Supporting Students' Mental Health and Academic Success Through Mobile App and IoT

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Supporting Students' Mental Health and Academic Success Through Mobile App and IoT

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ABSTRACT

Smartphones have become devices of choice for running studies on health and well-being, especially among young people. When entering college, students often face many challenges, such as adaptation to new situations, establish new interpersonal relationships, heavier workload and shorter deadlines, teamwork assignments and others. In this paper, the results of four studies examining students' well-being and mental health as well as student's perception of challenges and obstacles they face during their academic journey are presented. In addition, a mobile application that acts as a complement to a successful tutoring project implemented at the authors' University is proposed. The application allows students to keep their schedules and deadlines in one place while incorporating virtual tutor features. By using both, the events from the student's calendar and his or her mood indicators, the application sends notifications accordingly. These notifications encompass motivational phrases, time management guidelines, as well as relaxation tips.

KEYWORDS

Field Studies, Higher Education, IoT, Mental Health, Mobile App, Well-Being

1. INTRODUCTION

Research points out that happy people produce more and have better results at work (Yano, Lyubomirsky, & Chancellor, 2012). Based on this premise, one may assume that happy students will also perform better along their academic path. Higher education students often face many challenges such as, adaptation to new situations, establishing of new interpersonal relationships, managing heavy workloads and short deadlines and working successfully in teams. Tutoring (or mentoring) projects have shown to be a good way of helping students to be successful in their academic life. An example of this is the tutoring program implemented at the University of Madeira since 2012/13 (Faria, Oliveira, Lucas, Vasconcelos, & Soares, 2014). It aims to facilitate the integration of freshmen into

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the university and to promote their personal and interpersonal development through the creation of a peer support network. This project also provides tools to help students succeed in achieving their personal and academic goals, thus promoting motivation and self-determination as well as developing study skills and strategies to manage anxiety and stress.

Smartphones and other mobile and wearable devices are becoming ubiquitous in our daily lives and Internet of Things (IoT) deployments are also increasingly populating our cities, offices and homes. One of the important application areas of the IoT is healthcare. Mobile and wearable devices for health monitoring are becoming main stream and mobile applications for fitness tracking are flourishing.

In this paper, we will focus on mental health and look into the ways that technology in general, and particularly a smartphone can contribute to student's mental health and well-being. This research question has been addressed in research papers from both, computer science (Wilde, Zaluska, & Davis, 2013) and psychology areas (Luxton, McCann, Bush, Mishkind, & Reger, 2011). One of the main goals of the studies described in this paper is to develop mechanisms for virtual tutoring and fostering well-being and personal development among college students. Based on others evidence, our own experience as students, faculty and psychological counseling service members, and supported by the surveys we conducted at our University, we know that students' levels of stress increase when deadlines and exam periods are approaching. Also, most students own a smartphone equipped with considerable amount of memory and processing power and a quite interesting set of sensors. We want to find out how to leverage this fact in order to help students cope with the moments of higher stress and workload. What kind of feedback should an application provide to become a potential stress-relieve tool and to help students maintain their focus on what they are doing?

Mobile applications based on the Moofwd platform (MooFwd, n.d.) grant access on the move to several university services and are provided at some universities in Portugal (e.g., Porto and Coimbra). Although we agree that such an application is useful and beneficial, it does not respond to student's needs in terms of mental health, habit forming and well-being. As such, we propose, in the scope of our project, a mobile application that acts as a virtual tutor and is aware of the user's activities, appointments and mood levels. Additionally, we are planning to implement an IoT deployment for a smart study room with a network of intelligent objects (e.g., single board computers with attached sensors and actuators) and to provide feedback mechanisms that may contribute to improving students' well-being, developing good studying habits and reducing stress levels in the most critical periods.

The remaining of the paper includes an updated literature review, section 3 describes four field studies and their results, section 4 discusses the main findings and finally, section 5 concludes the paper and gives a final outlook.

2. LITERATURE REVIEW

Mentoring activity involves short weekly meetings between tutors (more experienced peers) and tutees. In this context, the tutors play a key role as they act as guides that support the student in decision making, taking into account their time availability, interests, rights and duties (Geib, Krahl, Poletto, & Silva, 2007). Although important, this type of meetings can overload students who are already struggling with time management. Moreover, it can also be an additional source of anxiety for those students who are especially shy or anxious. In their daily lives, students use different types of applications on their mobile devices and according to (Corlett, Sharples, Bull, & Chan, 2005), they use mostly applications for issues related to time management, communication and productivity. However, most of these applications are not specifically designed to support students in their academic tasks (e.g. attending lectures, reading course content, revising for exams and meeting course deadlines). So, in order to mitigate this, we propose a calendar based mobile application, called *Virtual Tutor*, which incorporates sensing functionalities and feedback messages related to academic issues, such as time management, studying methods, stress management and relaxation techniques. The feedback messages are generated based on student's personal schedules, tasks and deadlines, and their well-being levels.

