‘Smartphine’: Supporting Students’ Well-Being According to Their Calendar and Mood

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***Abstract*— Smartphones have become devices of choice for conducting studies on health and well-being, especially among young people. When accessing higher education, students frequently experience significant challenges, ranging from adapting to new situations and new social relations to heavier workload than in previous levels of education, short deadlines, teamwork assignments and so on. In this paper we present the results of three studies examining students’ well-being and propose a mobile application that acts as a complement to a successful tutoring project deployed at our University over the last four years. The app allows the student to keep their schedules and deadlines in one place while integrating a virtual tutor features. By using both, the events from the student’s calendar and his or her mood indicators, the app sends notifications accordingly. These notifications range from motivational phrases to time management guidelines and relaxation tips.**

Keywords—mental health; well-being; field studies; mobile app; higher education

I. INTRODUCTION

As smartphones and other mobile and wearable devices are becoming more and more ubiquitous in our daily lives, an interesting question has been emerging in research papers from both, computer science [1, 2] and mental health fields [3]: Can technology in general, and a smartphone in particular, contribute to one’s happiness and if it can, how? Several examples of the use of technology for detecting and measuring happiness at the workplace are reported by [2], describing a small badge called Hitachi Business Microscope that is able to retrieve and analyze the well-being of the employees based on their voice levels, body language and social interaction with their colleagues.

As the smartphones are increasingly being equipped with a plethora of sensors, such specialized devices begin to lose ground. Smartphones alone or combined with other wearable devices are used for activity tracking, mood detection [4], behavior analysis [5] and behavior change [6]. As such, smartphones have become devices of choice for conducting studies on health and well-being, especially among young people.

When accessing higher education, students frequently experience significant challenges, ranging from adapting to new situations and new social relations to heavier workload than in previous levels of education, short deadlines, teamwork and oral presentations and so on. Experience from a mentoring project developed at the University of Madeira [7] has shown that it is highly beneficial for younger students to be accompanied and advised by more experienced students (mentors or tutors) in areas such as stress and anxiety management, time management, motivation and teamwork.

One of our main concerns in the project we hereby describe, is to develop mechanisms for virtual tutoring and fostering healthy and happy behavior among university population. Based on others evidence, our own experience as students and faculty, and on a survey we conducted at our University, we know that students’ levels of stress start increasing when deadlines and exam periods are approaching. So, how can we leverage the fact that most students own a smartphone equipped with considerable amount of memory and processing power and a quite interesting set of sensors to help them cope with those situations? What kind of feedback should an app provide to lower stress levels and help students maintain their focus on what they are doing? Several universities in Portugal already provide mobile apps (e.g., UAmobile [8]; UCoimbra [9]) based on the Moofwd platform which has been acknowledged as a top mobile solution for higher education [10]. Although, we would certainly like to see this kind of app at our University, we find that this type of apps that only consume services exposed by the University Information Technology department does not respond completely to students needs. For now, as those services are still not available from our University, we propose, in the scope of our ‘Smartphine’ project, a simple mobile app that acts as a virtual tutor and is aware of the user’s activities, appointments and mood levels.

In this paper we present the results of three field studies examining students’ well-being and some aspects of our mobile application: (i) a survey (N=101) among our University students to find out their preferences for sharing their feelings and to get the general view of the perception they have on their academic path; (ii) a user study (N=4) with the prototype of our envisioned mobile application and (iii) two automatic data collection sessions (N=12; N=10) that were conducted during three and two week periods, respectively and where usage data was gathered from users’ phones.

II. LITERATURE REVIEW

Studies have shown that happy people produce more and have better results at work [2]. We expect that happy students will also perform better in their academic endeavors. A significant contribution to this has been a tutoring project conducted at our University since 2012/2013. This project's main goal is to integrate new students in the new environment and foster their personal and interpersonal development by creating a support network of peers. It provides tools for students to better focus on their personal and academic goals, find motivation for study, manage anxiety and stress and share useful studying methods. In the mentoring activity in the educational context more experienced peers can be considered as guides that encourage the student to make decisions consistently with their time availability, interests, rights and duties [11]. Mentoring usually involves short weekly meetings between tutors and tutees. However, this type of meetings can overload students who are struggling with time management, and can also be a source of anxiety for students who are particularly shy or anxious.

