View all personal and public notes
 - Search for notes (based on keyword, tag, author or slide number)
 - Filter notes on 4 tabs (all public notes, favorite notes, own notes, notes directly addressed to the learner)
 - Sort notes chronologically or based on slide number
 - Get live note updates and notifications
- Collaborate
 - Comment on peers' notes
 - Rate notes
 - Add note to favorites
 - Ask questions to peers (by using the dedicated note type)
 - Answer question notes
 - Mark best answer (as question initiator)

3.2 System Architecture

EduNotes was designed using a service-oriented architecture (SOA), with a RESTful API [11] back-end and a native Android² front-end (see Fig. 1). This service-oriented design allows for multiple front-ends to be implemented easily in the future, for example web- or IOS³-based.

The services (implemented in PHP) run on XAMPP with Apache web server⁴ and interact with a MariaDB⁵ database server. Google Cloud Messaging⁶ Connection Server was used for real time notifications. The server can push messages to all connected clients; these real time notifications are initially triggered by other client front-ends. The database is abstracted away from the front-end via the REST API that standardizes interaction.

The front-end is implemented using Java for Android and consists of 3 modules: (1) the GUI module containing the Layouts and Activities; (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; (3) the Updates Manager module that sends/receives real time messages to/from the GCM Connection Server.

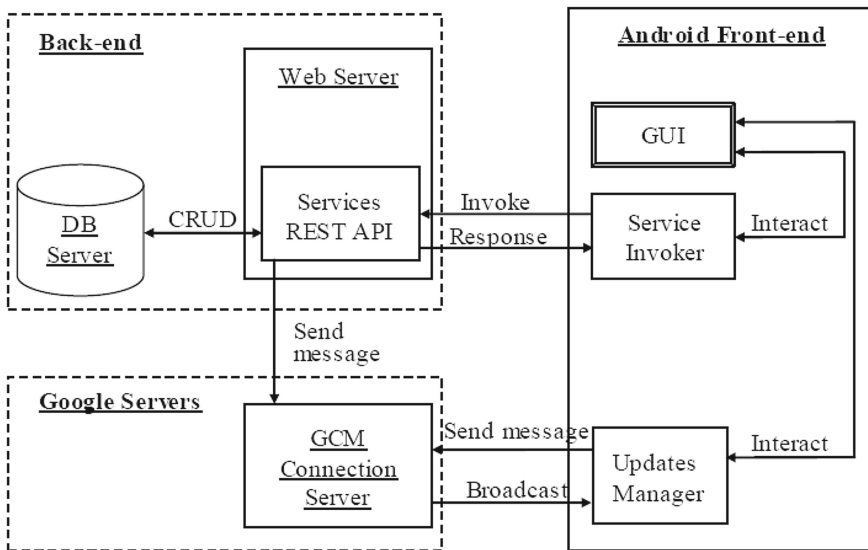


Fig. 1. EduNotes schematic architecture

² <https://developer.android.com>.

³ <http://www.apple.com/ios>.

⁴ <https://www.apachefriends.org>.

⁵ <https://mariadb.org>.

⁶ <https://developers.google.com/cloud-messaging>.

3.3 Illustrating EduNotes Functionalities

When accessing EduNotes app, right after login, the student can choose the course and lecture for which she wants to take notes (out of all the courses she is enrolled in). Alternatively, the student can choose to view a list of currently held lectures, as shown in Fig. 2. All subsequent student actions take place in the context of the selected lecture.

