Mobile Health Based System for Managing and Maintaining Health Data in Classroom: Case Study

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***Abstract*—It is necessary for young people to get appropriate medical education so that they can learn how to properly take care of their health from an early age. In this paper we are presenting a study that enables practical implementation of a mobile system for monitoring students' health using mobile devices and managing medical data in the classroom. About 600 students were engaged for the purpose of this study. The study results suggest that the application of these technologies leads to an increased concern about students' health and their proper medical education.**

Keywords **–mHealth, students, healthcare, smartphone, tablet, mobile devices.**

1. Introduction

Simply put, mobile devices are tools of the modern age without which one cannot imagine progress in any area. It is generally known that mobile devices have already largely replaced standard personal computers. Most of the activities that were once performed by a computer are now performed by using a mobile phone. The possibility of undertaking activities while in motion is attractive for a lot of people because it allows flexibility in operation. This raises the need for practical implementation of different mobile devices for working in different areas in order to obtain more sophisticated results, automate certain processes, or simply speed up operation. Various examples of the practical implementation of mobile technologies for various purposes can be found in literature. For example, [1] describes the use of mobile technology for educational purposes. According to this study, the use of mobile technology in the learning process significantly improves availability, efficacy and quality of the teaching process by improving the availability of educational materials and services. In this paper we describe a mobile system based on mHealth technology, the main purpose of which is to improve students' healthcare from an early age. The system we describe includes electronic registration of absence due to illness by means of a mobile device. The distribution of materials related to the disease is carried out electronically from the pupil/student to the teacher using a mobile device through a security protocol, proactive program for the prevention of misuse of antibiotics in children and adolescents from an early age by sending emails, educational materials and reports directly to pupils'/students' mobile devices, prevention and education on sexually transmitted diseases, prevention and proper education about possible occurrences of the curvature of the spine or scoliosis in young children.

The term mHealth describes the use of cell phones in medical purposes. For the purposes of this study we engaged about 600 students who volunteered to test the system. The criteria for selecting students for testing the system was basic knowledge of English, possession of a mobile device - iPhone, Android or Windows Phone and age over 19. Of the total 600 registered students, 575 or 95.83% proved suitable for participation. For this study an appropriate application system was made composed of the mobile application Student mHealth for students and the appropriate desktop application Teacher mHealth Desktop and Mobile designed for teachers through which they can manage the data coming from students' mobile devices, generate reports and manage all of the above mentioned activities of the system.

DOI: 10.18421/TEM62-11
https://dx.doi.org/10.18421/TEM62-11

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This study presents multiple results from surveys conducted during the research. The ultimate goal of this study was to see whether and to what extent mobile phones can serve as tools for monitoring, prevention and improving the health of children in schools.

2. Related work

mHealth is an area that has been significantly developing in recent years. The review of literature leads to the conclusion that today various attempts are being made in the world, tests and studies to practically implement the possibilities offered by smart mobile devices, tablets and smart watches in medical purposes. There are a number of studies dealing with the use of mobile devices in medical purposes and its benefits. Reference [3] mentions a web based system for recording students' absences due to illness. This is designed to allow teachers to update the status of students' presence in class with the help of mobile tablet devices. The data from this system from all schools and classes are sent to a central database for further analysis and monitoring of temporal and spatial patterns of absent students. Within this system there is also a research module enabling a connection between the data on absence from schools and from local health centers. In [2] the authors address safety in the process of sharing medical information via a mobile device. According to them, web based applications enable new ways of promoting health and reducing costs but, although personal health data is stored encrypted on servers, users are not able to share the data. Currently the cloud services that keep medical records have complete control over them, which means that users lose control of their data. In this reference the authors mention a security protocol through which users can share their data with cloud services and simultaneously retain complete ownership right over the data. Reference [4] relates to the implementation of a free program for quitting smoking based on text messages. The authors in [5] aim at exploring the possibilities of mobile technology for long-term monitoring of blood pressure at home. The study compares monitoring of blood pressure at home using technology aided by mobile devices and monitoring that is carried out in health centers. According to this study, technologies for measuring blood pressure aided by mobile devices represent a safe and promising method by which we can adhere and which in future will enable us to implement a number of large -scale studies.