These messages act as triggers for behavior change and/or motivational support (Fogg, 2009). Data collected from the smartphone combined with physical and social context data (Chen, Ding, Huang, Ye, & Zhang, 2015) collected from the environment can be of a great value to producing effective triggers that over time may lead to habit formation, less stress and better well-being.

There has been a lot of research involving mobile applications for mood and stress detection. In this section, we analyze some of the projects described in the literature. *Moodscope* (LiKamWa, Liu, Lane, & Zhong, 2013) is a smartphone application that detects user's mood based on usage patterns. Phone calls, SMS, emails, installed applications, browser history and location data were used as factors that influence and determine user's mood level. *BeWell* (Lane et al., 2011) and *BeWell+* (Lin et al., 2012), are mobile applications that detect user's well-being based on sleep patterns, physical activity and social interaction. Also, they provide passive feedback on the smartphone display based on individual well-being score calculations. Furthermore, they provide an additional web application that allows the user to correct and complete some of the inference results by undertaking the available surveys. *BeWell+* introduces several enhancements according to the user age group to set more realistic goals and mechanisms that allow to reduce energy consumption.

The *StudentLife* project (Wang et al., 2014) collected behavior data among college students using smartphones. They also used the collected data to assess mental health and student behavior during an academic term and their influence on the academic performance. Similarly, (Sano et al., 2015) report about the results of an extensive survey in which the authors wanted to identify the main factors that influence academic performance.

Other advances in stress detection were made by (Bogomolov, Lepri, Ferron, Pianesi, & Pentland, 2014), as they take into account not only smartphone data, but also weather data and personality traits of their users.

MoA^2 (Bachmann et al., 2015) is a mobile application for mood assessment and recognition to be used by mental health practitioners for patient monitoring. Like our application, it also considers user's calendar in addition to other smartphone data. Several types of events are used to trigger self-report surveys consisting of three simple questions related to the mood, the level of tiredness and the level of stress. An overview of the cited projects in terms of their focus, their input and output is shown in Table 1.

Our project is in line with above-mentioned projects as it uses the data collected by the smartphone sensors to infer individual well-being. Additionally, it relies on student's calendar and on self-reported and inferred mood indicators to trigger notifications that range from motivational phrases to time management guidelines and studying strategies. The novelty of this approach is in trying to find new ways of promoting virtual tutorial aids, based on gathered information (mood) and scheduled appointments.

3. FIELD STUDIES AND RESULTS

This section describes the details of four field studies that were conducted in the scope of this project. Frist, a general survey about student's communication habits and self-perception was conducted. The second survey's goal was to find out college students' perceptions of challenges and obstacles of being a college student, as well as some aspects of their mental health. Third, we held a user study session with a group of tutors to gain some insights about the app functionalities and user interface. Finally, the analysis of automatically collected data from users' smartphones is reported.

3.1. Survey About Students' Well-Being

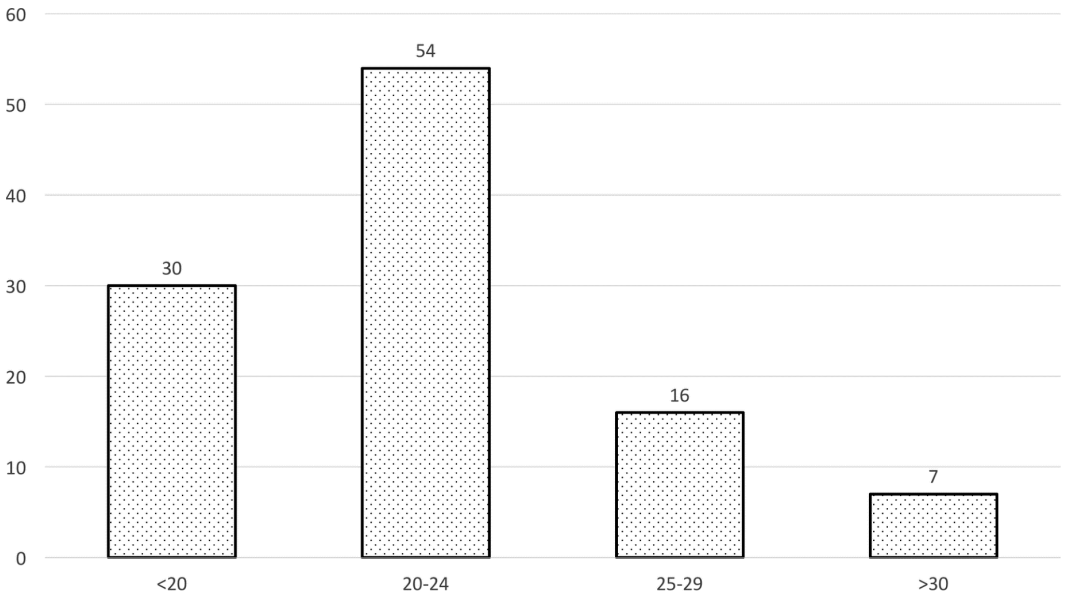
The first phase of the project started with a survey among students at the University of Madeira. The survey was handed in paper and it consisted of three sections. In the first section students were asked eight sociodemographic questions. In the second section, they were asked how frequently (on a Likert scale, 1 being 'Never' and 5 being 'Many times') they talked about their feelings and emotions with their family, friends, teachers, colleagues and others either directly, or through social networks, or

