

A Review-based Survey of Mobile Student Services

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Abstract. Mobile services tend to become ubiquitous. Following the trend of mobile applications becoming part of everyday life in all areas, there is a need for putting the mobile services in action for education purposes. This paper intent is to give an overview of the mobile student services that are currently being implemented and used by a list of acknowledged and proved world rank universities. Apart from the overview of their features, the paper analyses the users' feedback in form of ratings, reviews and downloads from the mobile market applications and uses this data to measure the influence of their features on the overall users' satisfaction and highlight the directions of the future mobile services.

Keywords: Mobile student services · University mobile applications · Feedback analysis.

1 Introduction

Smartphones have managed to get their place in every branch of the peoples' life – establishing phone calls, Internet browsing, instant messaging, business, working with different applications while on the go. Due to the increasing number of features, processing power, storage capacity and battery endurance, their number has been rapidly increasing from day to day. Thus, the number of mobile internet users in 2018 is about 3.3 billions and it has a serious tendency to become even bigger in the upcoming years [17]. A considerate part of these users are young people. In 2018, 94% of the young people in US aged between 18 and 29 owned and used a smartphone. 28% of them used their smartphones at home with no broadband connectivity [3]. Young population has become dependent on smartphones, and the major reasons for this are the online services and the easy Wi-Fi Internet access they get to provide these services [19]. This convenience results with over 77% Americans going online on daily basis [2]. Apart from the vast use of the smartphones in the everyday life activities, they also take part in the educational process. More than 44% of the young adults are accessing

educational materials [4] which proves that mobile devices can be a great tool for improving the process of education [6].

Although the smartphones are widely accepted by the students, there are still obstacles that slow down the process of their deeper penetration in the educational process, such as distraction of students during classes [15], university regulations that prohibit their use in classrooms, need for regular battery charge, lack of faculty member cooperation and limited charging points, to name a few [8]. However, as the universities address these problems by suppressing the technical obstacles, accepting the importance of the smartphones and providing proper professional training to the educators, the smartphones are quickly becoming incredible classroom resource [11]. The students are not alone in the use of the smartphones. Significant part of the academic staff replaced their laptops by the smartphones, which they use not only for personal purposes, but also for sharing knowledge with the students and supervising their projects and student activities [7].

There are many examples where mobile phones are part of the educational process both in secondary and higher schools and prove to affect the process in a positive manner [13]. Apart from the educational process, smartphones impact their social life, physical activities and psychological well-being [15]. Universities around the world are using this advantage and have created mobile applications and services that can be used by their students to access the learning materials, to be up-to-date with the events and to collaborate in between [5, 22, 14]. Another crucial importance of these services is that they help the students, especially the international students [21] and those who move to new cities, to integrate into the new environment and become part of communities sharing similar ideas and interests [19]. By means of the smartphones, the students and the academic staff also become part of virtual communities which enables them be part of the everyday student life even if they are not present on the campus premises [16]. A mobile student service is an application based on mobile computing and context-aware application concepts that can provide more user-centric information and services to the students [24, 9].

Because of the numerous advantages of the mobile applications versus the web applications and the preference of the students to use native application versus using the existing web applications on their smartphones [10], most of the universities that follow the technological advances move towards utilization of mobile applications as part of their educational process. “Because of the characteristics of mobility, mobile learning has become the main direction for the future development of higher education, and also drawn attention in the information construction of a new stage in universities” [18].

The advantage of using mobile devices in education is that they provide the students easy and quick access to educational materials and answers to their questions in a conformable environment, and at the same time, they still give them the opportunity to be in a social interaction with the other students or teachers [1, 16]. Therefore, many of the world recognized universities have invested in new mobile applications and use them to assist in the education

process. Other universities use their existing information systems and create new mobile applications to access the existing services in a more convenient way [23].

