Engaging the Net Generation Students in Enhanced Teaching and Learning with QTvity: The Next Steps

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Abstract: *In this paper we analyze an easy-to-use and non-expensive educational mobile application called QTvity from the viewpoint of its scalability and its potential to be used in different educational settings. The tool allows the lecturer to interactively display questions on students' mobile devices during the lecture and to project the answers on the screen, enabling immediate feedback and providing guidelines for discussion needed to improve students' understanding of the topics to be learned. QTvity has already proved to have a very positive effect on the quality of educational process in small groups. To use it effectively in larger classes, originally implemented presentations of answers are not sufficient. To overcome this problem, aggregations of answers and their suitable visualizations, such as word cloud, descriptive statistics and histograms were suggested. In addition to this, new suggested features include anonymity of answers for public discussion, evaluation of student self-studying during the semester and introduction of differentiated rewards for the answers according to their contents. Thus the new version of the tool will be considerably more universal and will be able to contribute to better teaching and learning of the Net Generation in a greater variety of educational environments.*

Key words: *Educational software, student-teacher interaction, mobile devices*

INTRODUCTION

The area of teaching and learning, both in theory and practice, has motivated vast amount of research in the last decades. The importance of the field is demonstrated also in the European directive [4], as well as by many international research projects and journal and conference papers. Moreover, in a report about the state of higher education in informatics in Europe [8] they emphasize the importance of improving the quality of teaching as a key enabler of the prosperous future in Europe. Among the most noticeable directions for future research several authors have identified the role of changes in the properties of generations of students [e.g. 1, 7, 11], where they specifically focus on the discrepancy between the expectations and abilities of the Net generation, also popularly called Digital Native generation, and the reality in our schools.

In the paper published last year [2] we presented an approach to using mobile devices to engage students' collaboration during lectures. The described evaluation covered mainly students' perspective of using the system; the lecturer's perspective was partially discussed in the lessons learned section; however, it mainly addressed the view of the engaging teacher in the classroom. The indicated impressions and observations were, therefore, bound to be limited and subjective.

This year a professor from a European university visited University of Nova Gorica under Erasmus Mundus programme of academic mobility. She actively participated in "Business information systems" course with the main intention to obtain experience with applying QTvity (pronunciation kyoo-tee-vi-tee) [2]. She provided valuable feedback through her evaluation from the observing lecturer's perspective. This resulted in several ideas for further enhancement of the QTvity tool, as presented in this paper. First, we give an overview of related work. Then we describe a common QTvity use case in the classroom, followed by a short evaluation on an enlarged group of students. In the main section we present the observing lecturer's evaluation together with her suggestions for further improvements that we elaborated and included into the plan for the expansion of the QTvity's functionality. We conclude by summarizing the most important findings and present some ideas for future work.

RELATED WORK

Engaging students in meaningful interactive tasks has been recognized as one of the key elements of successful teaching and learning by Kearsley and Shneiderman [5]. Being

related to student-centered and active learning approach, their engagement theory is still very relevant and after almost two decades, still offers valuable suggestions for improved teaching and learning effectiveness [12]. Although the principles of increased motivation through collaborative, project-based and authentic learning are important also in classical learning environments, they are carefully studied in the context of technology-based teaching and learning, including on-line learning [6, 9], where lack of concentration due to many potential distractive factors is a significant limiting factor for learners' success.

Similarly, students all too often lose their concentration and use their mobile phones during the lectures in class. To solve this problem in a constructive way, these devices are being turned from a distraction into a useful educational tool in combination with systems such as e.g. TXT-2-LRN, enabling the teacher to receive student's SMS messages and view them on the computer screen during the lecture [10]. An interesting discussion about the usage of mobile devices among students can be found in Denoyelles [3], with a clear suggestion that these devices could be used to a much higher extent to support students' learning.