In [6] the authors present the use of mobile technologies in the prevention and treatment of patients suffering from colorectal cancer. The results of this study say that the use of these technologies has increased the feeling among patients of their direct involvement in taking care of their health. In the results presented it is said that patients feel comfortable when using this kind of technology and they especially appreciate the fact that the system is not time consuming. Reference [7] relates to patients with complex chronic conditions who face difficult social challenges, such as patients with health restrictions. The results of this study say that its participants were subjected to 210 monitoring protocols involving 1300 questions answered by the patients on a daily basis. The report of this study suggests that tools based on mobile systems helped users involved in this study to better manage their health and surpass challenges more easily. According to its authors, the system described in this study is flawed because it has been shown that it takes up a lot of patients' time.

Many of the studies in this area are aimed at monitoring the heart as a vital organ essential for life. The authors [8] report on a pilot study concerning the use of a web-based system for managing health in patients with heart problems supported by mobile technologies and smart devices. This study demonstrates the feasibility of low-intensity remote monitoring programs for patients with heart defects belonging to the younger population. Reference [9] describes a pilot study in which an attempt was made to use mHealth technology as a tool for implementing psychotherapeutic treatment for patients with chronic diseases. According to this study, mHealth technology shows significant potential in treating depression and anxiety. From all the above mentioned we can conclude that mHealth technology has a broad potential for research and practical implementation in everyday life. All mentioned studies can be implemented in different ways in the pilot model of a system for monitoring health in the classroom that we suggest. Namely, children's health is important in every aspect; it is vital that children be properly informed about any disease from an early age, especially about severe diseases such as cancer. We believe that the purposed model for using mHealth technology in the classroom, based on the conducted survey and the review of existing literature, covers a small part of all possible functions that could be built in and implemented.

3. Methodology and technology

Description of the purposed model

We developed a system based on mHealth technology designed for remote monitoring of patients. For the purpose of this study the system was revised and adapted to the needs of this research. The model of the system we offer mainly consists of three parts. The first part consists of a desktop application for full system management together with all the data, a cloud based application and a mobile application designed for pupils/students by means of which they need to feed the system with data. The purposed model is visually shown in the figure below. (Fig.1.)

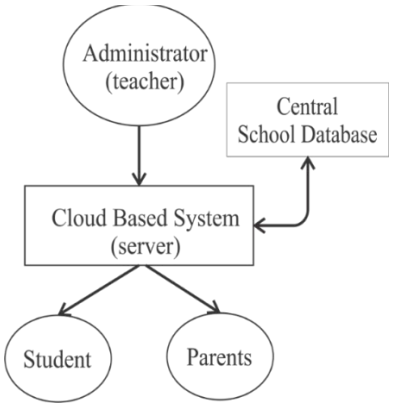


Figure 1. Visual description of the purposed model

The purposed system model consists of 6 separate modules designed to monitor the health of students, to create the habit of caring for children's health and managing medical data. The system is built up of the following modules:

Module for reporting absence from school. This module is designed to allow precise monitoring of absences among students due to illness or any other cause in order to avoid manipulations to which students are prone, especially in primary education. Each pupil or student has his/her encrypted account in a central database containing information on the psycho-physical health of the pupil/student. This base also keeps information about all pupils'/students' absences due to illness. Each pupil/student is obliged to report his/her absence with the application Student mHealth. To that end the module contains a simple button "Apply for Absence" so by clicking on it the pupil/student opens a form in which he/she can specify the reasons for absence.

By submitting, the application for absence is recorded in the central database and through the mHealth Desktop system SMS messages are automatically sent to mobile devices of the responsible teacher and pupil's/student's parent with a confirmation code. The parent can confirm or decline the announced absence through the mobile application mHealth Student by entering the code. The module is visually shown in Figure 2.