The main purpose of the universities when selecting and designing the features of the mobile applications is that they meet the needs and requirements of the students from educational and social. According to the analysis conducted by the authors of [12], the most preferred characteristics of the mobile applications is their availability and ease of use, while the entertaining features are at the least expected among students. Although the analysis considers the students satisfaction, it is based on a questionnaire among a geographically local group of students. In [20], a continental scale of analysis of features typical for the mobile application in the Australian universities is conducted, however, there is no information about the student's satisfaction. The goal of this research is to make a global feature-wise overview and comparison of the existing world universities mobile applications, taking into consideration the users' satisfaction, aiming to find a correlation between certain features availability and users' satisfaction. To our knowledge, no similar work that analyses both the features and the users' satisfaction has been published to present date. In our work, we used the QS list as a starting point for choosing the world universities. Then, for each university, a search for mobile application was made in the Google Play Store and in the iTunes App Market. Afterwards, each representative application found for the university was installed and its features were analyzed. We conducted the same analysis in two different time periods: in the year 2016 and 2018. Our search on the application market resulted with a total of approximately 50 downloaded and installed mobile student applications. It is important to mention that one half of these universities are from the USA. The reason for such dominance of universities from USA is that this country occupies most of the top 100 positions in the university world ranking. The rest of the universities considered in this work are from other parts of the world, mostly from Europe, which gives a wider perspective of the use of the mobile applications in the world. For every installed application we collected the ratings and the re-views of the users and used them to evaluate their popularity and to pin point their advantages and disadvantages based on users descriptive opinion.

The focus of this paper is an overview of the services offered by the student mobile applications, their contribution to the overall rating of the application, as well as analysis of the users' quality of experience when using these services.

The rest of the article is organized as follows: in Section 2 we give short overview of the different mobile application platforms considered in our work and the features of a set of downloaded mobile applications of some world top universities. Then, in Section 3, we analyze the results obtained from the users' feedback in form of ratings and reviews. After the discussion in Section 4, we eventually give conclusion from our work.

2 Overview of mobile applications platforms and services

The mobile student services used by the universities of our list are developed for different leading platforms on the market. Most of them, 47 out of 50, are built to support both Android and iOS mobile platforms. The rest of the universities support only iOS or Android mobile platform. The third place of the world known mobile platforms is taken by Blackberry, which is supported by only 7 Universities. The fourth place is taken by the Windows Phone mobile platform, supported by only 3 universities.

According to the basic services implemented in these applications, they can be divided in two major groups: open-access services, accessible by all users and limited-access services permitted to authenticated users only.

2.1 Open-access services

The open-access services allow all users to view and access basic information about the university, the educational process and diverse university services without the need for previous authentication. Table 1 lists the open-access services that we identified and their frequency of appearance in the mobile applications.

Table 1: Overview of open-access services

Name	Description	Freq.
News and events	Preview of news published and events related to the university	45
Location	Guides the students and the visitors within the campus	41
Course info	List of courses and programs of the university	40
Library	Access and preview of the books of the University's library	33
Public transport	Eases the access to the university campus with public transport	25
Office hours	Office hours of the lecturers	24
Emergency contacts	Emergency phone numbers	22
Sport	Information about sport activities	16
Communication	Communication between two or more users	16
Food	List of restaurants within the campus and menus	14
Multimedia	Sharing of multimedia content among the students	14
Admission	Information about the students that have applied or want to apply for study program	10
Photo	Gallery of photos provided by the university	9
Broadcast	Real-time broadcast of the student radio and TV	5
Career	Overview of active jobs, internships, scholarship and volunteering announcements	5

2.2 Limited access services

The limited access services are features of the mobile applications available for authenticated users only. Compared to the open-access services, these services provide more information and details about the university and the authenticated user. According to our survey, these services are not very common in the mobile applications, which can be also seen in Table 2.

Table 2: Overview of limited access services

Name	Description	Freq.
Contact	Information for the students registered in the university database	16
Grades	Grades for enrolled courses	15
Schedule	Schedule and location of classes for enrolled courses	14
News and events	News and events related to the user	13
Exam	Time and location of exams	13
Library	Book reservation	8
Career	Career opportunities based on the user's curriculum	3
Assigned task	Eases the access to the university campus with public transport	2

3 User feedback analysis

One of the major objectives of our survey on the mobile student services is to evaluate the users' experience and measure their satisfaction of using these services. In order to achieve this goal, we collected data from the official mobile applications markets and their discussion forums, as well as from the official web sites of the universities. The data of interest for our work was the rating of the users, the number of reviews and their content, the approximate number of downloads, the number of features they contain and the world ranking of the universities.

