Cross-Platform App Development for Blended Learning Courses

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***Abstract*—The survey data suggest a high technical and sufficient psychological readiness of Yaroslavl State University students to use mobile devices in learning. Nevertheless, it is obvious that there is a need in popularizing mobile learning among students by organizing explanatory talks and encouraging on the part of the teaching staff. The developed mobile application Study24Seven is cross-platform and is suitable for modern versions of the iOS and Android operating systems. This result is achieved both through the application architecture and the use of PhoneGap iOnic technology. The development of appropriate methods of the blended learning system will increase the efficiency of teaching the Humanities to students of technical specialties.**

I. Introduction

The organization of mobile learning in a classical university is a very complicated process requiring serious planning and coordinated actions of the educational establishment administration and teaching staff. The educational process organizers face the following challenges while implementing mobile technologies [1]:

- choosing the mobile technologies role and place in learning. Mobile devices can be used in different ways in educational process: both in the classroom and outside it, as an obligatory element of a course or as an additional one.
- assessing students' readiness for mobile learning. It is advisable to assess the level of students' technical facilities and competence as well as their psychological readiness before implementing mobile technologies in educational process. For that it is reasonable to make a survey (questionnaire), the results of which will help to make a deliberate decision about the necessity of using mobile devices in teaching and learning.
- choosing the strategy of providing students with portable devices:

1) BYOD (bring your own device) strategy – each student uses their own portable device, this strategy answers the purpose of mobile learning – to gain knowledge at any time and place – most of all. It is reasonable when students are technically well-equipped, thus avoiding considerable material costs.

2) providing the group with the devices belonging to the educational establishment – the supporters of this strategy mention such advantages as unified technical features of all the devices, the possibility to control learning activity and such things, that are impossible to do when students use their own devices.

The research revealing the level of Russian students' mobile devices facilities, that is a key factor in implementing BYOD strategy, shows that 100% of students have mobile phones and use them every day, while about 90% have smartphones with the Internet access and application installation facilities [2-4]. Thus, the data, collected by different researchers, corroborate the students' mobile competence. Nevertheless, I.S. Son has pointed out that both students and teachers are ill-informed about the effective use of mobile devices in educational process [4]. The same opinion was expressed by students in U.V. Eremin and E.F. Krylova's study: 75% of students voice fears that they might not be able to cope with such activities without the teacher's advice and supervision, because they "don't know where to start" [3]. These findings demonstrate the importance of the organizational factor in mobile learning as well as the necessity to give proper attention to the mobile learning organization issues in higher educational establishments.

Apart from the importance of having a mobile device with a necessary set of functions it is essential for students to be psychologically ready to make their learning efficient. Psychological readiness for any activity means a psychological state when a person mobilizes resources to carry out some specific short-term or long-term activities or tasks [2].

Nevertheless, mobile learning, as any other type of learning, is based on the students-and-teacher interaction, taking place both in virtual setting and physical environment. Only one in six studies analyzed the problem of teachers' readiness for mobile learning. The survey (questionnaire) made by I.S. Son, showed that only 15 out of 38 teachers approved of using mobile technologies in the English language learning, while some teachers demonstrated skepticism and even disapproval of such learning [4].

Besides analyzing students' technical and psychological readiness it is important to find out the advantages and disadvantages of using mobile technologies in learning activities. In the study, devoted to students' foreign languages mobile learning, U.V. Eremin and E.F. Krylova pointed out the following positive features: a smartphone is always close at hand; one can get information at any place and time; you can devote your time spent in public transport, queues and traffic jams to learning a foreign language; there is access to video and audio content in a foreign language [3]. Accumulator discharge

and instability of the Internet access were mentioned among mobile technologies shortcomings [2]. Such a project, devoted to foreign languages learning, was implemented in Yaroslavl State University (YSU) [5].

The rest of the paper is organized as follows. Description of the analysis of the student survey described in the second part. The development of cross-platform application for blended learning considered in the third part. Conclusions presented in the fourth part.

II. Analysis of mobile technologies application in YSU

Lower we analyze the results of the students' survey at YSU revealing their readiness for using mobile technologies in learning.

A. Student initial testing

The students' survey (questionnaire) at Yaroslavl State University was based on a scheme of assessing students' readiness for mobile learning, which is described in different literary works. The first- and second-year students of the Law Faculty, the Faculty of Philology and Communication and the Faculty of Information and Computer Science took part in this survey. There were 121 respondents. According to the questionnaire data, all students have at least one type of portable devices, among them 94,2% have smartphones, 26,5% - mobile phones, 43,8% - tablets, 30,6% - netbooks. In accordance with the presented data we can state that almost all participants are fully equipped with portable technical devices.