According to [12], students typically use time management, communication and productivity applications on their mobile devices. However, most of these applications are not specifically designed to support their activities, such as attending lectures, reading course content, revising for exams and other course deadlines. This supports our idea of proposing a calendar based mobile application with integrated sensing functionalities and feedback messages about time management, studying techniques, stress management, relaxation techniques and other according to students' schedules, tasks and deadlines, as well as their well-being levels.

Mobile sensing with smartphones has been deployed widely in trying to detect human physical activities, social interactions and behavior patterns as well as in quantifying and understanding all the interrelated factors that contribute to a certain behavior. The viability of smartphone applications for well-being monitoring and behavior change interventions is verified by several authors, e.g., [11-13], just to mention some.

Miller [14] advocates in his manifesto that the smartphones need to be taken seriously into account in the field of psychology clinical practice and research. Miller is the apologist of developing open source projects that allow sharing and building collaboratively better "psych apps". In the scope of the LifeGuide research project [15], a set of open-source tools are available for development of online interventions for therapists with limited or no experience in programming [16]. Emotionsense [17] provides a set of Android libraries on their website to help other developers in the area of sensing human behavior with smartphones.

Teams of researchers from around the world have been working intensively in the area of mobile sensing of human behavior and have produced and deployed several mobile and web applications that detect user behavior based on smartphone usage, analyze the collected data and return some kind of feedback to the user.

A smartphone application called Moodscope that detects its owner's mood based on usage patterns of the mobile device is described in [4]. In their study, phone calls, SMS, emails, installed applications, browser history and location data were collected. The authors recognize some privacy related issues that could not be overcome at the described stage of the project. Further developments from the same team of researchers resulted in BeWell [13] and BeWell+ [18] applications. These applications not only detect user well-being based on sleep patterns, physical activity and social interaction, but also provide some visual feedback on the smartphone display as a result of calculations of a well-being score and an additional web application that allows the user to correct and complete some of the inference results by taking the available surveys. In this way, better results are achieved and the computation burden is somehow distributed between the mobile device and the server. BeWell+ introduces several enhancements according to the user age group to make the goals more realistic and a new scheme for resource allocation optimization to reduce energy consumption. Finally, in 2014, the same team develops the StudentLife project [5], the first project of its kind to collect behavior related data among university students. The authors predict further developments that will include data collection in other American universities and the integration of feedback features based on the collected data about student activity, sleep patterns, social interaction, academic success, etc. The authors of [19] make a step further and take into account not only data collected from the smartphone, but also data about the weather and personality traits of their participants.

A survey on parameters that influence happiness and that can be measured with smartphone, smart home or office appliances and wearable sensors is reported in [20]. From ten measurable determinants of happiness that they identify in the related literature (activity, sleep, nutrition, mood/emotion, social interaction, personality, spirituality, work, family and health), only nutrition cannot be measured directly by smartphone or ambient sensors. However, user can insert manually some food related data. An interesting work in this area is reported by [6]. All the other determinants can be measured either by a smartphone only or by a combination of smartphone, wearable devices and ambient sensors.

Our work relates to the above mentioned projects as it takes advantage of the data collected by the sensors that are embedded in smartphones to infer well-being. It is closely related to the StudentLife project because it is focused on higher education students. However, the novelty of our approach is about looking into possible mechanisms for providing virtual tutoring features based on inferred mood and scheduled appointments.

III. FIELD STUDIES AND RESULTS

In this section we describe the details of three field studies that were conducted in the scope of our project. First, a general survey about student's communication habits and self-perception. Second, a user study with a group of tutors to gain some insights about the app functionalities and user interface. Third, an analysis of automatically collected data from users' smartphones.