Following the trend of mobile application, a considerable part of the world universities have already implemented a mobile solution for accessing their information. According to the services covered, the most advanced application for unauthenticated users is available for the students of the Harvard University. This application covered 14 out of total number of 17 services. From the users' perspective, this application has set the pattern of how a student application should look since its design and action workflow managed to reduce the user actions to get to the proper place and to see the desired information.

In the category of applications for authenticated users, the Ashford University developed the most advanced mobile application. It covers 7 out of 9 services

present in its category. Even though the two missing services are very handy for finding a contact from a colleague or a proper job, the Ashford University has implemented successfully the modules related to the enrolled courses and information and notification that are very basic and much needed for the students as target group that uses this application.

The applications of the Oxford and the Harvard Universities are the ones with the most user-friendly features. The Oxford University application has an advanced method for finding the optimal route to reach the university using Google Maps and the user's location. The Harvard University's application provides the easiest way to get and search through different sections. It allows more than one search criteria to be added as part of a search in every section. This feature allows consistency and easy accessibility in the different modules. On the scale from 1 to 5, the range of ratings in 2016 is from 2.1 to 4.6, and in 2018 from 2.6 to 4.7. From the information gathered from the application stores, the most downloaded application has 100.000 – 500.000 downloads and the least downloaded application has 1.000-5.000 downloads.

3.1 User ratings analysis

Our first goal was to find the influence of a single feature of the application on the overall application rating. Since the rating data we gathered refers to the user satisfaction of the entire set of services implemented in the applications, we measured the average rating of the applications that contain certain feature based on four different criteria. For that purpose, we defined four different measures of average rating of the applications depending on the presence of different services correlated to parameters like total number of implemented services, number of downloads and reviews.

Let us assume that there are n mobile applications in the data set $A = \{A_1, \dots, A_n\}$. Each application from the data set can have up to m services belonging to the service set $S = \{S_1, \dots, S_m\}$. The presence of the service S_j in the application A_i is marked with the variable a_{ij} having value 1 if A_i implements the service or value 0, otherwise. Each application has d_i downloads, it is rated with grade g_i and has r_i reviews from the users. Based on this definition, the first measure for the influence of certain service S_f on the application's rating is the average rating of all the applications that implement that service expressed as:

$$R_f = \frac{\sum_{i=1}^n a_{if} g_i}{\sum_{i=1}^n a_{if}} \quad (1)$$

The second measure for the influence of service S_f on the applications' popularity is the average rating of all applications that implement the service weighted according to their total number of services. The weight of the rating g_i of application i that implements service f , i.e., $a_{if} = 1$, is calculated as the normalized number of different services $\sum_{i=1}^m a_{if} a_{ij}$ that the application implements. Thus, the rating of the applications with more services will have higher influence on the value of the average rating of the applications that implement the same service.

The value of this average rating is expressed as:

$$\widetilde{R}_f = \frac{\sum_{i=1}^n \sum_{j=1}^m a_{if} a_{ij} g_i}{\sum_{i=1}^n \sum_{j=1}^m a_{if} a_{ij}} \quad (2)$$

For calculation of the third measure, we assume that each service j of the application i contributes with equal portion to its overall rating. Therefore, the weight of the rating of application i that implements the service f in the average rating is calculated as the normalized portion of that service $\left(\sum_{j=1}^m a_{if}\right)^{-1}$ compared to the total number of services. With such definition, given service of application with less services has higher influence on the rating of that application, compared to application with more services because its presence contributes more to the overall application's rating. The expression for the average rating of the applications that implement service f is:

