

## MOBILE QUIZZES IN MATH

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**Summary:** The paper presents new possibilities for learning offered by the use of mobile quizzes in mathematics. We present quizzes created with the *MobileQuiz2* application of the University of Mannheim. The main difficulty to overcome was writing mathematical texts and implementing interactive math applets. The applets illustrate particular issues and enable the students to interact with the course content more deeply than simple listening. The combination of interactive math applets and mobile quiz can then be used during the lectures as well as learning quizzes with hints. These are invaluable before a test or exam. The mobile quizzes can directly be enriched with equations, interactive formulas or drawings. When used in large variety, they are entertainment and a spectacular form of repetition of the material. In addition, the lecturer has the side benefit of an immediate feedback, which shows him the degree of the students' understanding of the topic.

**Keywords:** mobile quiz, m-learning, audience feedback.

## 1. INTRODUCTION TO MOBILEQUIZZ

## 1.1. Audience Feedback

Many implementations of various Audience Response Systems (ARS) were implemented in recent years. Their main purpose was to increase interactivity, (re-)activate the audience and get a realistic feedback of students' knowledge [1]. The early hardware clicker devices were detached by software solutions, designed to operate on students' internet-enabled, mobile devices. *Mentimeter*, *Kahoot!* and *Nearpod* are examples of such applications which were able to run quick quizzes in a classroom environment. Unfortunately, most of these systems do not support math symbols or equations. In many cases only a picture can be added. Furthermore, the systems are relatively closed and do not allow the embedding of interactive third-party applets. But these aspects are very crucial to create comprehensible and colorful content for math lessons.

Therefore, the *MobileQuiz2* was implemented at the University of Mannheim to enable lecturers to design and perform more customized and enriched mobile quizzes. When using the *MobileQuiz2*, the lecturer can choose different pre-existing mobile teaching scenarios or design individual new ones. Considering the special needs of mathematicians, we designed a particular scenario which covered the features we wanted to use in math teaching. This scenario includes: single and multiple choice questions, open

text questions, explanation texts, images, HTML-elements and numerical slider input. Each textual object accepts TeX-input and automatically converts it into HTML equations or symbols within the students' browsers. A visual editor enables the lecturers to easily attach one or more objects to a new quiz entity. It is enough to drag and drop the object and fill in the blank. An entity thereby describes a quiz prototype with a particular selection of objects, which can then be used several times in recurring lectures.



Figure 1. View of the Objects

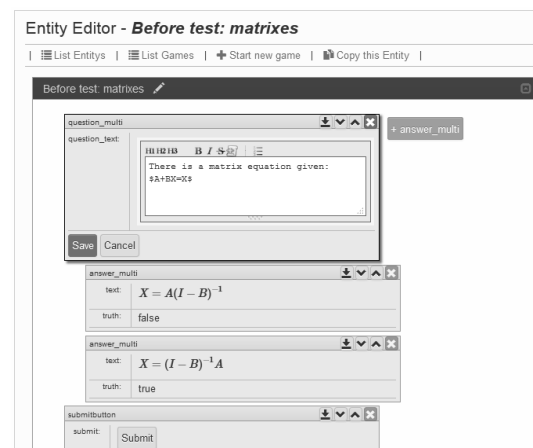


Figure 2. View of the Entity Editor

When the entity is ready a new game can be opened. A new game means a new voting (new for each group). With every new game, a QR-Tag is created which links to this particular quiz. Students can directly scan the QR-Code or manually enter a given URL. The quiz is then opened with the browsers on the students' devices. These typically are smart phones, tablet PCs or laptops.