A. Survey about students' well-being

The first phase of our project started with a survey among students at our University. The survey was handed in paper by

the teachers during classes. The sample was composed by 101 students, 47 female and 54 male, ranging in age between 17 and 54, being the average age 22. Fig. 1 shows the number of participants in each age group. As shown in fig. 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.

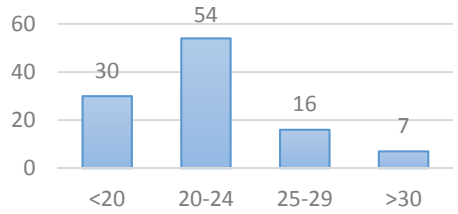

Fig. 1. Number of participants per age interval

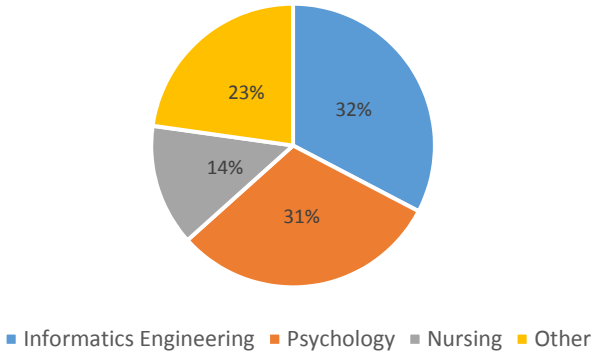

Fig. 2. Participants per course area

A great majority of the participants (85) are only studying, 13 work part-time and 3 full-time. We asked them 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 by mobile phone calls or by short messages (SMS). We also asked them to reply on a scale from 1 (strongly disagree) to 5 (strongly agree) to what extent they agreed with each one of 30 statements about their feelings and well-being indicators in five different situations: first month of the academic year, exam period, teamwork assignments, individual assignments and oral presentations.

1) Survey findings

From the first 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 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 second part of the survey, we can extract some interesting findings about our students: 52 of them expressed that they do 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 on a daily basis 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. There were no clear answers as if they made good friends at the university.

The remaining results will be analyzed according to two periods: first month of classes and exams and teamwork assignments periods.

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 are able to meet deadlines in spite of some difficulties they face.

To sum up, the findings of the first survey showed that during different periods of the academic year, students experience different challenges. They seem to lack time management and efficient studying skills and appear to be less motivated and self-confident when facing more workload.

B. User study with tutors

Based on our first study findings, we developed the first prototype of our 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 sending notifications to the user based on their mood and the scheduled events in their calendar.

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.

1) User study findings

At the time of the study, three of our participants had never used their mobile phone to schedule their appointments,

although they agreed that it could be helpful. 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 our 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 our 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 as it can be seen in Fig. 3. Based on the results of the first survey 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.

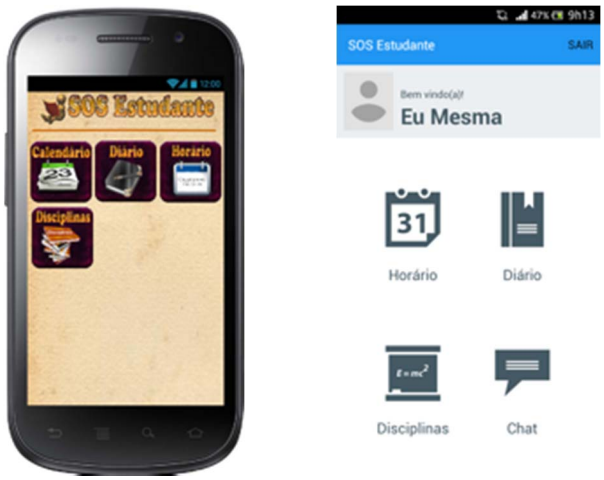

Fig. 3. App design before and after the user study

The following three 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, breath deeply and slowly. Be confident! You can do it!*"

Scenario 2: In his diary, a student includes a sleepy emoticon. A notification pops up: "*See how you feel after dinner. If you feel tired, you should execute easier tasks at that time of the day, like transcribe your drafts or make a table of contents for an assignment*." During the week, the student keeps feeling sleepy and tired. A new notification appears: "*Do you get enough sleep? Try to go to bed earlier to get at least 6 to 8 hours of sleep.*"

Scenario 3: 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*."