In [2] the authors presented QTvity, a mobile application developed to support interactive communication between the teacher and the students in class, collecting answers to a teacher's question as sent by students from their mobile phones and presenting the answers immediately. This serves as a prompt feed-back about the level of comprehension to the teacher, as well as a trigger for discussion, in which issues not sufficiently clear are explained in more detail. Besides describing functional requirements and architecture of the system, the abovementioned paper presents also the evaluation of the system from the students' perspective, reports about lessons learned and reveals some directions in which improvements would be welcome, some of them being related to the functionality of the tool, and some of them to its use in educational practice. One of them is the problem of efficiency, reflecting in the fact that approximately 20 % less contents was covered in class when QTvity was used. In this paper we complement these results with an observing teacher's view and present concrete ideas how to improve acceptability, scalability and efficiency of the tool and its use.

QTvity USE CASE SCENARIO

The aim of QTvity is to support and motivate students' engagement in answering lecturer's questions during lectures [2]. The lecturer prepares several short questions before the lecture, activates a single question at a suitable moment during the lecture, waits for the students to answer the question and then displays the submitted answers. Then, in a discussion that follows in the class, both the lecturer and students comment and explain the topics addressed in the answers.

The overview of the QTvity's architecture is shown in Figure 1. The application is implemented using server-based web technologies. To achieve the intended functionality it requires existing classroom devices such as computer and overhead projector; besides, the participating students use their mobile devices to prepare and submit their answers.

In its present from, QTvity allows the students to type their answers in a single edit field. The length of students' answers varies from one character (when selecting an option from the list) to several sentences (when the question requires more elaborate answers). The average length of students answers in the Business information systems course conducted in 2015/2016 academic year was 63,5 characters; the longest answer from the same course was 402 characters long. One potential consequence of such long answers is that, especially in a big class, it is impossible for a teacher to have a good overview over the list of answers if they are not aggregated.

