Student real-time visualization system in classroom using RFID based on UTAUT model

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Abstract
Purpose – The purpose of this paper is to monitor in-class activities and the performance of the students.

Design/methodology/approach – A pilot study was conducted to evaluate the proposed system using a questionnaire with 132 participants (teachers and non-teachers) in a presentation style to record the participant’s perception about performance expectancy (PE), effort expectancy (EE), facilitating conditions (FC), usability expectancy (UE) and user’s satisfaction (S) based on unified theory of acceptance use of technology (UTAUT) model.

Findings – The results show that PE, EE, FC had positive and significant influence on the UE of the proposed system. The effect of EE and FC on UE was seen to be more in female compared to male participants. The teacher category considered the PE and EE as important factors in determining their decision to use the proposed system.

Originality/value – A real-time student(s) visualization system based on the concept of real-time student locating system using radio frequency identification technology is proposed. Concepts can be categorized within the Internet of Things in the education domain.

Keywords Computer software, Educational innovation, Computer applications, Interactive devices, Teaching aids

Paper type Research paper

1. Introduction
Teachers play a major role in enhancing the learning experience of the student. In this era of technological advancements, teacher-student relationship has been hugely facilitated by the usage of online teacher-student communication, student monitoring systems and student performance visualization tools. This technological dependency is helping the learning system to evolve rapidly. Effective teacher-student interaction plays an important role in promoting academic motivation and enhances student involvement in class (Roorda et al., 2011).

Present day research in education and learning is not using education as a primary element; instead, the focus is on facilitating students and teachers interaction (Fardoun et al., 2012) and student activity monitoring and visualization.

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Moving away from the conventional teaching methods including the traditional lecture-based teaching enhances teacher-student interaction. Although interactive learning (also known as active learning) is not yet a well-adopted teaching methodology around the globe, the concept of interactive learning is emerging as a new holistic paradigm. The active learning environment has shown positive influence on student’s performance and behaviour (e.g. Fardoun et al., 2012; Hew, 2011). Teacher-student interaction is the key to make the overall learning process better. In the present day active learning environment, teacher-student interaction is not limited to in-class communication only, but has jumped into an ubiquitous and context aware paradigm. In active learning environments, the teacher-student interaction is facilitated through various means, including social networking websites such as Googleplus, Twitter, Weibo and Facebook (e.g. Asterhan and Rosenberg, 2015; Hew, 2011). The usage of cloud-based communication services is also gaining momentum to be used for maintaining teacher-student interaction (e.g. Fardoun et al., 2012; Romero-zaldivar et al., 2012).

The teacher-student interaction, ubiquity of information and communication technology and student monitoring have been prompted as a successful combination to run an interactive learning system. Interactive visualization systems that enable student monitoring also help to enhance student performance and improve the learning outcome. Recent concepts such as Internet of Things (IoT) and cloud computing within the area of education has been explored by authors such as González-Martínez et al. (2015) and Botta et al. (2016). González-Martínez discussed on sensing, database, ethernet, policy management and multimedia as services important to support IoT while Botta et al. (2016) discussed on how assignments, experiments, environment application and prediction relates to the IoT issues in education in relation to cloud computing infrastructure, platform and software as a service. However, less study has been done on the perception or experience of students, teachers and the general public on adopting IoT and cloud computing to support the learning environment.

Literature has recently shown proposed systems that facilitate teacher-student interaction and help to monitor students for the performance and attendance assessment (e.g. Coffrin et al., 2014; Lodha et al., 2015; Zeng et al., 2015). Teacher intervention is required to monitor the student with low-level skills and to help the student accordingly. Monitoring student’s activities in a way strengthens teacher-student interaction and enables the instructor to effectively act based on the observed events. However, there is a clear deficit of a comprehensive system to date that not only facilitates teacher-student interaction, but also helps them to monitor student activities and records effortlessly. Therefore, in this paper, we aimed to close this knowledge gap by introducing a radio frequency identification (RFID) based student activity monitoring and visualization system. Our research serves as an exploratory study of the much hyped concept of IoT within the domain of education. The proposed system helps to find student’s involvement in the classroom by monitoring his position, provides the instructor or teacher with an opportunity to visualize student’s interests and helps the instructor or teacher and administration to maintain attendance records.

