USING QR-CODES IN TEACHING ELECTRONICS – AN APPROACH TO INCREASE STUDENTS MOTIVATION

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Abstract
The main objective of this paper is to present our experience of using QR codes in teaching electronics in engineering higher education. QR codes, placed on the appropriate breadboard or apparatus in the Electronics laboratory, are used to access short videos concerning the topic of the laboratory exercise. The size of the videos assures acceptable download time, making them compatible for use with smartphones and tablets. The QR codes enable students to watch the multimedia material several times, which allows them to follow their own learning pace. The new approach was used in 2017/2018 academic year, with 40 first year students. To compare the motivational impact of using QR codes, laboratory exercises were taught using two different learning scenarios – traditional learning environment (control group) and leaning environment that incorporates QR codes (experimental group). At the end of the course, all participants were handed IMMS questionnaire to collect quantitative data. Only the students from the experimental group were asked to complete a questionnaire that gathers information about students’ attitude toward using of QR codes and mobile devices in education. In this paper we present the results obtained from both quantitative and qualitative data which show the significant impact on the students’ motivation that have the incorporated QR codes in teaching process. In this article, we present the results obtained from both quantitative and qualitative data, which show the significant impact on students’ motivation that have the incorporated QR codes in teaching process.

Keywords: QR codes, teaching, electronics, students motivation.

1 INTRODUCTION

Motivation is a crucial prerequisite for successful and effective learning. One way to improve students’ motivation is to integrate innovative electronic technologies in learning. Such technologies are mobile technologies and QR codes [1].

The QR (Quick Response) code is a 2D matrix code that has many advantages over a conventional barcode: high data storage capacity, fast scanning, omnidirectional readability, error-correction, etc. The popularity of the QR code grows rapidly with the growth of smartphone users and thus the QR code is rapidly arriving at high levels of acceptance worldwide [2]. There are many studies concerning the effectiveness of QR codes in education. The results show that they can improve the learning process by providing opportunities to [3]:

- Retrieve contextual or location-aware information;
- Support just-in-time and collaborative learning;
- Connect digital resources to printed text;
- Increase students’ motivation;
- Enrich students’ learning experience and provide them with authentic tasks that take place in real-world settings;
- Learn in a personalized, situated and authentic way.

2 METHODOLOGY

Electronics is one of the most important professional basic courses in engineering education and different strategies are used to stimulate students’ interest in this subject [4], [5], [6], [7]. This study was conducted to explore the impact of using QR codes in teaching electronics in engineering higher education [8]. The course is taught during the first semester of the academic year 2017-2018. 40 first year students were divided into two groups: control group (20 students), where laboratory exercises
were taught in a traditional learning environment and experimental group (20 students), where laboratory exercises incorporated QR codes. The use of learning methods was done within seven weeks, which is the half length of the semester. The selected topics, the same for both groups, were as follows:

- Calculation and Examination of Real Op-Amp Frequency Response;
- Calculation and Measuring of Practical Op-Amps Parameters I;
- Calculation and Measuring of Practical Op-Amps Parameters II;
- Calculation and Examination of Noninverting Practical Op-Amp Circuits;
- Calculation and Examination of Inverting Practical Op-Amp Circuits;
- Design and Analyze of Multiple-Input Amplifiers and Differencing Amplifier;
- Design of Amplifiers Using Multiple Op-Amps.

For the purposes of training with QR codes, seven short videos (one for each of the above-mentioned topics) were prepared, in which the teacher explains the methodology of the exercise. For each video a QR code is created and just before the class it is placed next to the appropriate breadboard or apparatus in the Electronics laboratory. By scanning the QR codes with their smartphones, students have access to practical guides needed to complete the assigned tasks. Students work alone or in groups while the teacher acts as a facilitator by providing consultation and help only if needed.

The traditional method includes the use of scientific texts and 2D images from specially prepared learning materials concerning the methodology of the exercise. The students worked individually or in groups. The teacher provides support only if needed.