The next step after assessing the level of students' technical facilities is analyzing their skills to use different technical devices functions, work with applications, employ mobile devices while learning. All these skills form the concept "competence in using mobile devices" or "mobile competence". Students were offered to estimate the frequency of their using different functions and applications in learning. The results of the survey are presented in Fig 1.

The results of the survey show that students almost fully exploit the potential of their portable devices both in everyday life and in learning. While learning students use the Internet access, search engines, e-reference books and e-dictionaries and applications for reading e-books. Such frequency of using some specific functions and applications corroborates the students' mobile competence.

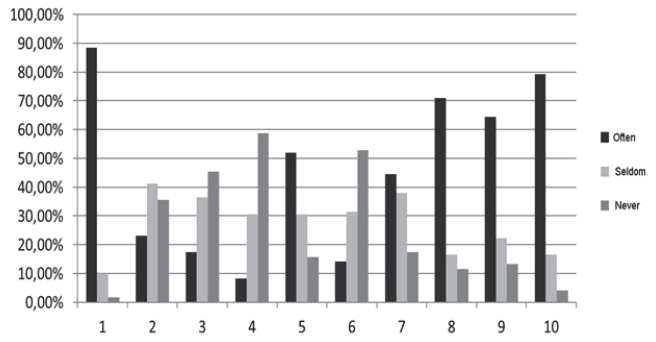

Fig. 1. The frequency of using different applications on portable devices in educational process.

The results of the research prove that students have an above the average level of interest and motivation in learning with the help of mobile devices. Nevertheless, it is obvious that there is a need in popularizing mobile learning among students by organizing explanatory talks and encouraging on the part of the teaching staff.

The survey also showed that about 17% of students have mobile learning experience. In general, portable devices were employed while getting ready to the Unified State Examinations, learning foreign languages and other school subjects. The students' responses about such experience are mostly positive, but many students mention inconveniences in using mobile devices in learning, which are connected with the screen size, low quality of the teaching material and its design, the lack of timely consultations on the topic under study.

Explanation:

1) Internet access;
2) watching video files;
3) listening to audio files;
4) SMS/MMS messengers;
5) applications for social networks (VK, Facebook, etc.);
6) messenger-applications (WhatsApp, Viber, Telegram, etc.);
7) e-mail;
8) e-reference books/ e-dictionaries;
9) applications for reading e-books;
10) search engines (Google, Yandex, etc.).

Let's look at pilot projects of employing mobile technologies in the current educational process at YSU.

III. Study24seven application development

The project is aimed at developing and testing the system of blended educational project for doing a Masters in technical and computer sciences [6]. The humanitarian course "The history and methodology of science" for YSU postgraduate students, specializing in "Information and communication technologies and communication systems", was chosen as a pilot project [7].

The choice of the pilot project is based on the following factors:

- students with the technical specialization have an extremely low level of humanitarian knowledge (the existing methods of giving lectures and presentations don't work properly);
- a very low percentage of technical students go to the library;
- such students demonstrate low activity during the term;
- there is an immense body of high-quality materials on the history of science (e.g. films by Leonid Parfenov "Zworykin-Muromets", films about Nicola Tesla, video materials devoted to the invention of radio, the Silicon Valley and other innovation clusters), which are publicly available.

To work out the cloud system of blended learning it was decided to choose the cross-platform mobile and web-development [8],[9]. The most popular today are the mobile iOS and Android platforms. The advantage of this product is that one can use this app on several initially incompatible platforms using one code. This allows to minimize the product costs as it is enough to have only one software developer to create the mobile application suitable for all platforms. But there are lees to every wine. The shortcomings of the product are the limited apps characteristics in comparison with native apps. The second drawback, the general design of the interface, is, to some extent, an advantage as well. No matter what platform is used it will have the same interface and screen logic (Fig. 2).

PhoneGap framework was chosen to develop the cross-platform mobile application (Fig. 3). PhoneGap, also known as Apache Callback, is based on Apache Cordova that includes a great majority of previously developed libraries for interaction with built-in smartphone services. This tool helps to create mobile devices applications using JavaScript, HTML5 and CSS3 without knowing 'native' programming languages (e.g., Objective-C), thus making these apps suitable for all mobile operating systems (iOS, Android, Bada etc.). The complete application is compiled in the form of installation packages for every mobile operating system. The developers created a system with 4 quick login options: via e-mail, facebook, vk, twitter.