The main aim of our proposed system was to help the teacher monitor student’s activities and interests. The teacher can use this observed information to build better interaction with students and to rectify student’s interests and concentration, which eventually improved the learning outcome. The study was conducted within demonstration of real-time student(s) visualization system environment to record 132 teachers’ and non-teachers’ experience of using the proposed system through questionnaire. The teachers’ responses were recorded mainly in terms of their perception about performance expectancy (PE), effort expectancy (EE), facilitating conditions (FC) and usability expectancy (UE).

The paper is organized as follows. Section 2 shows the background of the topic. Section 3 presents the research methods. Section 4 demonstrates the results and discussion.
2. Background

2.1 Teacher-student interaction

The online environments such as interactive visualizations have been widely adopted in present day learning. Student-teacher interaction enhances the overall teaching and learning process by increasing understanding (Patwardhan and Murthy, 2015). Social media is playing its part in maintaining student-teacher interaction through a variety of social networks e.g. Facebook, Weibo, Twitter, etc. The use of social media has enhanced the student-teacher interaction and has transformed it from an in-class interaction to an ubiquitous interaction. Literature shows examples of enhancement in the learning process and teacher-student interaction by using Facebook, email and cloud-based communication services (Asterhan and Rosenberg, 2015; Bloch, 2002; Fardoun et al., 2012; Hew, 2011).

A recent research study shows that maintaining a close teacher-student interaction helps the students to be more goal-oriented, in particular when they are experiencing emotional problems (Thijs and Fleischmann, 2015). Hence, it shows that positive teacher-student interaction plays a vital role in influencing a student’s academic, social, behavioural and emotional development (Mcgrath and Bergen, 2015).

There is a growing need to explore the importance of teacher-student interaction and to study its effects on student involvement and performance in the class. The literature shows that various studies have been conducted to improve student’s involvement in the class. According to the Person-Environment fit theory, the student’s internal (self-efficiency) and external resources (teachers) affect his/her involvement and performance in the classroom (Eccles et al., 1991). This shows that the students with a low understanding level or skills (internal resources) rely on teacher’s interaction (external resources) to improve their learning outcome and interest in class. A quality teacher-student interaction is an example of an external resource that helps in student involvement in the class (Planta and Hamre, 2009; Rimm-Kaufman et al., 2009). Although, literature claims that a strong academic self-efficacy contributes to a better academic performance (Appleton et al., 2008) and academic effort (Sakiz et al., 2012). However, the presence of positive teacher-student interaction influences the overall behaviour of the student (Mcgrath and Bergen, 2015) and helps the students with low internal resources more than others with better internal resources (Malecki and Demaray, 2006).

The teacher-student interaction is conducive to better the students’ engagement in class and has a powerful influence on the learning environment (Wubbels and Brekelmans, 2005; Martin and Rimm-Kaufman, 2015). To attain a better student engagement in class, it is recommended to involve the students in-class discussions and class activities that eventually help to exhibit the interest and motivation to learn (Skinner and Belmont, 1993; Marks, 2000; Fredricks et al., 2004). Summarizing above, the literature states that teacher-student interaction plays a vital role to achieve better academic performance.