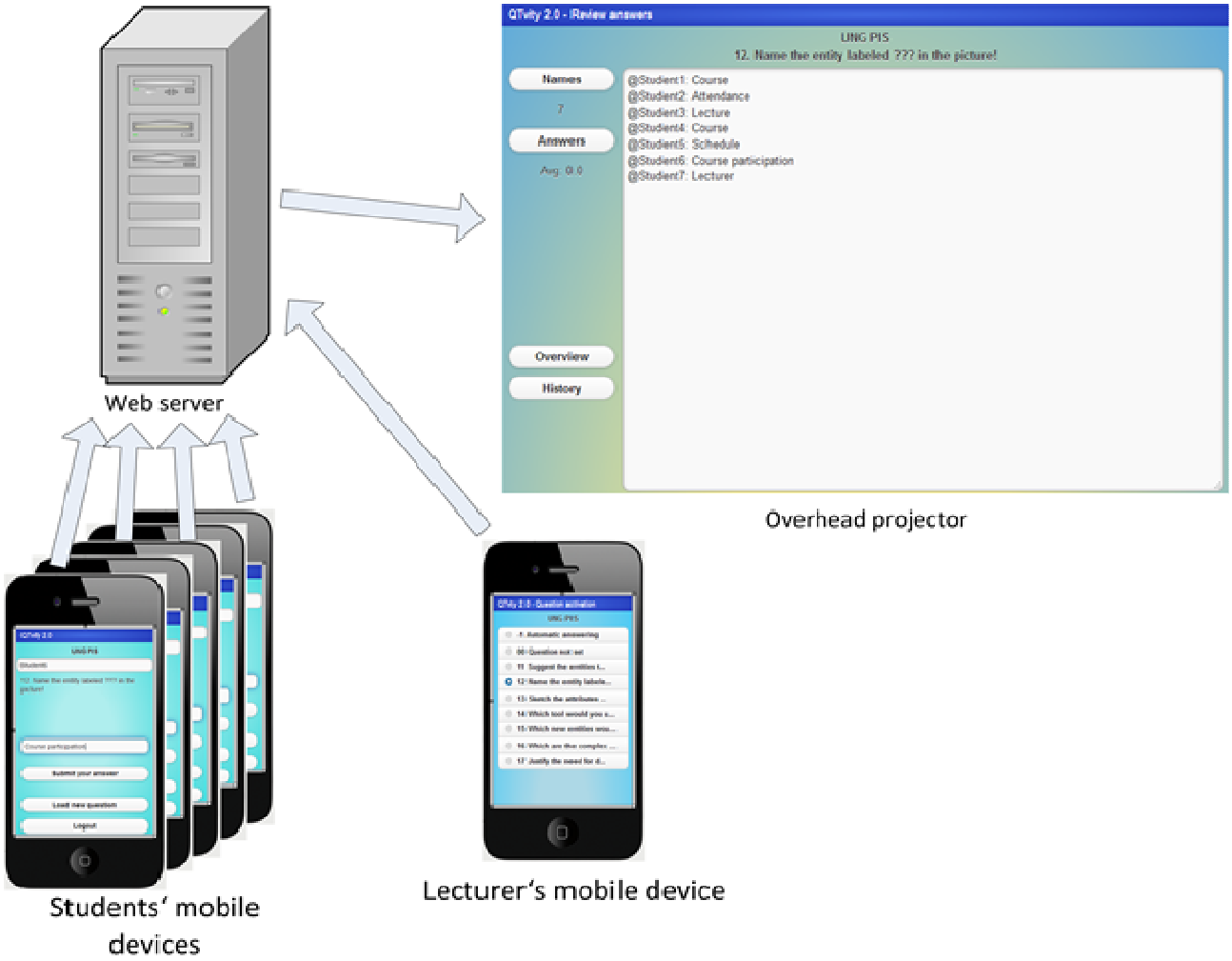

Figure 1: The architecture and information flow of QTvity [2]

In the study years 2014/15 and 2015/16 QTvity has been used in five graduate courses in the field of business information systems led by two professors at the School of Engineering and Management of the University of Nova Gorica and three other Slovenian faculties, European Faculty of Law, Gea College, and Jožef Stefan International Postgraduate School. In [2] we presented the results of the questionnaire for students' systematic feedback and evaluation of QTvity that included responses from 32 students. This year, we extended the evaluation and included in total 64 students from all institutions. The questionnaire [2] consisted of three parts: general questions about students' evaluation of QTvity, open questions that allowed the students to express their opinion and suggestions, and verification questions, where the students were asked to state their agreement or disagreement with given statements by grading them from 1 to 5 (1-strongly disagree, 2-disagree, 3-neutral, 4-agree, 5-strongly agree).

The results obtained from the enlarged population of students are in high accordance with the last year's results. For over 90 % of the students the use of QTvity during lectures remarkably improves the quality of the teaching process. The same majority of students stated that they would like to use it more often or regularly, and also during other courses in the curriculum. It comes as no surprise that most students regularly use their mobile devices to access internet applications and e-services (4.3 ± 0.7). They use them also during the lectures, however considerably less (3.0 ± 1.2) than outside the classroom. During the lectures supported with QTvity, which helps them more actively express their opinion (4.0 ± 0.8), they use them less for other distracting purposes (3.7 ± 1.1). Anonymity of the answers remained an important issue. Even though the percentage of students that have had no problem with their identity being revealed during the Q&A

review and discussion remained at 84 %, considerable 16 % stated that they would prefer anonymity of their answers.

There is, however, one difference between the results obtained in the last year's study and the newly acquired results. By enlarging the sample size to 64 students the gender differences between responses, identified in the previous study, became insignificant.

EVALUATION OF QTvity AND GUIDELINES FOR FURTHER IMPROVEMENTS

Traditional lectures can be described as a passive form of learning, where the teacher is the main protagonist, while the students play the role of passive audience. This form of teaching gives the opportunity to present a relatively greater amount of educational material in the limited time. However, the effectiveness of such approach depends on many factors, such as motivation of students, the attractiveness of topic and others. Later, in the framework of self-study, students may have questions about the material that they will have to ask the teacher in the following, possibly even during the next lecture. Thus, the interaction between the lecturer and student is performed in an asynchronous mode, which can also reduce the effectiveness of the educational process.

Various forms of activating the role of students may improve the efficiency of learning. They include polls, discussions, games, and others. QTvity is a tool that implements the ability to activate students belonging to the Net Generation in a natural way. This application supports the students and the teacher in three ways. First, it enhances the role of the student in the lectures, transforming a lecture from a passive form of learning into an interactive form. Second, it synchronizes (at least partially) the teaching process with the process of learning and development of comprehension. And third, it provides prompt students' feedback to the teacher, enabling the teacher to take into account immediately what has to be further explained. All of the listed functional tasks can be successfully performed with QTvity, as it has been proven in five university-level courses in the field of business information systems on four Slovenian faculties led by two professors during the last two academic years.