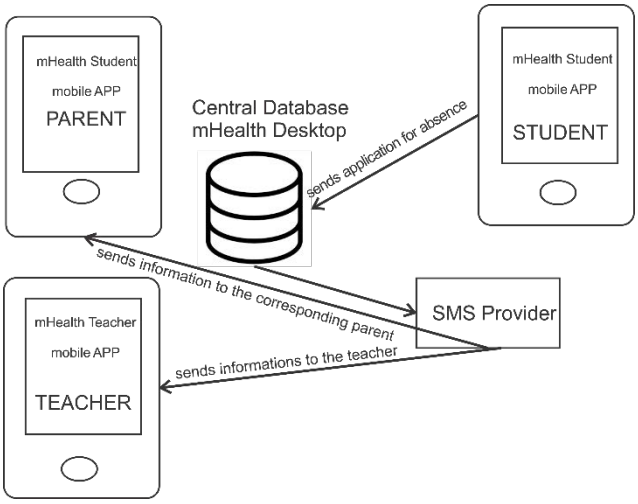


Figure 2. Absence module visualization

Module for informing about excessive air pollution. This module aims to inform pupils/students about increased levels of pollution according to the measuring stations in the cities in Macedonia. In Macedonia there is a tendency of increased pollution, especially in winter, which contributes to worse health especially for those with chronic obstructive pulmonary diseases. According to the results in [11], most pollution was recorded in the city of Skopje. The module uses the student's geo-location and thus detects the appropriate measuring station, then sends information in the form of a notification to the student's mobile device in order to alert him/her about the pollution in the area in which he/she is located. The module is designed according to the system described in [10]. The primary objective in designing this module was to provide data on the overall duration of students' exposure to polluted air. At the end of each month the module generates a report about every pupil/student respectively which contains data on the exposure to pollution that are sent to parents.

Using the experimental results presented in [11] the module calculates the risk of pollution to a student's health for each student individually. These data on students are available through the mHealth Student application.

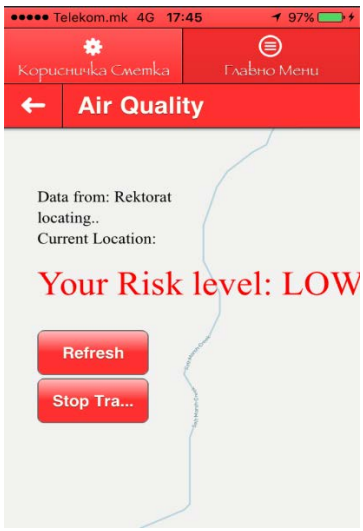


Figure 3. mHealth Student app screenshot from Air Quality Module

Module for informing on sexually transmitted diseases and curvature of the spine (scoliosis). This module is based on two aspects, health and educational. The educational aspect aims at informing students about sexually transmitted diseases and curvature of the spine (scoliosis) and their prevention. Using mHealth Desktop the teacher can create tasks in the form of quiz questionnaires containing questions related to these diseases that students are obliged to answer. After completing the tasks, the teacher can automatically generate reports with the results in PDF format. In this way we have a double benefit because students are informally educated about sexual diseases and scoliosis that are common in young people and we collect information about the level of knowledge of each pupil/student about each disease respectively. This module was not practically tested because of the extensiveness of the experiment. It also contains the so-called "Daily Facts" section in which different facts related to sexually transmitted diseases are daily presented.

Module for sharing educational materials related to cancer. This module is similar to the previous one and it also has educational character. We consider this module extremely important because its primary purpose is to increase awareness of cancer among students from the earliest age. By means of creating the so-called "Weekly Tasks" teachers are able to create different surveys quizzes related to various types of cancer each week. After completing the tasks, the pupil/student gets access to the appropriate educational text, animated and video materials related to the specific type of cancer. The third component of this module is called "Warning for Screening". With this component, students receive a monthly notification on their mobile phone which stimulates them to force their parents who are in a critical age to perform screening for early detection of certain types of cancer. Each pupil or student who managed to make his/her parents perform a screening examination for a particular type of cancer can click the button called CAlert Button and report it to the central database. In this way we get informal figures on the raising awareness about the risk of cancer in students and their parents. This is an experimental model we think in the long run can bring results. Initial results of the practical application within this study are presented in the chapter results.