Implementation of 4 types of authentication on the mobile application is a complex task. We use 'codeToGo' technology. This technology has been implemented to simplify the authorization. Authentication works via email and the generated code from the server with a limited lifetime. This greatly simplifies the development and support of mobile applications. If we have problems with authentication provider (social network) user do not need to update the mobile app to the new version. We solve the problem on the server side and the deployment of a new version of the back-end.

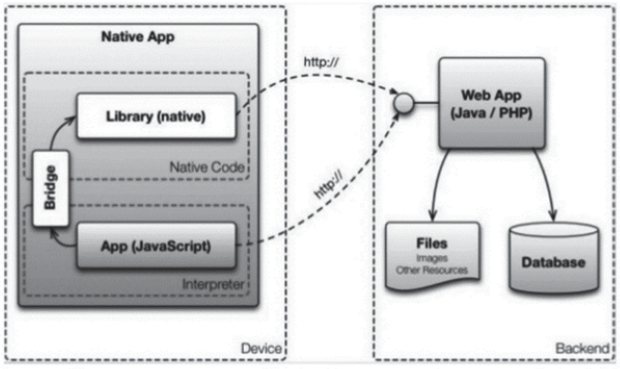

Fig. 3. Proposed iOnic project structure including API-server

A. Back-end architecture

Back-end has a microservices architecture [10-12]. This approach allowed to achieve:

- Autonomy development.
- Technological diversity. The main development language is Ruby on Rails. In the future, some of the modules to work with WebSocket will be implemented at Elixir.
- Stability. Failure of one server will not result in the termination of operation of the system.
- Scaling. application architecture allows scaling some micro-services.

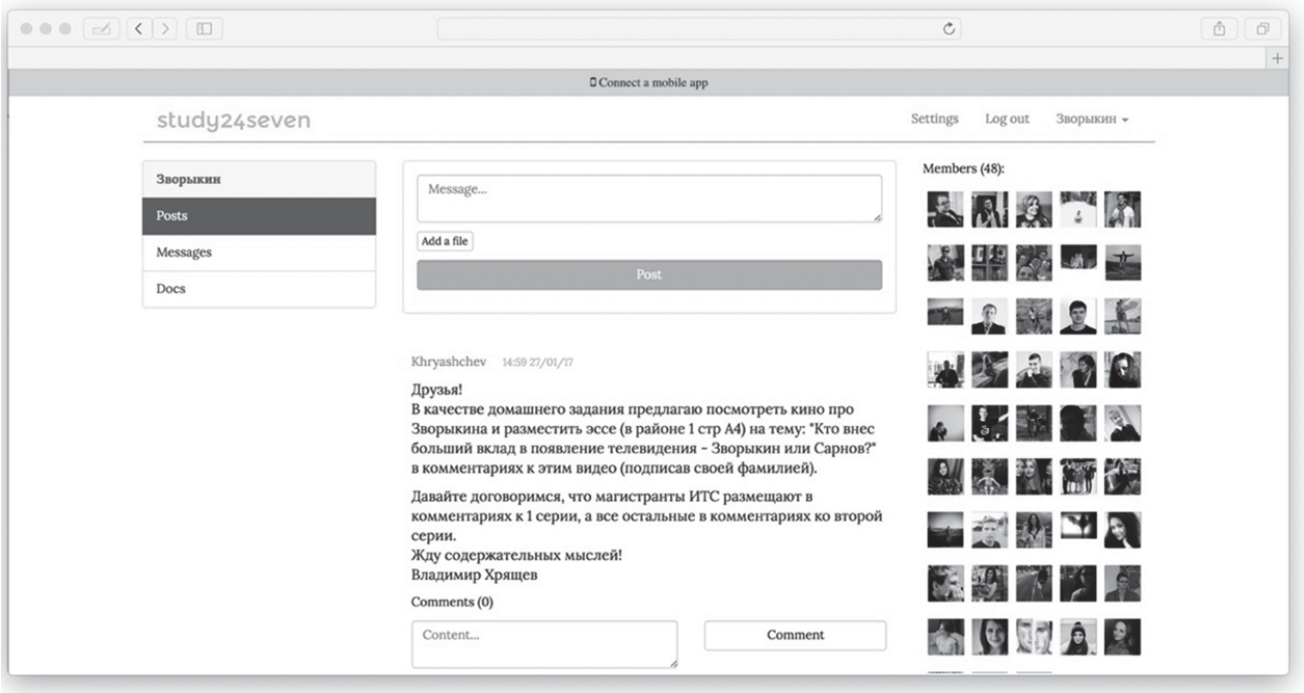

Fig. 2. The main screen of web application

1) The technological stack of server-side: An important aspect of the choice of technology has been the speed of development, ease of deployment and scalability. Total stack of technologies:

- Ruby on Rails.
- MongoDB and Redis.
- Sidekiq.