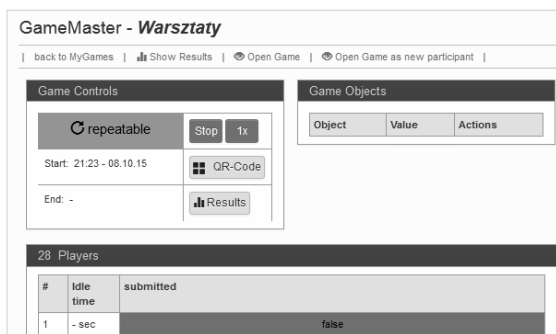


Figure 3. View of the Game Master

When the quiz round is started, the lecturer can observe the voting results in real time. He or she gets an overview about the amount of students participating and which percentage already submitted their answer. Afterwards, he or she can open a result view which shows the aggregated results of the participating audience. These can then be discussed during the lecture or used in preparation of the next lecture.

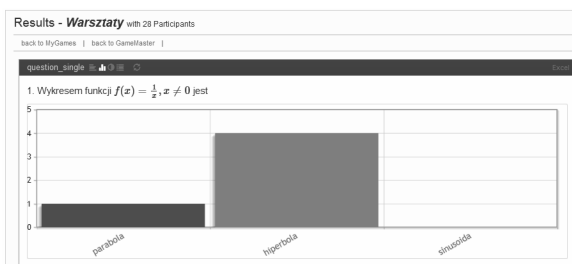


Figure 4. View of the Results

### 1.2. Technical aspects

The *MobileQuiz2* is written in PHP and works in a typical LAMP environment (Linux, Apache2 webserver, MySQL, PHP). The students' view, which renders the quizzes on the students' mobile devices is also written in PHP and additionally uses jQuery and jQuery mobile to render the layout and elements. The TEX transformations are realized with the help of *MathJax*. Hence the full application works like a usual web page, no installation on the students' devices is necessary and additional third-party content like *GeoGebra*-applets can easily be embedded.

As the *MobileQuiz2* supports a vast amount of different scenarios and object types, it uses a generic databank layout of 3x3 tables which describe the objects and attributes in the three quiz phases (blueprint, entity, game) [1]. Thus, the *MobileQuiz2* engine can treat the various objects with the same procedures. The core engine therefore does not distinguish between a student clicking a button or entering a text. Therefore, many different scenarios can be supported and new object types can be added without refactoring the core engine.

## 2. MATH QUIZZES

There is a special e-learning team working in the Center of Mathematics and Physics (CMF). Many of math quizzes have been built as a result of the team work. There have been prepared more than 100 math tests in Polish and almost 100 in English. As the quizzes are to be available for every student at every moment, they are placed on the university e-learning platform called *WIKAMP*. There scanning QR codes, students can use special math applets. For example, having a possibility of touching or moving the tangent line is invaluable. Students can also open it in their smartphones and fill in so called learning quizzes. If someone reads carefully the hints hidden in a question, image or applet – the answer is obvious. Finally, it is also possible to make a test. Unfortunately, there is no way to give the feedback automatically by *WIKAMP*. The correct answers can be analyzed during the classes. This kind of quizzes is especially valuable for teachers and the e-learning team, because analyzing results we can find out which part of the theory is a problem in general. It is an important hint for us, how to create new materials.

Anyway, the main assumption of mobile quizzes is a possibility of observing voting results in a real time. It can be fulfilled only by the teacher using *MobileQuiz2* application. That is why a special account *lodz* was created, where all our math entities are copied and each teacher of the CMF may use it. It is impossible to change anything there. The teacher chooses the entity from the list and opens a new game for his group. The QR code is shown and after scanning the code students solve and submit the test. At the beginning, the group can see the current number of participants and how many students have already finished their voting. After all, the voting results can be shown. Of course, the results presentation depends on a type of the question. There are different kinds of graphs to choose. Usually the correct answers are shown with the number of voting of the group.

The shown QR code presents some possible kinds of questions used in *MobileQuiz2*:



Figure 5. The QR code for one of the quizzes

## 3. EXAMPLES OF MATH QUIZZES

### 3.1. Lecture applets

As the first example let us see a quiz called “definition of the derivative”. This is an applet placed in the quiz especially for students who have just been told the theory and now have to practice.