Table 1. Projects involving mobile applications for mood and stress detection

Project	Focus	Collected Features/Input	Feedback/Output
Moodscope (LiKamWa et al., 2013)	Determine user's mood level	Smartphone usage patterns (phone calls, SMS, emails, installed applications, browser history and location data) Self-reported mood	Daily mood averages on a calendar view (facial expression and color varies according to self-reported mood)
BeWell (Lane et al., 2011)	Monitor user's well-being based on sleep patterns, physical activity and social interaction	Smartphone usage data Smartphone sensors data	Passive feedback (aquatic ecosystem) on the smartphone display based on individual's well-being score calculations An additional web application
BeWell+ (Lin et al., 2012)	Monitor user's well-being based on sleep patterns, physical activity and social interaction	Smartphone usage data Smartphone sensors data User age group Dimensions (sleep, physical activity, social interaction) user is struggling with	Passive feedback (aquatic ecosystem) on the smartphone display based on individual's well-being score calculations An additional web application
StudentLife (Wang et al., 2014)	Measure stress levels, sleep, activity, mood, sociability, mental well-being and academic performance among college students	Self-reports (EMA, PAM) Smartphone usage (calls, SMS) Smartphone sensors: accelerometer, microphone, light sensor, GPS, Bluetooth	Only one of the professors had access to collected data of their students No feedback was provided to students at this stage
(Bogomolov et al., 2014)	Automatically detect stress based on activity, weather and personality traits	Number of calls and SMS, proximity (Bluetooth) the diversity of calls, of SMS, and of proximity interactions regularity in user behaviors Self-reports Big five personality traits questionnaire Mean temperature, pressure, total precipitation, humidity, visibility and wind speed	No feedback was provided in the scope of the project; other apps could use their framework and provide a feedback layer
(Sano et al., 2015)	Identify the main behaviors that influence academic performance.	Skin conductance, skin temperature Phone usage (number of calls, number of SMS, number of people contacted) Email usage (number of emails, number of contacts) Activity Light exposure Sleep Surveys and questionnaires	Authors foresee feedback provision, but do not report on this
MoA² (Bachmann et al., 2015)	Mood assessment and recognition to be used by mental health practitioners for patient monitoring	Self-report surveys consisting of three simple questions related to the mood, the level of tiredness and the level of stress Daytime, day of week, location	Nothing reported

by mobile phone calls or by short messages (SMS). The third section of the survey consisted of 30 statements about their feelings and well-being indicators in three different situations: first month of the academic year, exam period and teamwork/individual assignments and they were asked to reply on a scale from 1 (strongly disagree) to 5 (strongly agree) to what extent they agreed with each one of the statements. This survey was elaborated taking into consideration some findings of the study of (Almeida, Soares, & Ferreira, 2000). 101 students, 47 females and 54 males, ranging in age between 17 and 54, being the average age 22, composed the sample. Figure 1 shows the number of

Figure 1. Survey 1: Number of participants per age interval

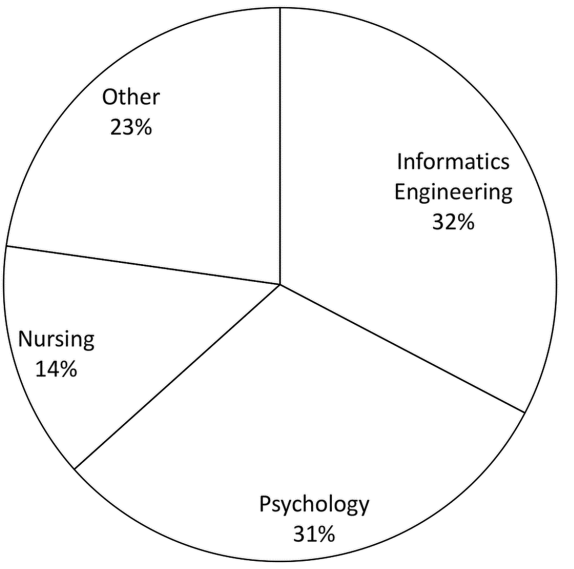


participants in each age group. As shown in Figure 2, 32% of participants were Informatics Engineering undergraduate students, 31% Psychology undergraduate students, 14% nursing undergraduate students and the remaining 23% were from other courses, both graduate and undergraduate. 85 participants were only studying, 13 worked part-time and 3 worked full-time.

