Internet of Things (IoT) Based Support System for Diabetic Learners in Saudi Arabian High Schools

Mona Alotaibi(✉) and Mike Joy(✉)

Department of Computer Science, University of Warwick, Coventry CV4 7AL, UK
{mona.alotaibi,m.s.joy}@warwick.ac.uk

Abstract. In this workshop position paper, we identify the importance of a proposed system to monitor and assess diabetic students using Internet of Things (IoT) technology and a decision support system. We survey the current studies on the application of IoT in the Saudi Arabian educational system and related work. The model of Unified Theory of Acceptance and Use of Technology will be used to specify the critical factors that affect the use of the system for diabetic students in Saudi Arabian high schools. Finally, our research is at the beginning phase, so future work will identify the academic issues of the diabetic students and factors that affect the system usage by using a mixed method approach. In addition, the proposed decision tree algorithm will be implemented and evaluated.

Keywords: UTAUT · Internet of Things · Decision support system · High schools · Diabetic students · Technology Acceptance

1 Introduction

Schools find it challenging to use the Internet of Things (IoT), which has the potential to dramatically change learning, teaching, and monitoring. The learning, management, and relationship processes between all those involved in education may benefit from the IoT, because the associated physical devices ensure that people are connected and active. Recently, the importance of IoT has been explicitly reported in the medical field, but implementing IoT in education, unlike in other fields, is extremely challenging. The IoT should ensure the creation of an environment that supports the acquisition of knowledge in a natural, novel, and effective manner such that it is consistent with learners' expectations.

The importance of a system for monitoring and assessing diabetic students is evident, since in Saudi Arabia many critical issues could be faced by diabetic students and teachers. First, students could experience severe health situations during their school day, such as fainting caused by diabetes [7]. Furthermore, in Saudi Arabian schools, teachers have faced dealing with such problems and assessing these students. Therefore, it will be a great achievement if, using IoT technology, they can be alerted to read abnormal vital signs using a decision support system prior to the occurrence of a situation that causes

A. I. Cristea and C. Troussas (Eds.): ITS 2021, LNCS 12677, pp. 131–135, 2021.
https://doi.org/10.1007/978-3-030-80421-3_16

hyperglycemia or hypoglycemia. Second, diabetic students experience difficulties in learning and demonstrating academic achievements more than non-diabetic learners [3]. They have problems with academic performance, participate less in social and dynamic activities, and are often less independent than non-diabetic students [6]. Another factor that can affect students' academic performance is irregular attendance. According to Holmes et al. [5], diabetic students demonstrate lower academic performance because they miss more days of school than their healthy peers.

Students' assessments traditionally depend on tests, assignments, and activity scores, and based on these scores, we measure their educational improvement; however, other factors, specifically for students with chronic diseases such as diabetes, are seldom considered.

Owing to the aforementioned issues and the lack of previous studies that address the issues of diabetic learners in classrooms, it would be more helpful if teachers and administration offices would be notified prior to the occurrence of crises such as hypoglycemia and hyperglycemia.

The proposed system is a new innovative smart environment to monitor and assess the achievements of diabetic students in Saudi Arabian schools. The targeted participants are teachers, administrators, and students with diabetes, the proposed system comprises IoT sensors to collect students' vital signs and all relevant information (concerning diabetes), to be wearable by a student either inside or outside the classroom. We will create an AI model, and we initially propose a decision tree (DT) algorithm because it is suitable for multiple decisions based on different situations. In the true negative case, the system will neglect these readings, but they will be saved for the future use and analysis. In terms of the false positive or false negative case, according to the precision percentage, an alert will be sent to users to check a student with a different color which indicates that there is a doubt. In the true positive case, an alert will be sent to teachers, healthcare providers in a school, and an administration office. The decision support system will enhance the assessment process by allowing teachers to visualize the students' attendance and scores.

2 Current Research on the Internet of Things in the Saudi Arabian Educational System and Related International Work

No previous study has been found that utilized IoT technology and sensors for diabetic students in the Saudi Arabian education system. Abed et al. [2] provided a study to examine the user acceptance toward IoT technology in Saudi Arabian universities and educational institutions using the Technology Acceptance Model (TAM). In addition, it demonstrated some of the practicalities of this technology and determined its potential for transition to IoT technology in the Saudi Arabian educational environments. This type of research targets helping and promoting Saudi Arabian educational institutions to utilize this technology. Using IoT at a university will assist teachers and students to improve communication, enhance the learning process, develop student experiences, and even save money (because IoT reduces the overuse of water and conditioning). The use of IoT technology on campus will improve classroom and campus environments, monitor safety and student health, and enhance student engagements.

Regarding the ease of use and the perceived usefulness, the researchers conclude that there is a strong consensus among the individuals on the future of the Internet in Saudi Arabia, and of the IoT in particular.

Owing to the lack of applications for ensuring the students' safety on school buses, Abbas et al. [1] proposed a safety sensor and tracking system for school buses in Saudi Arabia by utilizing GPS and passive infrared (PIR) sensors. The system allows the school to supervise the bus drivers and to follow up with the records of students' attendance. Furthermore, the efficient operation of the sensor and issuing of accurate alerts in the mobile application enables drivers to keep track of the students still in the bus. A total of 150 people used this system, and it was observed when evaluating the school bus safety tracking and sensor system that 65% of the users were satisfied.