One of the important tasks of increasing the effectiveness of the educational process is to motivate students to work independently on the ongoing study material during the semester. Regular learning without discontinuities can reduce the volume of the material that should be studied at the end of the session and can decrease the level of stress before and during the exam. In the current implementation of QTvity, all students receive an equal score for giving the answer to the questions. The functionality could be extended to allow one or more questions with a differentiated assessment (e.g., test question or computing), which will affect the overall assessment of the exam. Such questions could be given at the beginning of each lecture (except for the first lecture). Being related to the contents of the previous lecture, they would additionally motivate the students and would encourage more desirable, regular study patterns.

The next factor to be taken into account in expanding the functionality is more related to the psychological characteristics of the educational process. In particular, some students may be quite reluctant to openly discuss their responses, especially if their answers are incorrect. For these students, open presentation of their responses may be stressful, and may consequently lead to a decrease in motivation and attendance. The most obvious solution for this issue is the anonymization of all responses for the sake of public discussion. In the current implementation of QTvity, anonymity is the attribute of a question as a whole and cannot be attributed to the answer given by a particular student. By giving the students the possibility to submit an anonymous answer at their own will, which will in turn display only the content of the answer without specifying the name of the student, the student's stress might be substantially alleviated.

The practical use of QTvity has already started taking place in several European universities with small groups of students. Upon extending the use to a broader level we

have to take into account that in some cases there will be substantially more students present at the university lectures. In some cases the number of students can even reach 200, which makes it impossible to discuss the entire set of responses to each question during the lecture sessions.

As a first idea how to solve this intriguing issue we considered the use of a random selection of 10-15 responses for the overhead display. This would be easy to implement and would function also for big groups. However, we decided not to choose this option, since a random sample of the responses can lead to a distorted representation. It can occasionally result in a set of mostly wrong or mostly correct answers. In both cases the resulting conclusions and guidelines would not be appropriate. In addition, some points interesting for discussion may be lost.

As an alternative approach we propose preliminary aggregation of students' responses where the system selects the most suitable method according to expected forms of the responses, goals of the activity and some predefined heuristics. The following three options are offered:

1. ***Word cloud***. This option can be used when students' answers contain lists of candidates (names, labels, words, etc.) for describing a particular object or concept. The goal of the activity is to prepare students for the perception of a new topic. For quality feedbacks and discussion the teacher needs to receive some text interpretation of knowledge or opinions of students. This can be based on Text Mining methods and implemented as a frequency word cloud, as shown in Figure 2, where the task was to list the attributes that describe the *patient* entity. Note that in this option the answers are anonymized in the process of aggregation and is, therefore, highly suitable for "crowd-sourcing" and "brain-storming".