3.1.1. Survey Findings

From the second part of the survey we could see that students still prefer to share their feelings in personal conversations, although SMSs, mobile phone calls and social networks had also significant

Figure 2. Survey 1: Participants per course area



results. Friends are the most frequent confidents, followed by family members. Colleagues come in third place with much lower number of students sharing their feelings and emotions frequently with their colleagues. Teachers and others had similar results, so it seems that students do not talk frequently about their feelings or emotions with their teachers and when they do, they do it in person.

From the third part of the survey, we could extract some interesting findings about students' behavior: 52 of them expressed that they did not experience difficulties in their relationships with their teachers, while 23 do have some issues. Some students expressed their concern with their financial situation. Most of the students seem to be enthusiastic and have their academic goals clear. They also expressed some difficulties in attending classes over the entire year and no significant results were found concerning their interest during classes. During the first month of classes some students referred minor problems in relationships with their colleagues, some lack of concentration, lack of organization of their study and some lack of self-confidence. Curiously enough, at the same time they feel more capable of fulfilling their course requirements than during the rest of the year.

Exams and teamwork periods are clearly when the students feel more physically tired, sleepy, sad, anxious, with more mood oscillations and under a lot of pressure. This is also the time when they start to doubt about their capabilities. Some of them also refer lack of time management skills that is much more notorious during these periods. Nevertheless, most of them can meet deadlines despite some difficulties they face.

The remaining results will be analyzed according to three periods: first month of classes, exams and teamwork/individual assignments periods. There are three statements that appear with a high score in all three periods: "Successful in meeting deadlines", "Have a good group of friends", "Have well defined academic goals". The statements with the highest average scores (higher than 3.5) for each period are summarized in Table 2.

To sum up, the findings of the first survey showed that the students seem to lack time management and efficient studying skills and appear to be less motivated and self-confident when facing more workload. Despite all that they seem to be able to achieve their academic goals.

Table 2. Survey 1: Statements with the highest average scores in each one of the three considered periods of an academic year

First Month of Classes		Exam Periods		Teamwork/Individual Assignments	
Statement	**Average**	**Statement**	**Average**	**Statement**	**Average**
Successful in meeting deadlines	4,14	Feeling physically tired at the end of a day with classes	4,32	Feeling physically tired at the end of a day with classes	4,11
Have a good group of friends	3,99	Feeling anxious	4,13	Successful in meeting deadlines	4,02
Have well defined academic goals	3,95	Successful in meeting deadlines	4,02	Have a good group of friends	3,94
Managing the time well	3,85	Have well defined academic goals	3,98	Have well defined academic goals	3,94
Feeling enthusiastic	3,85	Have a good group of friends	3,98	Feeling tired or sleepy during the day	3,84
Feeling confident in reaching academic goals	3,84	Feeling tired or sleepy during the day	3,93	Feeling anxious	3,83
Feeling self-confident	3,78			Feeling confident in reaching academic goals	3,60
Feeling prepared for the challenges	3,77				
Have good working rhythm	3,63				
Have good level of concentration	3,53				

3.2. Survey About the Challenges and Obstacles Faced by College Students

After the first survey, we conducted an additional survey aimed at better exploring college students' perception about challenges and obstacles they face during their academic life. This survey included three sections: (1) college student's sociodemographic data; (2) student's mental health assessment and (3) challenges/obstacles of being a college student. Student's mental health was measured by using Mental Health Inventory – short version (Ribeiro, 2001, 2011). This is a self-report questionnaire with 5 items, presented on a six point Likert scale, ranging from "always" (6) to "never" (1). The scores are calculated by summing up the items. Some of the items are coded in reverse. Higher scores indicate better mental health. Students' perceptions of challenges/obstacles faced in their academic journey were evaluated by asking students to rate each item, using a five point Likert scale, from "totally disagree" (1) to "completely agree" (5). The items are clustered into four scales, namely: adaptation to university (4 items), academic area (15 items), interpersonal relationships (9 items) and others (6 items).