Our hypothesis is that the using of QR codes will improve the students' motivation in Electronics. To evaluate students' motivation in both groups, the Instructional Material Motivation Survey (IMMS) was used at the end of the experiment. The IMMS is a motivational assessment tool based on the ARCS model defined by Keller [9]. This approach is widely applicable in technology-enhanced as well in traditional learning environment [10]. According to the ARCS model four major categories (attention, relevance, confidence, satisfaction) influence a student's motivation to learn [9], [11]:

- Attention - aims to capture the interest of learners, to stimulate their curiosity to learn;
- Relevance - refers to meeting learners' needs and goals to stimulate positive attitude;
- Confidence - centres on establishing positive expectations for achieving success in learning;
- Satisfaction - refers to reinforcing accomplishments with internal and external rewards.

The IMMS questionnaire consists of 36 items and 4 subscales: attention (12 items), relevance (9 items), confidence (9 items) and satisfaction (6 items). The students assess each statement in the questionnaire according to a 5-point Likert scale: 1– not true; 2– slightly true; 3– moderately true; 4– mostly true; and 5– very true.

The collected data are analysed using SPSS (version 17.0). Comparison between two groups is performed using independent t-test. The significance level is 5%.

3 RESULTS

3.1 Results from the IMMS questionnaire

Table 1 presents the results obtained from the IMMS questionnaire.

<table>
<thead>
<tr>
<th>Motivation dimension</th>
<th>Mean Control group (N=20)</th>
<th>Mean Experimental group (N=20)</th>
<th>SD Control group (N=20)</th>
<th>SD Experimental group (N=20)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention</td>
<td>3.025</td>
<td>3.983</td>
<td>0.506</td>
<td>0.412</td>
<td>.000</td>
</tr>
<tr>
<td>Relevance</td>
<td>3.211</td>
<td>4.117</td>
<td>0.238</td>
<td>0.229</td>
<td>.000</td>
</tr>
<tr>
<td>Confidence</td>
<td>3.194</td>
<td>4.072</td>
<td>0.357</td>
<td>0.175</td>
<td>.000</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>3.175</td>
<td>4.058</td>
<td>0.082</td>
<td>0.193</td>
<td>.000</td>
</tr>
</tbody>
</table>
The performed t-test states that learners from the experimental group are more motivated than the students in the control group – there is significant difference in the mean values of all motivation components (p<0.05). Students think that QR codes stimulate their interest (Attention component), enhance their satisfaction, they are more confident in successfully engaging with the learning activities (Confidence). Further more they think that laboratory exercises enhanced by QR codes are more relevant to their own needs and goals (Relevance). These results give us reason to claim that the hypothesis of this study is confirmed.

3.2 Results from the students’ questionnaire

At the end of the experiment only the students from the experimental group were asked to complete a questionnaire that gathers information about their attitude toward using of QR codes and mobile devices in education. All questions are open-ended. From 20 students only 11 filled the questionnaire.

To the first question “Did you encounter any difficulties in working with QR codes?” 90.9% give negative answer. Only one student answers that “sometimes the internet connection was bad, and it was impossible to download the video”.

All students are confident that they support the use of mobile devices and QR codes as a learning tool. The most common positive answers are: “Yes, lessons were more interesting”, “I wasn’t bored”, “these were the most attractive lessons I have ever had”. Some students indicate that mobile devices improved their learning: “I worked more concentrated and fast”, “QR codes are easy and convenient tool for providing information”.

To the third question “Did the developed videos helped you to do the laboratory exercises?” all student answer “Yes”, because: “they were detailed”, “the explanations were clear”, “I understood everything”, “they were not only informative but also amusing”.

90.9% of students unanimously agree on the opinion that the use of QR codes improved their motivation in learning. The most common positive answers are: “Yes, because it was more interesting”, “QR codes give me opportunity to work without teacher’s help”, “if you have missed something you can see it again”, “I felt more confident doing my laboratory exercises”. There is only one student who answers negatively to this question because ”sometimes I felt tired after watching the video on the phone”.

To the fifth question ”Would you like the QR codes to be used in other learning subjects?” all students answered “Yes”, because: ”the lessons were more interesting ”, “I was able to watch all videos at home”, “it is easier to remember and if you have missed something you can see it again”, “Yes, although I prefer to watch the videos on a computer”.

4 CONCLUSIONS

The use of QR codes can be considered as an effective strategy for improving students’ motivation in learning electronics. The results from our research confirmed the findings from the preliminary study that QR codes can stimulate students’ interest in the learning material, enhance their satisfaction from learning and establish a positive expectation for personal success.

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