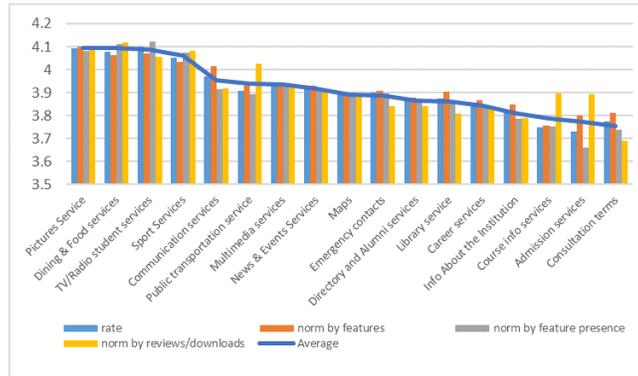
$$\overline{R}_f = \frac{\sum_{i=1}^n \left(\sum_{j=1}^m a_{ij}\right)^{-1} a_{if} g_i}{\sum_{i=1}^n \left(\sum_{j=1}^m a_{ij}\right)^{-1} a_{if}} \quad (3)$$

The fourth measure of influence gives more credit to the applications that are not only more downloaded, but also stimulated the users that downloaded them to give feedback. The weight of the rating of each application i that implements service f is proportional to the normalized ratio of the number of reviews and the number of downloads r_i/d_i . Hence, the average rating of the applications with service f is given as:

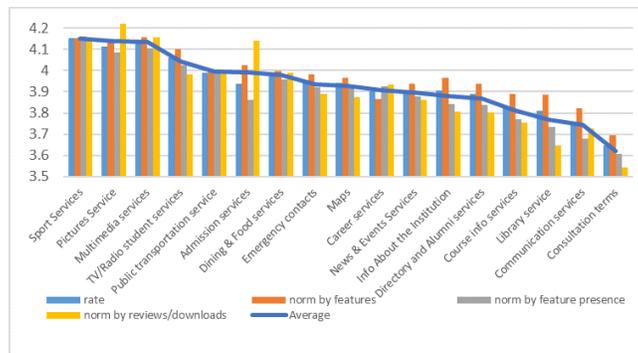
$$\widehat{R}_f = \frac{\sum_{i=1}^n \frac{r_i}{d_i} a_{if} g_i}{\sum_{i=1}^n \frac{r_i}{d_i} a_{if}} \quad (4)$$

Using these definitions and the information we obtained for the reviewed applications of the set A , we calculated the four different measures for each possible feature of the set S . Then, we calculated the average value of these results and used it to sort the influence of each feature on the rating of the application in descending order. The results of these calculations for the two different time periods are shown in Fig. 1. The series rate, norm by features, norm by feature presence and norm by reviews/downloads refer to the defined measures R_f , \widetilde{R}_f , \overline{R}_f and \widehat{R}_f accordingly. The last series, named as average is calculated as the average of the four series. Fig. 1a shows that in 2016, the applications with the highest average user ratings implement the Pictures, Food, TV/Radio and Sports service. These services vary only slightly in the values of the average ratings and can be observed as a group of services that have significantly higher influence in the user satisfaction compared to the rest of the services. The later services have even influence that linearly decreases within the entire range, except the last two services, the Admission and the Office hours services which do not follow the linear decreasing fashion and contribute less to the satisfaction of

the users. One of the main reasons of the low popularity of the Office hours services is that, according to the users' comments, the data is sometimes outdated or not present at all.



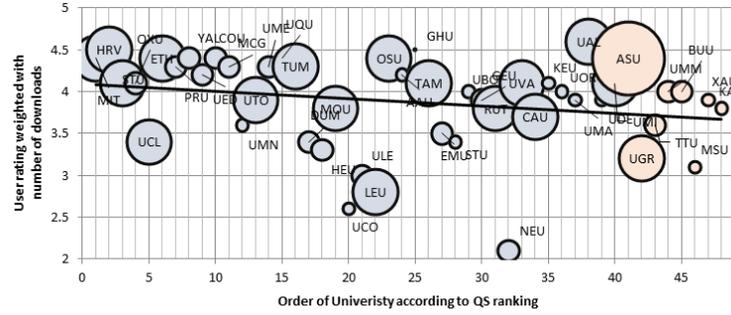
(a)