3.2.1. Survey Findings

77 college students of Madeira University participated in this survey. Of these students, 53.2% were female ($n = 41$) and 46.8% were male ($n = 36$). The mean age of participants was 22.8 ($SD = 4.021$), ranging from to 20 to 48 years old. Nearly half of the participants were enrolled in a psychology program (49.4%, $n= 38$), 44.2% in Informatics Engineering program ($n = 34$) and 6.5% in Electronics Engineering program ($n = 5$) as shown in Figure 3. Figure 4 shows the distribution of the participants according to the cycle of studies and the year.

More than half participants only study (72.7%; n = 56), 14.3% study and work on part-time job ($n = 11$), 10.4% study and are looking for a job ($n = 8$) and only 2.6% ($n = 2$) study and work in a full-time job. In terms of students' academic performance, 63.6% of the students reported that they have no unfinished courses from previous academic years (n = 49) and only 36.4% of the students (28 subjects) reported still having courses to finish.

Figure 3. Survey 2: Participants per course area

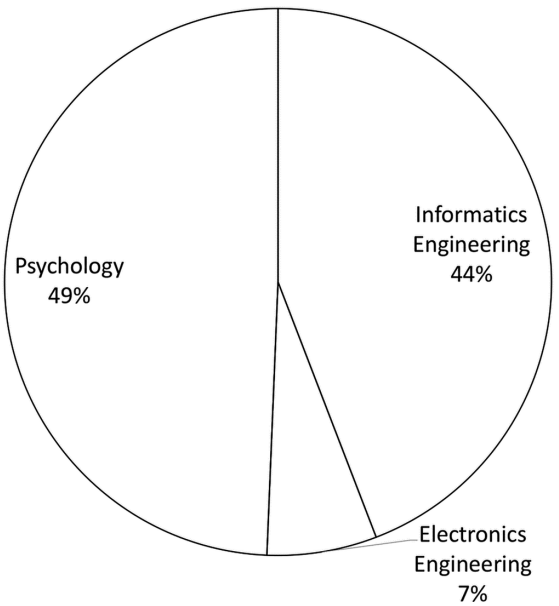
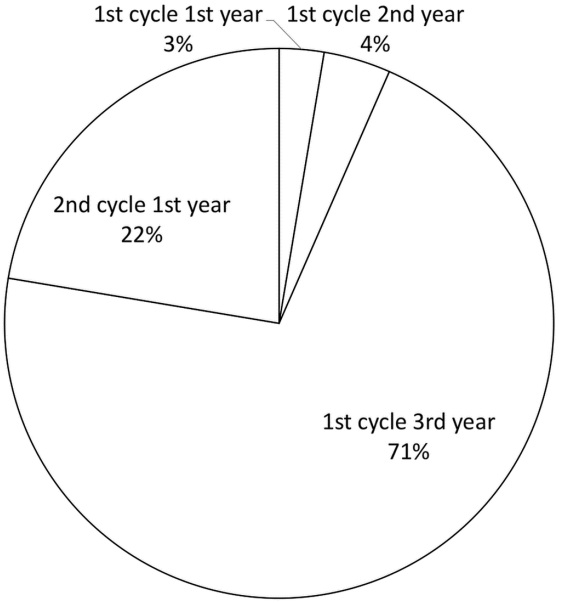


Figure 4. Survey 2: Participants per cycle of studies and year



Regarding university course choice, 83.1% of participants reported that they had entered in their first option ($n = 64$). 89.6% ($n = 69$) of the sample managed to stay in the university of their choice.

To the question "How do you evaluate your overall University experience?" 42.9% of participants classified as "Neither dissatisfied nor satisfied" ($n= 33$) and 32.5% as being satisfied ($n = 25$).

Regarding student's mental health, to better analyze the sample in terms of overall mental health, two cut-off points for this scale were created, therefore organizing the sample in three groups (33.3% of sample in each group). 30.4% of the sample presented high levels of overall mental health ($n= 24$). However, 41.8% of the sample showed low levels of overall mental health ($n = 33$).