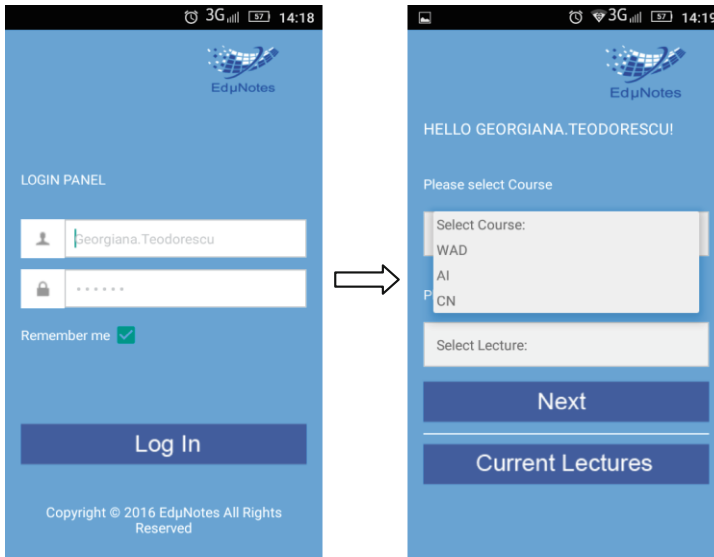


Fig. 2. EduNotes - Student welcome screen

The note view functionality is illustrated in Fig. 3a; filters are implemented as tabs to quickly sort through the potentially long list of notes. Tapping an existing note allows the learner to view the note details (full text, slide number, tags, timestamp, author, privacy level) and also to rate it, add it to favorites or reply to it (see Fig. 3b). At the bottom of the view notes interface there is a multipurpose textbox. A student can start to write a note straight from this textbox and the list of notes will be filtered automatically to match his keywords. This can reduce the possibility of redundant notes written separately: if a student starts to write but sees someone already noted his idea, he can simply use that existing note and mark it as favorite; alternatively, the student can also complete or correct the note, by adding a reply to it.

If the student decides to write a new note, she can tap the round “plus” button, which leads to an Add note form (see Fig. 3c). The text of the note will automatically be populated with whatever content was written in the search textbox before tapping the add button. The note can be associated to a particular slide or to the whole lecture. The form also allows the student to add tags, set note visibility (as public, private, group or peer) and choose if the note is meant to be a question or not. Furthermore, the “Browse” button offers students the possibility to take a picture with the integrated camera or select a document from the file system and attach it to the note.