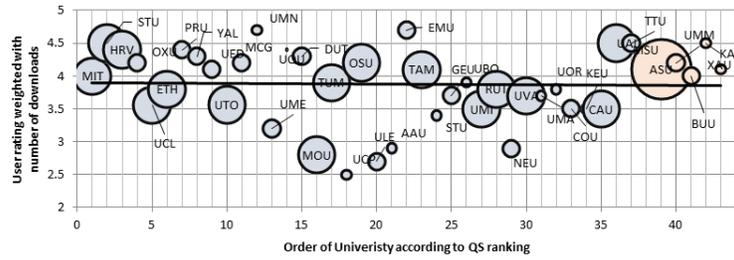
(b)

Fig. 1: Overview of average contributions of features to applications popularity in the year a) 2016 and b) 2018

Fig. 1b shows that, in 2018, the applications with the highest average user ratings implement the Sport, Multimedia, Pictures, and TV/Radio service. Compared to the year 2016, the Dining and food service is replaced by the Sport service in the top popular services. The distinguishing popularity of the services related to multimedia data is expected since we are living in a modern age where the social platforms have deeply penetrated in the everyday life of the general population, especially the young people, and the exchange of multimedia data has become a common practice. Another considerable result from the comparison is that the communication services in the year 2018 are among the least popular services, which can be explained with the fact that the current mes-



(a)



(b)

Fig. 2: Weighted rating of mobile applications for ascending order of world university ranking in the year a) 2016 and b) 2018

saging and social mobile applications are so dominant and well established [15], that the communication service of the universities' application have little odds of becoming convenient tool for communication among the students.

In Fig. 2, we show the ratings of the analyzed mobile applications in two different periods, organized in descending order based on their world ranking. As a reference, we used the QS world ranking list, which annually evaluates the universities based on their academic and employer reputation, number of citations, number of students and number of international students. The world best university has rank 1, and each following university in the figure is assigned value incremented by 1, although the rank difference is not necessarily 1. The figure shows only the order of these universities sorted by their rank. Some of the considered universities are not ranked in the QS world ranking, and therefore, we assume they have lower rank and add them as last items in the figure. Additionally, each university on the figure is represented with a circle with size proportional to the number of downloaded applications. Fig. 2a shows that in the year 2016, on macro level, the ratings of the applications follow a linear dependence on the university ranking. Their rating decreases as the world rank of

the university decreases. However, if we cluster the universities in regions based on the regularity of the ratings relative to the decreasing trend-line, we can see that the first region of the quarter top rated universities (with real ranks from 1 to 16) consists of applications with relatively high user rating placed above the decreasing line, following its direction. It is also important to note that the top three world universities, not only have one of the best rated applications, but also offer their service to responsive users for longest period. Therefore, these ratings can be considered as one of the most objectively calculated values. The second region, formed by the middle range of considered universities, consists of applications with highest deviation of ratings relative to the trend-line. Compared to the other ratings, this region contains the worst rated applications, but also one of the best rated. The last region also contains regular values of ratings placed near the trend-line. Even though the region consists of applications from lowest ranked universities, as well as from not ranked universities, the applications have in average higher rate than the better-ranked universities from the second region. The figure also shows that many of the ratings are based on higher number of reviews.

Contrary to the previous results, Fig. 2b shows that in the year 2018, on macro level, the ratings of the applications do not depend on the university ranking, which can be seen by the almost parallel to the x-axis trend-line. If we cluster the universities in regions based on the regularity of the ratings relative to the trend-line, we can see that there are three regions, where the applications from the first and the third regions are above or near the trend-line, while the second region (in the middle) consists of applications with high deviation of ratings relative to the trend-line. This observation leads to the conclusion that the students are equally demanding and critically oriented to the mobile applications, no matter what quality of education the university offers.

In the analysis of mobile applications in 2018, fewer mobile applications were considered since some of the applications considered in 2016 were not on the market, or they were on the market, but the latest ratings were outdated.