So, looking at the quadratic function, they can try to find the derivative in the given point using only definition in their workbooks and later check their answers.

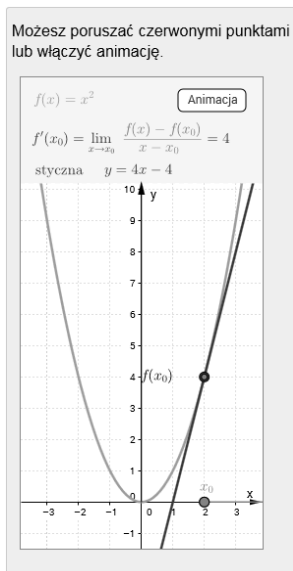


Figure 6. View of the entire applet

Another example shows an applet that can be used during lecture. It's about Normal Distribution. A student after scanning appropriate QR code opens a *GeoGebra* applet:

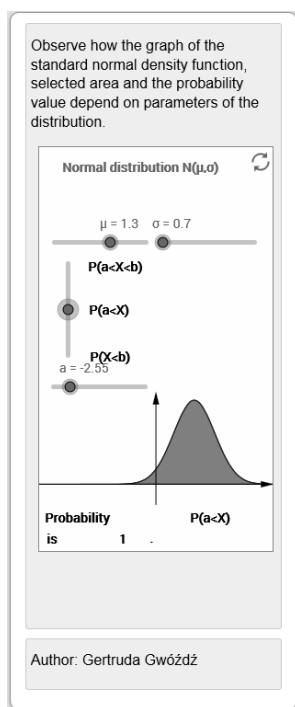


Figure 7. View of the *GeoGebra* Applet

Then he or she can move the sliders and change the parameters  $\mu$  and  $\sigma$  of the Normal Distribution which affects the movement of the graph of the density function. So the students can see how the parameters affect the graph and additionally observe how the chosen probability is connected to the size of colored region. After some time given to explore the applet, the lecturer can ask questions about identified connections and at the end formulate the theorem.

### 3.2. Learning quizzes

Now we present a couple of learning quizzes.

The first learning quiz that will be mentioned is about the equation of a straight line. A student reads the definition,

Postać kierunkowa prostej  $l$  przechodzącej przez punkt  $A(x_A, y_A, z_A)$  i równoległej do wektora  $[a, b, c]$ , którego żadna ze współrzędnych nie jest równa zero, jest następująca

$$l: \frac{x - x_A}{a} = \frac{y - y_A}{b} = \frac{z - z_A}{c}$$

Figure 8. The definition of a straight line equation

then watches the example showing how to find the right form of the line and at the end he or she is given a question which has to be answered. We suppose that looking at the model above it should be easy to select correct response.

Dana jest prosta  $p$  o równaniu zapisanym w postaci

$$p: \frac{2-x}{3} = \frac{y}{4} = \frac{z-5}{-6}$$

Przekształcając to równanie równoważnie, otrzymujemy

$$p: \frac{-(x-2)}{3} = \frac{y}{4} = \frac{z-5}{-6}$$

oraz

$$p: \frac{x-2}{-3} = \frac{y}{4} = \frac{z-5}{-6}$$

Na podstawie definicji postaci kierunkowej prostej, wybierz właściwą parę: punkt  $A$ , przez który przechodzi prosta oraz wektor do niej równoległy.

- $A(-3, 4, -6), [2, 0, 5]$
- $A(2, 0, 5), [-3, 4, -6]$
- $A(-2, 0, 5), [-3, 4, -6]$

Figure 9. The problem of a straight line equation

In the second quiz a student can write his or her function in the input box and observe how the graph of the chosen function looks like. It's worth mentioning that there is a hint in the applet that shows the syntaxes of expressions.