Facchinetti et al. showed the importance of Continuous Glucose Monitoring (CGM) sensors in their application and how the real-time algorithms improve CGM sensors through decreasing the uncertainty and inexactitude and enhancing their ability to warn about decreasing or increasing blood glucose levels [4]. The smart CGM sensor includes a commercial CGM sensor that incorporates three real-time software units for noise reduction, improvement, and prediction, that was implemented on glucose control for the Dexcom SEVEN Plus monitor. They evaluated the execution of the CGM from data gathered at 2 experiments with 12 type 1 diabetic patients in each one. The results showed that the noise reduction unit improves the efficiency of the CGM series by an average of approximately 57%, the optimization module minimizes the absolute proportional difference from 15.1 to 10.3%, which raises the value pairs in the Clark error grid region A by 12.6%, and it could predict hyperglycemia and hypoglycemia events 14 min earlier.

3 The Unified Theory of Acceptance and Use of Technology Model (UTAUT)

The critical factors that affect the use of the system for diabetic students are based on a well-established theory of acceptance and use of technology, the Unified Theory of Acceptance and Use of Technology Model (UTAUT). The UTAUT model includes a total of four key constructs defined by [8] as follows.

- Performance expectancy (PE) is the level of individuals believing that using the system will benefit them in their job performances. It has a significant impact on adopting the use of the IoT and sensor based support systems. If users perceive that using the systems can improve their job performance, they are likely to be motivated to use the systems.
- Effort expectancy (EE) is the level of ease associated with the use of the system. Designing an easy to use system which meets users' requirements is likely to motivate using the system.
- Social influence (SI) is the level of individuals perceiving that important others believe they should use the new system. It is also described as the degree of social pressure from others to use the new system.
- Facilitating conditions (FC) represent the level of an individual believing that an organizational and technical infrastructure exists to support the use of the system, i.e., to what extent is the infrastructure available.

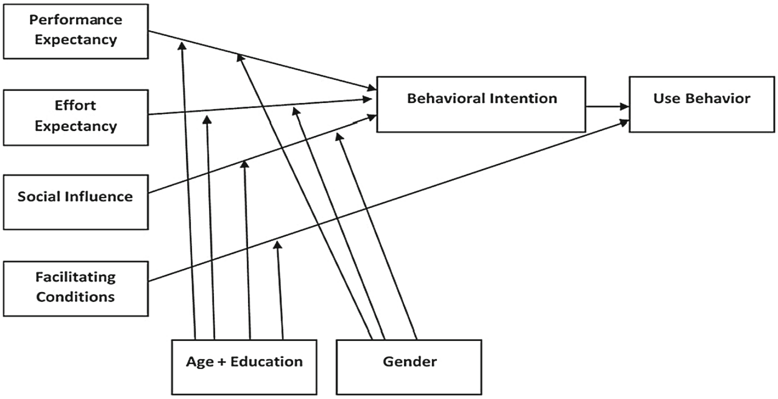

Fig. 1. Theoretical model

4 Future Work

4.1 Research Design

The research design is based on mixed methods comprising quantitative and qualitative research methods. The quantitative study will explore the diversity of specific behaviors or perceptions of adoption by diabetic students to assist in the educational process, by teachers, administration staff, and parents of diabetic children. In addition, it will explore the academic issues of diabetic students. In terms of the qualitative study, it will explore the perception of adoption of the system and the cognitive functioning issues from the viewpoint of diabetes specialists. This research is at the early stage, the proposed decision tree algorithm will be implemented and evaluated later.

5 Conclusion

The importance of the proposed system for monitoring and assessing diabetic learners was discussed, and examples of education related research on the IoT in Saudi Arabia and related work were presented. The UTAUT model will be used to investigate users' perception of the system adoption. Future work will involve the use of mixed-research methods to further develop and evaluate the system.

References

1. Abbas, S.A., Mohammed, H., Almalki, L., Hassan, M., Meccawy, M.: A safety tracking and sensoring system for school buses in Saudi Arabia. Period. Eng. Nat. Sci. **7**(2), 500–508 (2019)
2. Abed, S., Alyahya, N., Altameem, A.: IoT in education: its impacts and its future in saudi universities and educational environments. In: Luhach, A.K., Kosa, J.A., Poonia, R.C., Gao, X.-Z., Singh, D. (eds.) First International Conference on Sustainable Technologies for Computational Intelligence. AISC, vol. 1045, pp. 47–62. Springer, Singapore (2020). https://doi.org/10.1007/978-981-15-0029-9_5

3. Dahlquist, G., Källén, B.: Swedish childhood diabetes study group: school performance in children with type 1 diabetes—a population-based register study. Diabetologia **50**(5), 957–964(2007)
4. Facchinetti, A., et al.: Real-time improvement of continuous glucose monitoring accuracy: the smart sensor concept. Diabetes Care **36**(4), 793–800 (2013)
5. Holmes, C.S., Fox, M.A., Cant, M.C., Lampert, N.L., Greer, T.: Disease and demographic risk factors for disrupted cognitive functioning in children with insulin-dependent diabetes mellitus (IDDM). Sch. Psychol. Rev. **28**(2), 215–227 (1999)
6. Shiu, S.: Issues in the education of students with chronic illness. Int. J. Disabil. Dev. Educ. **48**(3), 269–281 (2001)
7. Varni, J.W., Curtis, B.H., Abetz, L.N., Lasch, K.E., Piault, E.C., Zeytoonjian, A.A.: Content validity of the PedsQL^{TM} 3.2 Diabetes Module in newly diagnosed patients with type 1 diabetes mellitus ages 8–45. Qual. Life Res. **22**(8), 2169–2181 (2012). https://doi.org/10.1007/s11136-012-0339-8
8. Venkatesh, V., Morris, M.G., Davis, G.B., Davis, F.D.: User acceptance of information technology: toward a unified view. MIS Q. **27**(3), 425–478 (2003)