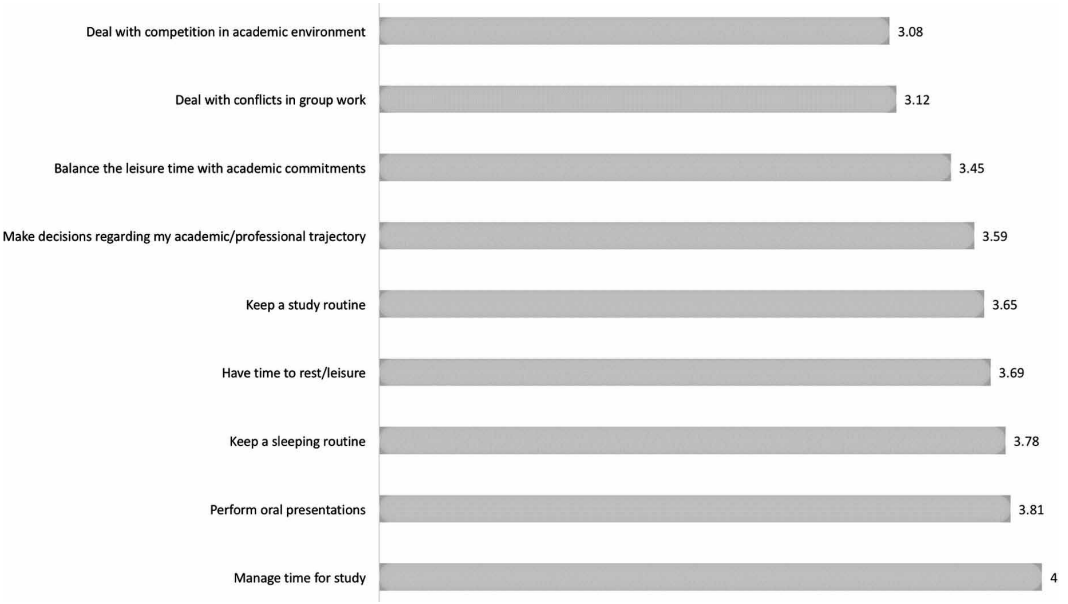
Regarding college students' perceptions toward challenges/obstacles faced throughout their academic journey, students report having more difficulty in academic area, namely "Manage time for study" ($M = 4.00$, $SD = 0.903$), "Perform oral presentations" ($M = 3.81$, $SD = 1.148$) and "Keep a study routine" ($M = 3.65$, $SD = 0.979$). Regarding "interpersonal relationships", the statements that had higher values were "Balance the leisure time with academic commitments" ($M = 3.45$; $SD = 0.095$), "Deal with conflicts in group work" ($M = 3.12$; SD = 1.147); "Deal with competition in academic environment" ($M = 3.08$; SD = 1.109). Figure 5 shows the identified challenges/obstacles that had the highest scores.

To sum up there is a high percentage of students that face problems in terms of mental health. Furthermore, students find it challenging to manage time, balance leisure time with academic commitments, keep a study routine, perform oral presentations, manage group works, keep a sleeping routine and make decisions regarding their future.

3.3. User Study with Tutors

Based on the first and second study findings, we developed the first prototype of the envisioned mobile application and we conducted a user study with a group of four students (3 female and 1 male; 3 aged 18 to 25 and 1 aged more than 35) that were acting as tutors during that academic year. We wanted to test the app usability and to assess to what extent the envisioned functionalities for the app were meeting students' interests and needs. We were particularly interested in getting feedback about the idea of notification triggers based on students' mood and the scheduled events in their calendar.

Figure 5. Survey 2: Challenges/obstacles in the academic life



A navigable app prototype was provided to participants on a laptop. Each participant completed a sequence of predefined tasks and was observed while interacting with the prototype. Required tasks were: logging in, creating a new event in the calendar, writing an entry in the diary, changing diary settings, receiving a notification and finally imagining that in three days they had an exam and that they received a notification about it while at the café with friends. At the end of the session, they were asked to fill in a short questionnaire with eleven items, four of which were open-ended questions.

3.3.1. User Study Findings

At the time of the study, three of the participants had never used their mobile phone to schedule their appointments, although they agreed that it could be helpful, especially if done automatically based on their class schedules. All participants found it very easy or easy to interact with the prototype.

The notifications functionality was found by all our participants to be an incentive and a motivation to better study. According to one of the participants, it would help her to "…be more relaxed, not checking my calendar all the time. I would be more prepared and motivated to study." Another participant wrote: "It would be really helpful because sometimes one lacks study methods and time management skills and also there is a lack of motivation among students."

The diary functionality that allows entries about how the user is feeling (text or emoticons) was considered important or very important by three of the participants and not at all important by one of them. Most of them would share those entries (an event and related emotions) with their friends on social networks.

In general, what the participants liked more was the fact that they could receive automatically notifications related to their scheduled appointments, deadlines and events and their mood (based on the emoticons in the diary entries). The notifications related to studying strategies, time management and motivation were found the most useful.

One of the participants suggested a new functionality, a chat that allows the student to talk to their tutor and share their calendar and emotions with them as a complement to periodical follow-up meetings that are usually scheduled.

After this user study, some usability issues were also resolved and the overall design of the app was changed and improved. Based on the results of the two surveys and this user study, our team of psychologists prepared a set of phrases to be used for the notifications. The phrases are organized in eight categories: sleep/ fatigue, relationships/ teamwork, mood, study (during regular classes), how to deal with stress/ pressure/ anxiety, enthusiasm/ motivation/ self-realization/ interest, oral presentations and exams/deadlines.