2.2 Student monitoring systems

Monitoring students’ activities, attendance and progress in close interactive environments affects the overall learning process. Literature shows that self-monitoring techniques are conducive in attaining productive behaviour in students with emotional and behavioural disorders (Menzies et al., 1998). The literature shows examples of certain student monitoring systems used to attain various purposes including attendance, interest and behaviour monitoring. For instance, an autonomous student attendance monitoring system was introduced at Budapest University of Technology and Economics using a Near-field Communication system to monitor student’s attendance in lectures (Doktor and Gergely, 2012). The study resulted in the identification of students who missed the lectures and became the reason for lowering the overall result of the semester. Similarly, a text message-based attendance monitoring system was introduced that resulted in an improved attendance of the student athletes (Bicard et al., 2012). The literature shows that several
modern technology based attendance monitoring systems have been introduced in the recent past. For instance, attendance monitoring systems using RFID (Hameed et al., 2015) and the Bluetooth smart technology (Lodha et al., 2015). The studies’ result stated that the proposed attendance monitoring system eliminates the time consumed in manual attendance and also helps to maintain an online record for further analysis and administrative tasks. Likewise, progress monitoring system using virtual appliances was introduced to enhance the overall student-teacher interaction and learning experience (Romero-zaldivar et al., 2012). Summarizing the above discussion, it can be seen that teacher-student interaction and student monitoring enhance the learning process and enable the students to perform better. However, there is a need to explore modern technology based student monitoring system to attain better performance and enhance the teacher-student interaction. Therefore, we aimed to fill this gap by introducing an RFID-based real-time student monitoring and visualization system focussed on teacher-student interaction and student monitoring in this study.

2.3 Student visualization systems
Interactive visualizations have been known to offer several benefits for both learner and instructor, including increased learners’ engagement (Kriz and Hegarty, 2007). In Shanabrook et al. (2012), low-state student behaviour was determined through the prediction of affective states of students. The authors stated that it helped the teachers to better respond to the students. A student data visualization tool named CourseVis was proposed in Mazza and Dimitrova (2004) which helped teachers to learn social, behavioural and cognitive aspects of distant learners. The tool made use of graphical representations of student tracking data and the instructors can identify their interests in classes and quickly identify individuals that need special attention. Virtual Interaction Mapping System was proposed by Jyothi (2011) for Moodle to support teachers and administrators to analyze interaction patterns and knowledge construction of the participants involved in ongoing online interactions.

The literature shows that student interaction and cooperation data are also studied using data mining techniques and web-based data visualization techniques, to help and guide students in a better way (Polaków and Metzger, 2009; Zeng et al., 2015). Likewise, visualization tools were also developed for students to monitor their own performance throughout the semester to examine themselves in comparison with other students (Hassan et al., 2012). In addition, patterns of student engagement were visualized in order to assess their performance and identify student type (Coffrin et al., 2014).

Summarizing the above, it can be seen that the student monitoring system and student performance and interaction visualization lead to better student performance and assessment of student’s behaviour that ultimately lead to better teacher-student relationship and guidance. This fact leads to the motivation for this paper in which we aimed to propose an RFID-based student activity monitoring and visualization system that enhances teacher-student interaction and positively affects their learning experience.

3. Research method
3.1 Participants
The participants involved in the study were from two different educational institutes. A total of 132 participants took part in this study, where 46 were from the Sultan Zainal Abidin University, Malaysia and 86 were from the Sultan Idris Education University, Malaysia. The sample consisted of 50 males and 76 females with an average age of 23.45 (SD = 6.42). In total, 13 responses were discarded because the participants did not respond to the questionnaire properly. The education levels of the participants were a minimum of 0.8 per cent (STPM and PT3) and a maximum of 57 per cent (degree). In all, 60 per cent participants had good computer skills and 33 per cent had moderate computer skills.
3.2 Research instrument
A questionnaire-based survey was used in this study to test the proposed theoretical model. The questionnaire comprised of two parts: the first part had 17 questions to measure the constructs in the research model from teachers/admins, and the second part had questions about the participants’ demographics. Each item corresponding to the constructs was measured using a five-point Likert scale, with answer choices from “1” = “strongly disagree” to “5” = “strongly agree”. The questionnaire items were adapted from the previous literature (Venkatesh et al., 2003). The details of the constructs used to measure acceptance variables (PE, EE, FC, UE, and satisfaction) were measured using the UTAUT model (Venkatesh et al., 2003) as shown in Table I.