Module for preventing medicine abuse among pupils and students. This module is experimental and aims at reducing the use of antibiotics in pupils/students. According to the research presented in [12], there is a serious problem with self-taking antibiotics without consulting a doctor throughout the Republic of Macedonia. This problem also persists worldwide. The study conducted among university students in Nigeria [13] presented results on the prevalence of this phenomenon showing widespread practice of independent taking of medicines, especially in the age group between 25-34. Our idea was to test the independent use of medicines among students during one semester by means of their mobile phones. With the help of the mHealth Student application each student, using his/her mobile phone, enters the name of the medicine he/she uses, the reason for using it, the frequency of using it, and whether the medicine is taken independently or not. 280 first-year students of the Medical Faculty participated in the experiment. The results are automatically processed in the specially created statistical module in the application mHealth Teacher Desktop. The results of this experiment are presented in the chapter results.

Module for healthy diet and physical activity. The last module built into the system that we present is the module for healthy diet and physical activity. This module consists of two parts. In the first part students using mHealth Student application enable all-day measuring of their physical activity. The application follows movement, counts steps, daily mileage and calculates burnt calories. The second segment of this module consists of the form of a healthy diet made up of 4 groups: fruit, vegetables, fatty food and meat, and soft drinks and alcohol. Here students have the task of uploading information on their diet on a daily basis. All these data are automatically recorded in the central database and automated analysis is performed by the mHealth Teacher Desktop application. In this way individual monthly reports are received about each pupil's/student's habits concerning healthy eating and physical activity. The results of these reports will not be shared here as we do not consider them relevant in the area. The aim of the experiment was to demonstrate the possibilities of using mobile

devices to monitor students' psycho-physical health in terms of healthy eating and physical activity so that they can be successfully advised during classes. The module is designed according to the conclusions drawn from the results presented in [14].

4. Results and discussion

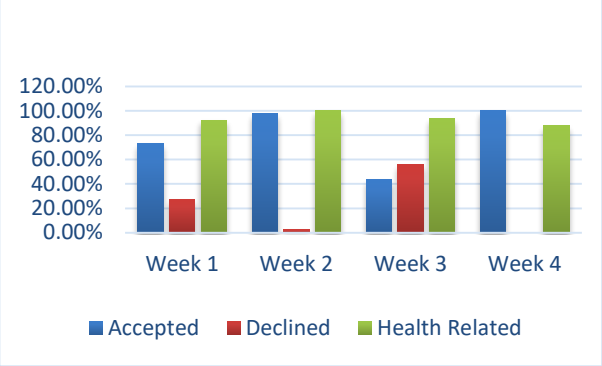
In this chapter we present the results of the practical implementation of the system described above. The experimental part of this research covered practical testing in which 600 students from three faculties of the University "Goce Delchev" in Stip participated in the period from February 2016 to November 2016 during two semesters. The intention in designing this system is that it can collect information from students' mobile devices, simultaneously process data and generate reports in an automated way. The results are presented for each module of the system separately.

The results of the module for reporting absence from school. 170 students who took part in testing this module had the task to report absences from classes due to illness using mHealth Student mobile app from their mobile devices in the course of 1 month in which they have 4 classes. The numbers of reported, confirmed and declined absences are presented in Table 1.

Table 1. Overview of the results from the module for reporting absence from school

Week Number	Applications of Absence	Accepted	Declined	Health related
1 week	26	19	7	24
2 week	44	43	1	44
3 week	16	7	9	15
4 week	9	9	0	8

According to the results, most requests for absence were in the second week, 44 of which 43 were accepted or confirmed by parents and one was declined. The following graph shows the results in percentages.