3.2 User reviews analysis

The feedback of the users given in their comments is another important part of the survey. The comments are a descriptive measure of the user ratings and the quality of their experience, emphasizing the pros and cons of the features offered in the applications. For that purpose, we collected the comments and reviews of the analyzed applications written in English in two different periods, before the year 2016 and before the year 2018, and used their content to create word clouds.

In our analysis, we preprocessed the users' feedback using standard procedures in the natural language processing. First, we converted all words into lowercase. Then, we performed tokenization using the NLTK (Natural Languages Tool-Kit) which separates the words and the punctuation into string tokens. In the next pre-processing phase, we removed the so-called stop-words. We used the

NLTK English stop-words list, which currently contains 153 stop-words, however, we deliberately removed the words “no” and “not” from this list since they are essential for evaluation of the connotation of the comments. In the last phase, we performed stemming and lemmatization of the obtained token array which group and reduce inflected forms of a word, so they can be analyzed as single word. The stemming process uses heuristic that crops the ends of the words, while the lemmatization process uses a vocabulary and morphological analysis of the words to return their base form. We used the WordNet based lemmatizer from NLTK to perform the last operation.

After measuring the frequency of appearance of each single word in the pre-processed comments, we created word-clouds. We deliberately omitted the word “app” since it is multiple times more frequent than any other word and gives no significance to the users’ quality of experience expression. The single-word word cloud generated from student service mobile applications comments collected up to 2016 are shown in Fig. 3.a. The size of a single word in the word cloud is proportional to its frequency of appearance in the pre-processed token array. According to the figure, the users have positive general experience since the most frequent word is “great”. There are also other positive words like “love”, “like” and “good”. However, many users share negative experience which can be concluded by the frequent presence of the explicit negations “not”, “no”, “can’t”. There are also implicit negative words which express malfunction or lack of up-to date information of the latest application version, such as “fix”, “update” and “need” or report a critical problem in a recent update. The word cloud from the comments collected between year 2016 and 2018 in Fig. 3.b demonstrates that students have much worse experience with the mobile applications intended for them compared to the earlier period. The most frequent words in the cloud are “work”, “not” and “crash” which, if combined, imply negative experience regarding the stability of the applications. Apart from the students experiencing problems and malfunctional features, there are satisfied users which considerate the mobile applications to be great and useful for obtaining information about the classes.

Although the word clouds if Fig. 3 show the general connotation of the users’ experience, the overall opinion of the users cannot be precisely depicted since some of the words may appear in both positive and negative connotation. A typical example is the word “work” which students can use to complain that the application is not working properly or emphasize that the application works flawlessly. Other such frequent verbs are “open”, “access”, “show” and “read”. Therefore, we added another step in the preprocessing of the comments which pairs the consecutive words in so-called bigrams and measured their frequency of appearance. Based on the frequency, we created the bigram word clouds shown in Fig. 4. Fig. 4.a demonstrates that in the first period of analysis, the students consider that the university mobile application is great, they love it or just think that it is good and easy to use. Nevertheless, there are students which are not satisfied with the application offered by their university, and therefore, require that the issues are fixed, or new extra features are added. On the contrary, in

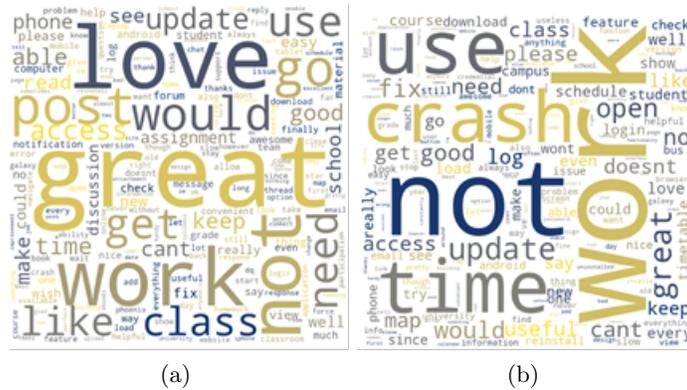


Fig. 3: Word cloud of single words for student mobile applications reviews in the year a) 2016 and b) 2018

Fig. 4.b, we can see that in the second period of analysis, many the students are not satisfied with the applications because some of them do not work, do not open, crash or do not accepts users’ credentials. Yet, there is portion of the comments that imply positive user experience with the application offered by their university.