3.3 Procedure
This study was conducted in two different public sector universities in Malaysia. First, we participated in the exhibition organized by both the universities. We managed to present this research as a research poster in a local conference to demonstrate the use of student real-time visualization system (SRTVS) to the participants of the exhibition. After the demonstration, we distributed the questionnaire among the participants to gather their opinion and viewpoint on the proposed system. This procedure was chosen to get insights about the system used in classroom from both teachers and non-teachers perspectives.

3.4 Materials
3.4.1 SRTVS. The SRTVS is the proposed system for learning environments specially designed for teachers to monitor the class activities of students. The SRTVS is used to enable teachers to monitor the students inside the classroom, assist the teacher in analyzing the student’s grades for the overall grade improvement, work as a data management system, allocate time slot and subject to teachers and assist teachers for the student’s attendance. The proposed system helps the teachers to view/update and edit the student’s profile, view/update the attendance list and view/update exam records. The SRTVS also facilitates the administrative staff to manage the data by organizing the user, classroom, student, and subject details. The system has an additional functionality to graphically represent the track record of students, which makes it easier for the teachers to

<table>
<thead>
<tr>
<th>Construct</th>
<th>Questionnaire items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance expectancy</td>
<td>I would find the SRTVS useful in my teaching</td>
</tr>
<tr>
<td></td>
<td>Using the student’s performance analysis provided by the SRTVS, I am able to improve</td>
</tr>
<tr>
<td></td>
<td>my teaching process</td>
</tr>
<tr>
<td></td>
<td>Using the SRTVS enables me to improve the overall student performance</td>
</tr>
<tr>
<td></td>
<td>Using the SRTVS assists me in taking the attendance of the students</td>
</tr>
<tr>
<td>Effort expectancy</td>
<td>My interaction with the SRTVS would be clear and understandable</td>
</tr>
<tr>
<td></td>
<td>It would be easy for me to teach using the SRTVS</td>
</tr>
<tr>
<td></td>
<td>Learning to operate the SRTVS would be easy for me</td>
</tr>
<tr>
<td>Facilitating conditions</td>
<td>I have the resources necessary to use the SRTVS</td>
</tr>
<tr>
<td></td>
<td>I have the knowledge necessary to use the SRTVS</td>
</tr>
<tr>
<td></td>
<td>Assistance is available with SRTVS difficulties</td>
</tr>
<tr>
<td>Usability expectancy</td>
<td>The user interface of SRTVS is suitable and attractive</td>
</tr>
<tr>
<td></td>
<td>The color chosen for SRTVS is suitable</td>
</tr>
<tr>
<td></td>
<td>The SRTVS looks easy to use</td>
</tr>
<tr>
<td></td>
<td>Errors in using the SRTV can be avoided through its interface</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>Using the SRTVS increases my teaching process more effectively</td>
</tr>
<tr>
<td></td>
<td>Using the SRTVS enables me to monitor the students in the classroom</td>
</tr>
<tr>
<td></td>
<td>Using the SRTVS is flexible</td>
</tr>
</tbody>
</table>

Table I. Constructs and scales
identify their interests in class and to point out individuals who need special attention at a glance. Figure 1 presents the graphical outlook of SRTVS.

The SRTVS is developed on the concept of real-time locating system using RFID technology. The system architecture consists of two tiers: client-side, and server-side. Client-side connects the users with the systems (such as desktop user), and the server-side manages the configured application software. The software used to develop this system is the Apache server; MySQL database and middleware used to connect the RFID with the hardware. With the support of the Apache server, the system used passive RFID tags to detect the objects (students) with the RFID tags. Passive RFID technology is based on radio frequency as the medium of sending and receiving signal between the transmitter (teachers) and receiver (students). Figure 2 presents the conceptual framework of SRTVS.