From these figures, we can conclude that there is a high percentage of accepted requests for absence but also that a good part of the requests was false. Over 90% of the requests for absences were health related. These figures are only experimental to demonstrate the functionality of the system. For more relevant results in terms of controlling health-related absences of students we believe that the testing sample should consist of at least 2000 students. The system is designed to automatically insert points for presence and absence from school based on accepted or declined requests for absence.

The results of the practical implementation of the Module for informing about excessive air pollution. In the period of 3 months we received data from 145 mobile devices. Of these, 141 (97.24%) at least once found themselves in an environment where pollution exceeded 100 μg/ m^3 PM10 particles, and 19 (13.10%) were continuously exposed to pollution (over 20 hours a day). In the data from 4 mobile devices the system never registered movement in an environment with increased air pollution. The system sent 1,254 notifications of increased risk of pollution of which 143 (11.40%) were calculated to be high risk. The results show that a very small percentage, only 12 of these 143 or 8.39%, changed location after receiving the notification. With the application of this model, the teacher gets a complete picture of exposure to pollution of all pupils /students in his/her group. With further improvement, this model can help reduce exposure to pollution.

Results of testing the module for sharing educational materials related to cancer. Within the practical implementation of this module a total number of 5 tasks were realized in the form of quizzes with questions. In this experiment 240 students were involved. All 5 tasks were completed by 172 students (71.66%); over 80% wrong answers were recorded by 74 (43.02%) students. The "CAlert Button" was never clicked which shows that the implementation of the module has not given the expected results.

Module for preventing medicine abuse among pupils and students. In this experiment, over a period of 3 months, 280 students took part of which 232 (82.85%) at least once took antibiotics on their own. The most common reason for this is stated to be a light cold which is mentioned by 147 male and 53 female respondents, or 86.20% of the total number. Other reported reasons include menstrual pain, headache and toothache. The analysis shows that 176 (75.86%) students did not complete their therapy and they stopped the treatment without consulting a doctor. In this part, it is interesting to note that 70 participants in this experiment also took part in the experiment with recording absences due to illness.

The analysis shows that the period of taking antibiotics is not consistent with the reported absence, or only 9 students (12.85) took antibiotics therapy during the period when they were reported as absent due to illness. The results of this module indirectly challenge the results of the practical application of the module for recording absence due to illness. The last sentence is a logical assumption that has not been proven.

5. Conclusion

The main objective of this study was to see whether a prototype of a system for monitoring and managing pupils'/students' health could be implemented in educational institutions and what interest it would arouse. Our calculations show that on a scale from 1 to 10 the aroused interest may be assessed approximately as 4 or as approximately average. We believe that this is due to the comprehensiveness of the system and students being overloaded. The first module suggests that the presented method of monitoring absences shows a high level of efficiency and can be used in schools because it is user friendly. We consider the module for calculating the risk of pollution one of the most successful because it provides accurate and reliable figures on the health risks of each student. The module for monitoring self-taking of antibiotics allows precise figures if properly implemented and it can serve for raising awareness about the harmful effects of antibiotics from the earliest age. The module for healthy diet and physical activity gives us an accurate picture of the life style and psycho-physical health of the targeted group participating in the experiment. We believe that the implementation of this module within educational institutions will contribute to competitiveness in pupils/students and, primarily, to the increase of their physical activity. Other modules are optional and subject to change. We believe that the implementation of this purposed model of a system consisting of 6 modules within a classroom can contribute to the improvement of the psycho-physical health of students by creating an overall picture and relevant health information that could not be obtained in any other way for such a great number of pupils/students. Mobile devices are more than 10 hours a day in the hands of young people, and it depends on us whether we will use this or not. This is a purposed model for utilizing the potential of mobile devices for monitoring pupils'/students' health directly through educational institutions. It is important to mention that the purposed prototype model we have developed is fully multiplatform oriented and it does not depend on the type of the mobile device or computer that is used. It is supported by all existing mobile and desktop platforms.

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