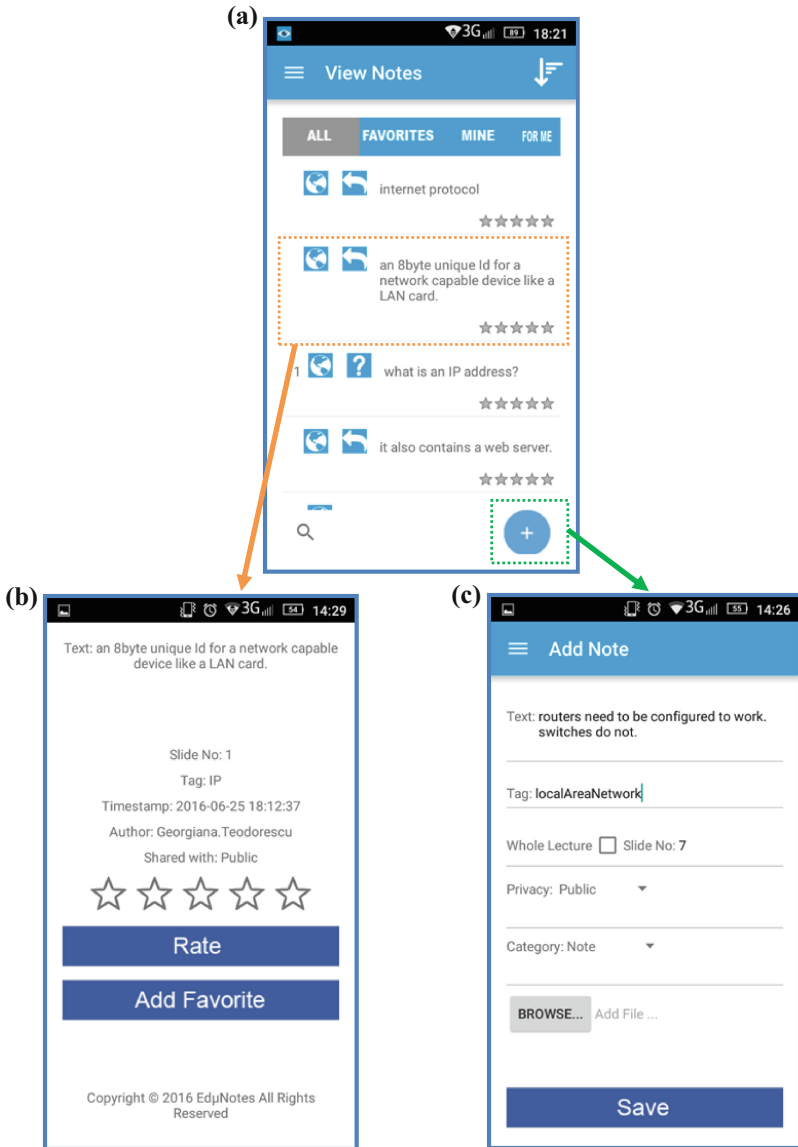


Fig. 3. EduNotes screenshots: (a) View notes; (b) View note details; (c) Add a new note

4 Initial Experimental Validation

We tested EduNotes in real classroom settings, in a small pilot study with 25 undergraduate students in Computer Science, from the University of Craiova, Romania. The students used the app for taking notes during a lecture session of the Computer Networks course. At the end of the lecture, students were asked to complete an opinion

Table 1. Results of learner experience survey (percentages of answers on the five-point Likert scale; highest values in boldface)

Questions	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I like the idea of taking lecture notes on my smartphone	8%	4%	24%	24%	40%
I like the idea of sharing my lecture notes with my peers	0%	8%	16%	16%	60%
I like the idea of viewing my peers' lecture notes	0%	0%	8%	24%	68%
It was easy for me to learn how to use EduNotes	4%	0%	16%	36%	44%
It was easy for me to use EduNotes	12%	4%	4%	32%	48%
I read the notes shared by my peers in EduNotes	8%	0%	12%	44%	36%
The note-taking process with EduNotes was quick	4%	8%	16%	40%	32%
The note-taking process with EduNotes was not distracting	8%	20%	20%	36%	16%
The note-taking process with EduNotes made me pay more attention to the lecture	8%	28%	16%	28%	20%
Overall, I was satisfied with EduNotes app	12%	8%	16%	44%	20%
I would like to keep using EduNotes in the future	8%	4%	32%	36%	20%
I would like to use EduNotes in other courses	12%	4%	28%	36%	20%

survey regarding their learning experience with EduNotes. The results of the survey are summarized in Table 1.

As can be seen from the results, the mobile note-taking application concept was very well received by the students (questions 1–3); the large majority of learners welcomed the idea of taking notes on their smartphone and sharing them with peers. The EduNotes app was found easy to learn and easy to use by most of the students (questions 4–5). Learners generally read their peers' notes and perceived the note-taking process as relatively quick (questions 6–7). However, using the app proved somewhat distracting to around a third of the students, which made them pay less attention to the actual lecture (questions 8–9). This can be explained by the fact that it was students' first interaction with the app and it took them some time to get accustomed to it. Furthermore, since the app was in a beta version during the pilot study, some small bugs were still present, which further hindered the experience.

Overall, the survey shows (questions 10–12) that students were generally satisfied with EduNotes app and willing to integrate it in their lecture process, also for other courses.

5 Conclusion

We designed and implemented a mobile learning application for collaborative note-taking during lectures. Unlike generic note-taking apps, EduNotes was specifically conceived for educational settings and offers a wide range of learning support functionalities. Students can write notes associated to a specific lecture slide or to the whole lecture and share them with peers. Features like note tagging, commenting, rating, adding to favorites, live notifications, advanced search, filtering and privacy options help reduce the overhead of note management. Summary notes facilitate the process of reviewing and recording key points, while question notes boost learner engagement. Students' subjective evaluation of EduNotes, in the context of a small pilot study, supports the validity of our approach.

As future work, we plan to extend EduNotes with a web-based client, which will be facilitated by the flexible service-oriented design. This web application is aimed for after-class use, providing students with the annotated lecture slides (which will integrate the notes taken during the lecture); a more advanced note management functionality will also be included. In addition, a web-based module for the teacher is envisioned, which will help monitor students' notes and activity. Finally, larger scale experiments are planned to be conducted, in order to investigate note management and use in the long term and measure the effects of EduNotes on the learning process.

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