3.5 Research model and hypotheses

UTAUT is a unified theory of acceptance about the acceptance and use of a new technology and where eight essential model theories are combined (Venkatesh et al., 2003). According to the model, PE, EE, social influence and FC are the determining components of UE or satisfaction on the acceptance of the system; gender and category are the moderators whose impacts on the usage of system have been identified (see Figure 3). The proposed model consists of five hypotheses. UTAUT is used as an underlying theory for the proposed model (see Figure 3). According to the model, PE, EE and FC are the determining components (independent variables) of the UE (dependent variable) based on the user’s acceptance of the proposed system; gender and category are the moderators which are used to find out the impact of system usage. PE is the teachers/admins faith, that the use of the SRTVS will help them to monitor the students’ performance; EE is the teacher/admin user’s belief level about
the ease of use of the system; FC are the belief level of teacher/admin user that an organizational and technical infrastructure exists to support the use of the system. Dependent variables of the model are UE, which represents users’ intention to use SRTVS in the future, and their satisfaction with the use of the proposed system (SRTVS).

The literature has proven that UTAUT explains 70 per cent of the technology usage (Venkatesh et al., 2003). Therefore, the basic structure in UTAUT was applied as a useful tool by the researchers to evaluate the adaptation levels of various new and emerging technologies to estimate its perceived success probability or acceptance (Venkatesh et al., 2003). For instance, UTAUT has been used to investigate the user acceptance level
for the usage for diverse applications including computer-based student assessment system, tablet computers, mobile devices, web-based technologies and parent-teacher interaction, among others. Likewise, UTAUT has been extensively used to explore the usage of virtual or eLearning environments.

In this study, the proposed research model was used to investigate the determining factors and moderators, for the acceptance and use of SRTVS using UTAUT. The model consisted of five hypotheses, where all hypotheses were created according to the UTAUT structure:

\[ H1. \] The PE has a significant effect on UE.

\[ H2. \] The EE has a significant effect in UE.

\[ H3. \] The FC have a significant effect on UE.

\[ H4. \] The UE has a significant effect on user's satisfaction.

\[ H5. \] Gender and category will moderate the relationship between PE, EE, and FC on UE and satisfaction.

4. Results and discussion

In this study, the partial least squares approach was used to analyze the questionnaire data, because our sample size was small and the partial least squares approach is a well-suited approach for small samples, e.g. \( N = 20 \). In this paper, SmartPLS 2.0 was used to assess the measurement and structural models (Ringle et al., 2005).

4.1 Measurement model

The measurement model was evaluated using item loading, convergent validity and reliability of measures. An item was considered to be reliable if its loading value was greater than 0.60. The convergent validity was assessed by using average variance extracted (AVE), which must exceed a standard minimum level of 0.5 (Fornell and Larcker, 1981). Cronbach’s \( \alpha \) was used to assess the reliability of the measures. In general, the minimum acceptable value of Cronbach’s \( \alpha \) is 0.6 (Hair et al., 2006). The discriminant validity was assessed by using the square root of the AVE and latent variable correlations; the AVE of each construct should exceed the correlation shared between one construct and the other construct in the model (Fornell and Larcker, 1981). Tables II and III present the results of the measurement model within the acceptable range, since all the values had met the standard level.

4.2 Structural model

We verified the hypotheses by using path coefficients and \( R^2 \) value (Chin and Newsted, 1999) as used in the structural model. \( R^2 \) was used to assess the ability of the model to explain the variance among the dependent variables. The path coefficients were used to assess the statistical significance of the hypotheses. Figure 5 shows the results of the structural model. The model (Figure 4) shows 58.7 per cent of variance in UE and 61.5 per cent in satisfaction. Figure 5 also shows the path coefficient values of the variables. First, the path coefficient value calculated between PE and UE was 0.378, \( p < 0.05 \), which indicated that PE had a positive and significant influence on UE. Second, the path coefficient between EE and UE was 0.216, \( p < 0.05 \), which indicated that EE had a positive and significant influence on UE. Third, the path coefficient between FC and UE was 0.287, \( p < 0.05 \), which indicated that FC had a positive and significant influence on UE. Fourth, the path coefficient between UE and satisfaction was 0.784, \( p < 0.05 \), which indicated that UE had a positive and significant influence on satisfaction.
Table V shows that the path coefficient value calculated between PE and UE for male was 0.336, $p < 0.05$; and 0.421, $p < 0.05$ for female, the expectancy and UE was 0.309, $p < 0.05$ for male; and female was 0.209, $p < 0.05$; and 0.203, $p < 0.05$ for female, and the UE and satisfaction was 0.784, $p < 0.05$ for male and 0.800, $p < 0.05$ for female.