C. *Automatic data collection sessions*

A total of 22 students (18 male and 4 female) were recruited for two sessions of data collection. 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 our 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 app we developed for data collection is called EmotionStore. It 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 [21]). 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)

[22] was made to reduce the burden of filling in the survey two times a day during several weeks.

1) Data analysis

In this section we report on our findings related to the phone usage features, based on the following categories, as proposed by [19]: (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 in order 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, our participants interacted with 19 unique contacts in 50 calls and 22 unique contacts in 653 SMS exchanged during 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 our 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 our first study in which some students referred that they experienced more tension during the first month of the academic year in spite of 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 I. 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.

TABLE I. PEARSON CORRELATION COEFFICIENT (R) BETWEEN SMS FEATURES AND MOOD DESCRIPTORS FOR THE 2ND 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

IV. DISCUSSION

The first study, although with a limited sample (less than 10% of all students responded), allowed us to get a fairly 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 our mobile app prototype an algorithm that, according to student's calendar and their logs in the diary, launches short notifications containing advice on healthy living habits, guidelines for efficient studying and time management.

The second study allowed us to assess some of our initial ideas for the mobile app. We obtained invaluable comments and suggestions from a small group of students-tutors. As a result, we made a significant improvement on our prototype and developed a set of motivational phrases and tips for studying to include in the notifications that our 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 app 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. Further user studies are needed to evaluate to what extent these exact notifications are adequate, whether they appear in a timely manner and whether the users find any value in them.

Finally, we tested an automatic data collection mechanism and analyzed collected data based on a set of features from 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. Nevertheless, further and deeper analyses with bigger samples need to be done in order to obtain more significant results. We also need to research the impact of other sets of features beyond smartphone usage, such as personality and weather [19], social interaction [17] and mobility. Moreover, we need to study and deploy more sophisticated methods from the area of machine learning, such as some of the state-of-the-art classifiers that showed to perform well in previous studies (e.g., Random Forests).

V. CONCLUSION AND FUTURE WORK

We conducted a set of field studies to collect data about students' well-being, both by using self-perception surveys and by collecting data automatically from their smartphones. We proposed a calendar based mobile app that allows the student to keep their schedules and deadlines in one place. The novelty of our approach is the integration of a virtual tutor features. Besides being a calendar, the app is aware about 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.

Currently, we are in the course of preparing our app for the fine tuning before the deployment among a larger number of students during at least one semester, having one test group and one control group. The fine tuning will consist in conducting a user study with at least twenty students from different areas to test the overall app, but especially to assess the notifications contents, their usefulness, timeliness and value to students. Based on the collected data from a larger deployment, we plan to measure the overall impact of the application on students' well-being and their academic success. We expect to use the collected data to analyze 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 [5].

For the future work, we plan to design and deploy an IoT project in one of our study rooms to complement the mobile app. Deployed sensors and the existent infrastructure (e.g., WiFi access points) will measure the physical context of the room, such as noise level, temperature, illumination, the number of people and their mobility. We also envision the installation of a wall display 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. The mobile application will be used for data collection and virtual tutoring on an individual level, 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.

For the feedback, we expect to develop several strategies besides the existing notifications in order to evaluate the effect on the users in the room and on the mobile. Previous projects adopted a garden [23] and an aquarium scenarios [13] [24] for their feedback wallpapers. We expect to engage students in the design and the conception of our feedback scenarios as they are and will always be the key players in this project.

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