The following scenarios exemplify types of notifications a user can receive according to their diary logs and scheduled activities:

Scenario 1: A student inserts her assignment deadlines and exam dates in her calendar. One month before the written exam, she receives a notification: "Hi! It seems you have an evaluation in a month time. Are you getting ready? Keep your notes organized and keep reviewing them." One week before the exam, the student receives another notification: "Hi! One week from now, you have an exam. Are you getting enough sleep? It's important to be relaxed and self-confident." On the day of the exam: "Arrive early, breathe deeply and slowly. Be confident! You can do it!"

Scenario 2: A student has just begun a new academic year. She installed the app and set up her courses and schedules. She is feeling very confident and very happy to be at the University. She expresses her feelings in the diary. A notification appears a few moments later: "Feeling good? Excellent! Share your joy with others. Make someone smile. Make a compliment to a colleague who did a good job."

3.4. Automatic Data Collection Sessions

A total of 22 students (18 male and 4 female) were recruited for two sessions of automatic data collection using their smartphones. The first session of data collection occurred between May and June 2015 during exams period during three weeks and it involved 12 participants while the second session took place in the beginning of the academic year, between September and October 2015, during two weeks and had 10 participants.

In the first session, twelve students installed the app for data collection on their smartphones. They were informed about the data that were going to be collected and the purpose of the study. The application we developed for data collection runs in the background and collects data about phone calls (duration, type: incoming/outgoing/missed, number per type and total number), SMS (type: received/sent, number per type and total number), localization (latitude, longitude) and physical activity (walking, running, in a vehicle, on bicycle, still, tilting or unknown, as described in Google Activity Recognition API ("DetectedActivity," n.d.). Additionally, a short questionnaire was defined to pop-up on the smartphone screen two times a day (at 1 p.m. and at 8 p.m.) so that the user could self-assess their mood during the morning and the afternoon periods. This questionnaire consisted of just one question: "How did you feel this morning/afternoon?" Six mood descriptors (anger, confusion, depression, fatigue, tension, vigor) and a scale from 1 to 5 for each were provided so that the user could respond more quickly and easily. The choice of the six subscales as opposed to all twenty-four descriptors from the Brunel Mood Scale (BRUMS; (Rohlfs et al., 2008) was made to reduce the burden of filling in an extensive survey two times a day during several weeks.

3.4.1. Data Analysis

In this section, we report on the findings related to the phone usage features, based on the following categories, as proposed by (Bogomolov et al., 2014): (i) general phone usage, (ii) active behavior, (iii) regularity and (iv) diversity. Features for the first category include: number of incoming calls, number of outgoing calls, number of received SMS and the number of sent SMS, both in the morning and in the afternoon. We calculated separately the values for mornings and afternoons to correlate them with the survey results that were obtained for each of these periods. For regularity, we measured

the time between receiving and replying an SMS and the time between calls. The feature chosen for diversity was the number of unique contacts for both calls and SMS. As for the short surveys, for each mood descriptor, average values were calculated for morning and afternoon results, respectively.

Data on general phone usage from the first session of data collection revealed that most participants receive and initiate more calls and SMS in the afternoon than in the morning. On average, the participants interacted with 19 unique contacts in 50 calls and 22 unique contacts in 653 SMS exchanged for three weeks. The most highly scored mood descriptors were fatigue and vigor, which may seem slightly contradictory but somehow makes sense knowing that the study took place in the end of the semester. There seems to be no significant difference in mood scores in the morning and in the afternoon. We calculated Pearson correlations between phone usage features and mood descriptors scores and found small significance in these findings. The most significant positive correlation (r=0,548) was found between the number of outgoing calls in the afternoon period and tension mood descriptor which may indicate that the number of outgoing calls may increase users tension levels.

In the second session, ten students installed the app for data collection on their smartphones. They were informed about the data that were going to be collected and the purpose of the study. Data collected during this session are to a great extent similar to those of the first session, except for mood descriptors score, which show the highest values for confusion, tension and vigor. This is in accordance with the results of the first study in which some students referred that they experienced more tension during the first month of the academic year despite being confident about their capabilities. The most significant correlations were found between the number of received/sent SMS and four mood descriptors, confusion, anger, depression and vigor as shown in Table 3. Although the results are very similar to those of the first session, we noticed a slightly higher average value for vigor for several participants, which is expected at the beginning of the academic year.

4. DISCUSSION

The first study allowed us to get a good general feel about students' perceptions of their well-being while at the university. In order to tackle the identified issues in the study findings, we included in the mobile application prototype an algorithm that, according to student's calendar and the inferred mood, launches short notifications containing advice on healthy living habits, guidelines for efficient studying and time management.