Table V also shows the path coefficient value calculated for the teacher category between PE and UE was 0.640, $p < 0.05$; and 0.295, $p < 0.05$ for the non-teacher category. The path
The path coefficient between EE and UE was 0.008, not significant for the teacher category; and the non-teacher category was 0.236, \( p < 0.05 \). The path coefficient FC and UE for the teacher category was 0.241, \( p < 0.05 \); and 0.385, \( p < 0.05 \) for the non-teacher category. The path coefficient of teacher category between UE and satisfaction was 0.818, \( p < 0.05 \); and the non-teacher category was 0.731, \( p < 0.05 \) (Table IV).

### 4.3 Hypothesis testing

To validate the proposed hypotheses and the structural model, the path coefficient between two latent variables was assessed. Based on previous studies, the path coefficient value needed to be at least 0.1 to account for a certain impact within the model (Hair et al., 2011; Wetzels et al., 2009). The assessment of the path coefficient showed that all proposed hypotheses were supported. From the analysis, the supported hypotheses were significant at least at the level of 0.05, had expected sign directions (i.e. positive) and consisted of a path coefficient value ranging from 0.203 to 0.800.

The findings of the original regression analysis table (\( t \)-value = 4.3851; \( p < 0.001 \)) in relation to \( H1 \) showed that PE had a significant effect on UE; thus, \( H1 \) was supported.

The findings of the original regression analysis table (\( t \)-value = 2.0442; \( p < 0.005 \)) in relation to \( H2 \) showed that EE had a significant effect on UE; thus, \( H2 \) was supported.

The findings of the original regression analysis table (\( t \)-value = 3.5593; \( p < 0.001 \)) in relation to \( H3 \) showed that FC had a significant effect on UE; thus, \( H3 \) was supported.

The findings of the original regression analysis table (\( t \)-value = 22.0412; \( p < 0.001 \)) in relation to \( H4 \) showed that UE had a significant effect on user’s satisfaction; thus, \( H4 \) was supported.

The findings of the original regression analysis table for the male and female genders in relation to \( H5 \) showed that PE had a significant effect on UE; EE had a significant effect on UE; FC had a significant effect on UE; and UE had a significant effect on user’s satisfaction (refer to Table V).

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Independent variable</th>
<th>Dependent variable</th>
<th>SD</th>
<th>SE</th>
<th>( t )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( H1 )</td>
<td>PE</td>
<td>UE</td>
<td>0.0862</td>
<td>0.0862</td>
<td>4.3851</td>
</tr>
<tr>
<td>( H2 )</td>
<td>EE</td>
<td>UE</td>
<td>0.1056</td>
<td>0.1056</td>
<td>2.0442</td>
</tr>
<tr>
<td>( H3 )</td>
<td>FC</td>
<td>UE</td>
<td>0.0808</td>
<td>0.0808</td>
<td>3.5593</td>
</tr>
<tr>
<td>( H4 )</td>
<td>UE</td>
<td>S</td>
<td>0.0356</td>
<td>0.0356</td>
<td>22.0412</td>
</tr>
</tbody>
</table>

Table IV. Results of regression analysis table

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![Diagram](https://via.placeholder.com/150)

**Figure 5.** Factors influencing user’s satisfaction: resulting model.
The findings of the original regression analysis table for the teacher and non-teacher categories in relation to $H5$ showed that PE had a significant effect on UE; FC had a significant effect on UE; and UE had a significant effect on users’ satisfaction. However, the teacher category showed that EE had no significant effect on UE ($t$-value = 0.0545; not significant), while the non-teacher category showed that EE had a significant effect on UE ($t$-value = 2.5543, $p < 0.005$). Thus, $H5$ was supported.