Based on the single word and bigram word clouds we can conclude that there is a trend of bigger criticism of the newer versions of the student applications. This fact coincides with the results obtained from the analysis of the users rating based on the world universities ranking. Since the mobile applications have become an inevitable part of students’ everyday routines, their requirements for more reliable and feature-rich applications have grown. As the mobile devices become more complex and equipped with more diverse and sophisticated sensors, the expectations for more complex applications are a natural consequence. Moreover, the mobile application market offers so many free, feature-rich applications for navigation, content sharing, text and voice communications, that the university mobile applications must maintain high quality of service to keep their users satisfied. The universities should pay special attention to the services that are unique for the educational process such as course information, office hours, course materials and campus navigation. Based on the analysis of the reviews of all university applications that were found on the Market, we summarize that the users from all universities appreciate the most the detailed information provided by the mobile applications. They like the good design of the applications, their responsiveness and the overall user experience. In most of the applications the users are satisfied with the accurate course information and schedules. They especially appreciate the applications that embed the useful information, instead of links that redirect the user to external apps or browsers. Other features that users find very useful are the maps and the routes that navigate them around the university campuses. The users of the student mobile applications, in most



Fig. 4: Word cloud of bigrams for student mobile applications reviews in the year a) 2016 and b) 2018

of the cases, are irritated when the application crashes, feels buggy and unstable or when the provided information is inaccurate and not up to date. The reduced performance like the long waiting times for retrieval of the latest data from the Internet and the slow response due to the delay between switching contexts and modules in the applications are other reasons that make users unsatisfied. The users also dislike when the applications do not keep the user’s credentials, and hence, require frequent re-logging when accessed after certain period.

4 Desirable behavior of the mobile applications

Judging according to the contents of their reviews, the users of the analyzed mobile application would appreciate quick response with accurate information. They would like to receive notifications when important information, like schedules, grades or new materials are added or changed. Another feature required by the users is accessing the university mail from the mobile application that would provide attaching files from their mobile devices. Users also find very useful the trend of opening everything as part of the application, without using the default browser for accessing external links. As an overall overview of the applications, the users require consistent access provided by a stable application that can run smoothly with fast switching between screens and contexts. The most important requirement is low memory utilization and uninterrupted access to all functionalities, especially the basic ones like search, maps, navigation and local public transport. Another important requirement by the users is the functionality where authenticated users can communicate and collaborate with other students and teachers.

5 Conclusions

This paper presents a brief overview of the mobile student services and their basic functionalities. Therefore, a set of 50 world class universities were considered and their mobile applications were examined. The applications were categorized in to major groups based on whether they require authentication or not. The services of these applications were further categorized according their basic functionalities and analyzed. To quantitatively measure the influence of these features ratings, number of downloads and comments data was collected from the mobile application markets for the most common mobile operating systems for two different periods: before 2016 and before 2018. We defined four measures of the users' satisfaction and used them to analyze the influence of the features of the applications on their overall rating. The results show that the features related to non-educational activities like sports, multimedia and dining enjoy highest popularity with a slight change of the rank in the different time periods. We also show that the overall popularity of the applications used to be related to the university ranking in the past years, while in the recent years, the university ranking has nothing to do with its mobile application attractiveness. The analysis of the user comments additionally shows that the students used to share more positive experience with the services offered by the applications, however, after their latest updates, students are considerably unsatisfied with their stability and outdated information. They also criticize certain feature and require new updates where the issues are fixed. Nevertheless, there are still universities that offer great applications with features that make the life of the students easier, especially those who are at the beginning of their studies. The results from this paper can serve as guideline for the university applications developers that will give the essential features for a state-of-the-art student mobile application, emphasizing the importance and influence of each feature and functionality for gaining satisfied users. This task is becoming a bigger challenge taking into consideration the fact that the smart mobile devices are becoming more powerful, and at the same time, new free applications are emerging on the market that offer so many features that become a main environment for information retrieval, communication and navigation.

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