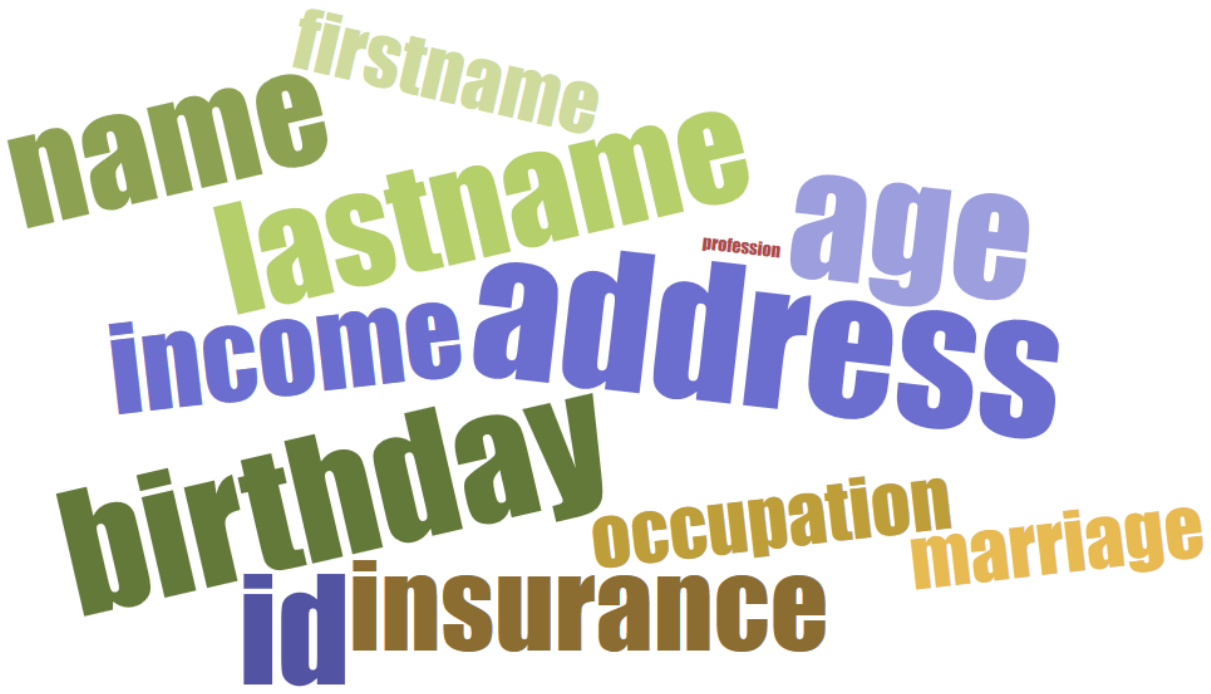

Figure 2: Aggregation of the QTvity's answers in the form of a frequency word cloud

2. ***Box-plot***. When a form of response is a number, aggregation in terms of statistical properties (e.g. mean, standard deviation, median) can be displayed. The purpose of the activity may be checking comprehension and memorizing of the presented material, qualitative assessment of the proposed judgment (1-strongly disagree, 2-disagree, 3-neutral, 4-agree, 5-strongly agree), etc. Aggregation of responses can

use descriptive statistics and different visualizations, e.g. a diagram box-plot as in Figure 3, which gives the aggregation of the answers to the following question: "Select a number between 0 and 100. The answer that is the closest to 2/3 of the average wins the prize". This representation enables discussing the opinion of the majority (the mode, median, and mean) and other important values (the minimum, maximum, and outliers).