System Architecture was divided into five independent micro-services (Fig. 4):

1) Auth – user authentication and determine its access rights.
2) Groups – access control to the groups and providing information about them.
3) Posts – collective communications in groups.
4) Messages – personal communication between users.
5) Mailer – mailing system for notifications.

Each microservice has its own MongoDB database to store their own entities. If some microservice required by another entity, the micro-service makes a request to the other microservice through a REST API. Access to internal REST API methods is open only on the local network and does not require additional authorization. Each entity has a rule for data caching. Minimum time for caching is 1 minute.

To demonstrate the approach of the architecture design consider 2 microservices: Auth and Groups.

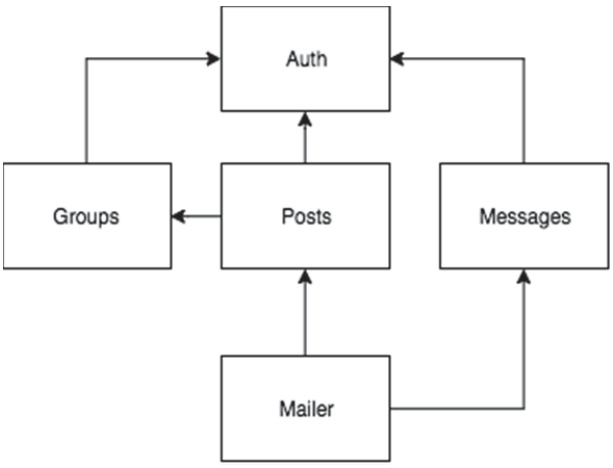

Fig. 4. The block diagram of the micro-service application architecture

2) Auth microservice: This micro-service has 3 objectives:

- User registration.
- User authentication.
- Create tasks in Sidekiq for password recovery.

The logic of the service is implemented using “devise” library [13]. Each request upgrade an authentication token which is used in HTTP token authentication.

Example:

Authorization:

Token token = "gY2nPM5BEa8RLcEqNG93G11ekfr8b7yr", user_email = "example@example.com".

3) Groups microservice: Groups microservice is a realization of CRUD (Create, Read, Update, Delete) API architecture. Microservice endpoints is:

GET	/groups	Getting a list of available groups.
POST		Create a group.
GET	/groups/:group_id	Get information about the group.
PUT		Update the group Information.
POST	/groups/:group_id/follow	Subscribe to the group.
DELETE		Unsubscribe to the group.

4) Background tasks: All asynchronous tasks are implemented as background tasks. To store queue of links to background tasks using Redis. Runs the task in 8 Sidekiq streams.

This approach is chosen to reduce the number of the logic of the backend for the parallel running of the tasks. An example is shown below describing NotificationWorker which works in low queue (2 streams) without retry.

```
class NotificationWorker
  include Sidekiq::Worker
  sidekiq_options queue: :low, retry: false

  def perform(name, count)
    user = User.where(email: email).first
    Mailer::NotificationService.new(user).send_notifications if user
  end
end
```

5) Deployment: Each microservice is a Rails-application with its own database. Deploying should occur with minimal resources. The ideal option is to prepare a prepared virtual machine image for a cloud infrastructure such as Amazon ASW or Microsoft Azure. But microservices allocate to a separate host is expensive. We wanted to run multiple virtual machines on the same host with minimal resources.

We selected a Docker [14]. Docker allows to compose an application from microservices without worrying about inconsistencies between development and production environments. The image has been created for each

microservice that runs in a container. All external requests that come from the outside proxied by Nginx to the correct container. If necessary to increase the resources for some microservice then to start it can be isolated to a single service.

IV. Conclusion

The survey data suggest a high technical and sufficient psychological readiness of Demidov Yaroslavl State University students to use mobile devices in learning.

The developed mobile application Study24Seven is cross-platform and is suitable for modern versions of the iOS and Android operating systems. This result is achieved both through the application architecture and the use of PhoneGap iOnic technology. This approach has allowed us to increase the speed of development, as well as reduce the cost of future support by working on the same code that is adaptable to different platforms. The developed mobile application is suitable for Android and iOS platforms. It has been uploaded into the respective applications stores Google Play and AppStore. The development of appropriate methods of the blended learning system will increase the efficiency of teaching the Humanities to students of technical specialties.

Acknowledgement

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