4.4 Discussion

We aimed to study the teachers’ experience of using the proposed system in terms of their perception about PE, EE, FC and usability based on the UTAUT model. The results showed that the variables were relevant in determining that the proposed system was suitable for usage.

The results showed that the PE, EE and FC had a positive and significant influence on the UE of the proposed system. Likewise, the results approved of the fact that the UE had a positive and significant influence on the satisfaction level of the users, which in our case were the teachers and administration staff. This meant that the users found the system conducive in enhancing their experience in monitoring the students’ performance and attendance, and found it easy to use with enough support material available. This echoed the results obtained from the recent studies conducted to monitor students’ attendance in class through RFID (Hameed et al., 2015) and Bluetooth technology (Lodha et al., 2015). In addition, the ease of use and attractive features of the proposed system enhanced the satisfaction level of the users.

The results obtained for the variable dependency calculated for study moderators (i.e. gender and category) showed that the effect of PE on UE and the effect of UE on satisfaction were more for males as compared to the female participants. However, the effect of EE and FC on UE was calculated to be more in female participants. This showed that the female participants considered the proposed software suitable for use because it was clear and understandable, easy to operate, and had all the necessary assistance available in it. However, the male participants considered that the performance aspects including the proposed system’s effectiveness in monitoring the students’ performance and attendance in class, helped to conduct the teaching process effectively, and improved the students’ performance as the main factor to determine its usage.
The results also showed that the non-teacher category did not consider PE as an important factor in determining the usage of the proposed system. However, the teacher category gave a prime importance to the PE and EE factors in determining their decision to use the proposed system. This restated the fact that teachers considered online visualization systems conducive to perform their job better in guiding the students (Polaków and Metzger, 2009; Zeng et al., 2015). The availability of support material and assistance was given equal importance from both the teacher and non-teacher categories’ participants in determining the usability of the proposed system. The UE of the proposed system including its ease of use and attractiveness played the part equally for both of the categories in determining their satisfaction level. This reiterated the results obtained from the virtual interaction system proposed to support teachers and administrators in ongoing online interactions (Jyothi, 2011).

5. Conclusion
To explore the in-class activities and performance of students, RFID-based real-time student visualization was proposed in this paper. The UTAUT model was applied to construct the research model, and partial least squares was used to assess the model. The results revealed that the SRTVS system was well-received among the teachers and the administration staff in determining the students’ activities and performance in the classroom. The results further showed that the teacher category participants were more concerned about the PE and EE in determining their usage expectancy of the proposed system. However, both of the participant categories considered that support material, attractiveness and ease of use were equally important in determining their usability and satisfaction.

Three practical implications drawn from this study can be the stepping stones for the instructional tool vendors and teachers. First, the results indicated that teacher participants were more about performance and EE as compared to the administration participants. This implied that the teachers and non-teachers category participants had different requirements for an online monitoring and visualization tool, especially in the case when both of the users determined the UE of such software. Accordingly, the instructional tool vendors may construct the instructional software according to the types of users. Second, in this work, RFID-based student monitoring and visualization system was found useful by the teachers to perform their job better by identifying weak and low performing students. This implied that such online monitoring and visualization system can be used as a method to motivate the students to improve their learning experience and skills by helping the teachers to identify the weak students and to help them progress. Third, the proposed RFID-based student monitoring and visualization system was accepted by the teachers and administration staff. Likewise, this system can also be extended to let the students visualize and monitor their own in-class performance in comparison with the other students.

Limitations of this study included less moderating factors, the type of the measurements, and the relatively small sample size. In this study, more moderating factors like user’s experience and background knowledge of online learning software can also be included to give a diverse estimate of the user’s satisfaction level. The measurements of this study were limited in the students’ self-reported perceptions. In the future work, we will introduce additional measurements to explore the effects of the proposed system on students’ performance and learning skills. Moreover, increasing the sample size will help to obtain stronger results that will easily be generalized because at present, our limited small sample size might amputate the power to generalize the results of this study.
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