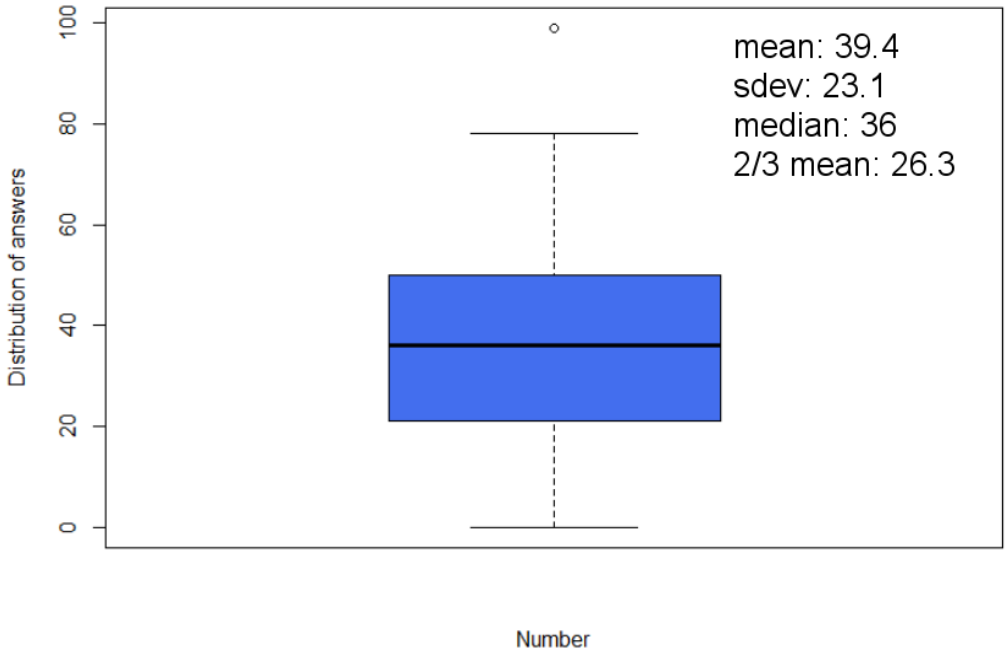

Figure 3: Visualization of the QTvity's answers in the form of a box-plot

3. ***Bar chart***. When students are required to submit their answers to a single-choice question, their answers can be aggregated and displayed as a bar chart. The goal of the activity is to check the understanding of presented course material. As shown in Figure 4, frequency distribution of the responses and its visualization allows the teacher to adjust the presentation according to the more specific goals of the discussion, as well as identifying potential sources of misunderstandings of the subject topics.

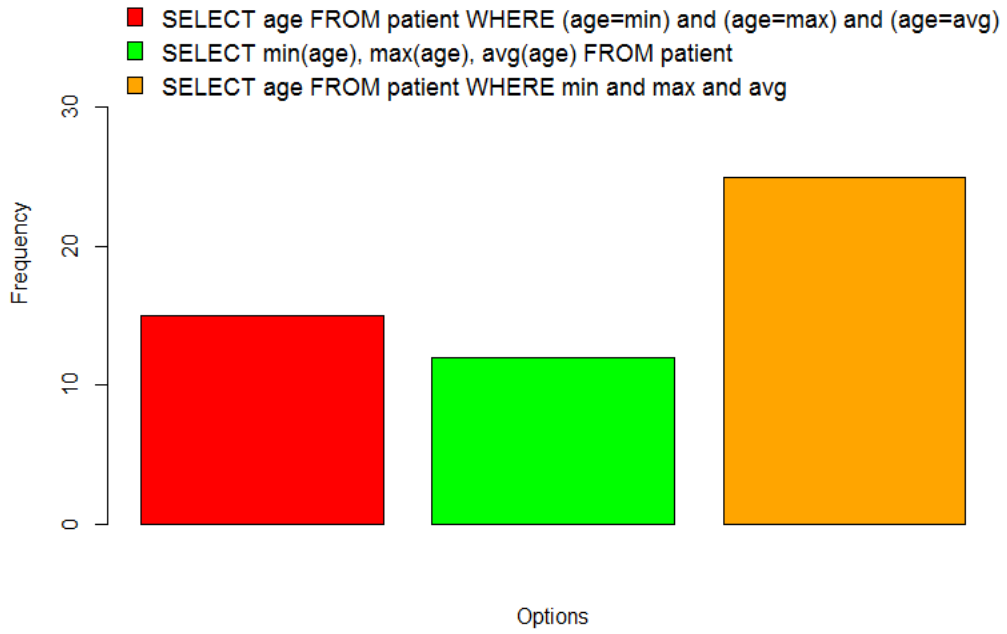

Figure 4: Visualization of the QTvity's answers in the form of a bar chart

CONCLUSIONS AND FUTURE WORK

QTvity can be used in teaching process to actively support students' engagement in lectures. In the last two academic years, the application was used in five university-level courses by two teachers. The results of students' survey have shown that QTvity can profoundly improve the quality of communication between the students and the lecturer [2]. This has also been confirmed by the teachers that are using the system. In this paper we complement these results with an additional, observing lecturer's perspective that has been used to plan further improvements of QTvity. While the tool already allows for an easy extensibility and scalability in technical terms, the improvements described in this paper were planned to better meet the educational requirements in new, potentially very different educational settings, especially in terms of the number of students. Aggregations of responses of different types, as well as new visualization possibilities might become a very important issue, not only by making the usage of the tool possible in large classes, but also by providing better support to teachers that might more efficiently use the time in class, concentrating immediately to the core issues needed to be discussed with students, without first scanning the list of responses and loosing time for on-the-spot analyses and decision making, how to lead the discussion.

In the next academic year, we will test QTvity with larger groups of students and different educational settings, such as teaching without QTvity, using QTvity in its original form and using QTvity with differentiated assessments. In the planned comparative study we will analyze the attendance of students, students' involvement in discussion at the lecture, the volume of the material presented during the lectures and the qualitative progress of students during the interim monitoring and final examination.

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The paper has been reviewed.