The second study explored college student's mental health and their perceptions towards challenges and obstacles they face. The results suggested that a significant percentage of college students presents low levels of mental health (41.8%). These results are in line with the research literature (Fernandes et al., 2005; Hunt & Eisenberg, 2010). Further analysis is needed with larger and more diverse samples to get more robust results. Notwithstanding this limitation, these results alert us to the importance of developing measures to promote mental health among university students.

The results also reveal that college students identify several obstacles faced during their academic experience (university adjustment, interpersonal relationships and academic issues). These difficulties are also described in the literature e.g., (Almeida et al., 2000). As so, these are several clues about the challenges faced by the students that need special attention in further development of the application.

Table 3. Pearson correlation coefficient (r) between SMS features and mood descriptors for the second session of data collection

	Mood Descriptors			
	Confusion	**Anger**	**Depression**	**Vigor**
Received SMS	0,739	0,618	0,542	0,532
Sent SMS	0,756	0,627	0,573	0,528

The third study allowed us to assess some of the initial ideas for the mobile application. We obtained invaluable comments and suggestions from a small group of students-tutors. As a result, we made a significant improvement on the prototype and developed a set of motivational phrases and tips for studying to include in the notifications that the app provides to its users according to their calendar and their mood. These phrases are organized in eight different categories which resulted from our first study findings. For example, if a student has a teamwork assignment to finish in two weeks, he or she will receive advice on how to work better with his or her team mates, about goal definition strategies and task planning or, if the exams are near, the application will remind the student to organize their study time as to be able to make short breaks, to eat well and to get enough sleep daily. These notifications, together with a chat or other type of social networking functionality can act as triggers for behavior change and studying related habits formation among students. In an informal evaluation, we received a lot of positive feedback about including a social networking functionality for the students to schedule studying or practice sessions and share their knowledge through, for example, short quizzes accessible to all students of a study group. Moreover, this is also supported by the results of the first study that showed that students value their group of friends during all the academic year (Table 2). With a sensor network installed in the study rooms, additional context can be extracted from the environment and it can further contribute to students' well-being and academic success. Future user studies will evaluate the right format of the notifications (text, image, video, audio), whether they appear in a timely manner and to what extent they are able to change or influence users' behavior.

Finally, in the fourth study, an automatic data collection mechanism was tested and collected data were analyzed based on a set of features from the related literature. The obtained results for call and SMS features are quite similar to those reported by other researchers. However, they exhibit important limitations due to a small number of participants.

5. CONCLUSION AND FUTURE WORK

A set of field studies was conducted to collect data about students' well-being both by using self-perception surveys and by collecting data automatically from their smartphones. A calendar based mobile app that allows the student to keep their schedules and deadlines in one place was proposed. The novelty is the integration of virtual tutor features and personalized notifications in the mobile application. Besides being a calendar, the app is aware of the user's well-being based on diary logs and the data collected automatically from the smartphone. By using both, the events from the calendar and the user mood indicators, the app sends notifications to the user according to their needs. These notifications range from motivational phrases to time management guidelines and relaxation tips. According to the results of our second study, students found this feature most useful to support their academic life.

Based on the collected data from a larger deployment, the overall impact of the application on students' well-being and their academic success will be measured. The collected data may be used to analyze further the levels of happiness over all phases of an academic year and to compare these data to other datasets and results, such as those from *StudentLife* project (Wang et al., 2014).

Additionally, an IoT project is being deployed in one of our study rooms to complement the mobile app. Deployed sensors, single board computers and the existent infrastructure (e.g., Wi-Fi access points) will measure the physical context of the room, such as noise level, temperature, illumination, the number of people and their mobility. Also, a wall display will be deployed for feedback purposes.

As such, we will be able to use ambient sensors and smartphone data simultaneously to infer individual behavior, social interaction between students during different phases of their academic life, their mobility around the campus and the physical conditions of the study room (Hentschel, Jacob, Singer, & Chalmers, 2016). The mobile application will be used for data collection and virtual tutoring on an individual level, as well as for studying sessions scheduling and knowledge sharing among

students, while the situated display will provide feedback based on both, the study room physical context and on the individual levels of engagement and happiness of the people present in the room. Simultaneously, we need to delve deeper in the study and comparison of state-of-the-art classifiers for detecting happiness among students.

As pointed out in recent related works, having event-based features (Bachmann et al., 2015) and personalized feedback (Sano et al., 2015) seems to be the way to go. For the feedback, several strategies (e.g., image, audio, video) besides the existing mobile phone textual notifications are envisioned to evaluate the effect on the users in the room and on the mobile. Previous projects adopted a garden (Consolvo et al., 2008) and an aquarium scenarios (Lin, Mamykina, Lindtner, Delajoux, & Strub, 2006) for their feedback wallpapers for mobile apps. Students will be actively engaged in the process of design and the conception of the feedback scenarios as they are the key players in this project.

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