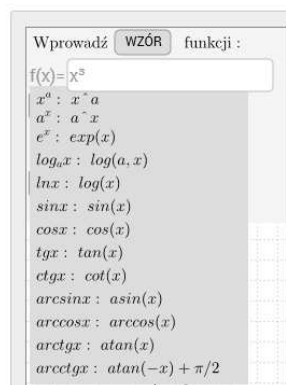


Figure 10. The hint shown after clicking the text "formula"

Also the applet shows the graph of the derivative, the value of the derivative in a chosen point (it can be moved) and the tangent line. So it can be used not only to draw the graphs

but to check if the tangent in a certain point is correctly found, too. The situation in which the student has to answer no questions is a big advantage and makes him/her feel more comfortable while exploring.

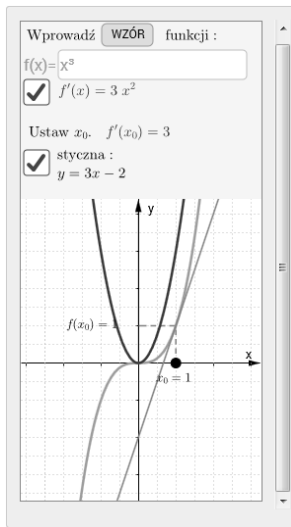


Figure 11. View of the entire applet

This quiz can be used during classes and then, after submitting the teacher can show correct answer with the number of participants who have been right and explain the notion once again to those who have been wrong.

It can be also used at home and students can get the feedback at the nearest meeting.

### 3.3. Tests

A non-standard mobile quiz will be served as an example of a standard quiz used to check the students' knowledge. This is a kind of puzzle game prepared to make the test more attractive. Knowing the rules of finding the domain of the function, players are given an inverse problem: to find correct formula of a function satisfying given condition about it's domain.

The biggest advantage of this quiz is a possibility of checking automatically if the puzzles are completed which doesn't have to be done by the lecturer.

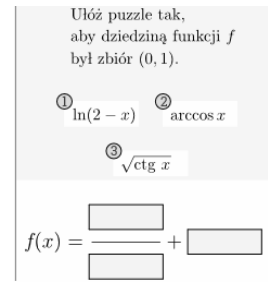


Figure 12. The puzzle domain problem

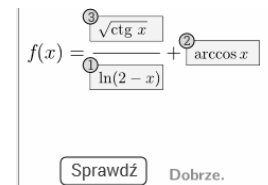


Figure 13. The solution of the problem

## 4. CONCLUSIONS

Presented mobile quizzes and tests have been done many times. First of all, during classes or lectures, students played with applets (not just a teacher using his computer). It helped them understand the theory much better. Learning quizzes were useful when a certain part of a theory ended. This was an excellent consolidation of the theory. Students found the solutions and we checked the correct answers. Finally, many times before written tests mobile tests were done. They looked similar to the learning ones, but the questions were more difficult, because of lack of the hints. Anyway, it was enough to point out all the difficulties and eliminate them.

The combination of interactive *GeoGebra* applets and lightweight mobile quizzes is a potential benefit for many teaching methods and teaching scenarios. Every scenario can use its customized quiz with a fitted volume and fitting object types.

## 5. BIBLIOGRAPHY

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## QUIZY MOBILNE W MATEMATYCE

Artykuł przedstawia nowe możliwości uczenia, jakie dają matematyczne quizy mobilne. Prezentujemy quizy napisane przy użyciu aplikacji *MobileQuiz2* Uniwersytetu w Mannheim. Twórcy tej aplikacji uwzględnili specyficzne potrzeby matematyków. Podstawową trudnością wymagającą przezwyciężenia było użycie czcionki matematycznej i wykorzystanie apletów mobilnych np. *GeoGebra*. Powstały aplety ilustrujące poszczególne zagadnienia (do użycia np. na wykładzie, by każdy student mógł „poczuć pod palcem” abstrakcyjne obiekty matematyczne), quizy uczące – z odpowiedziami w formie apletów bądź rysunków (idealne by ugruntować materiał), oraz quizy sprawdzające – bezcenne przed kolokwium czy egzaminem. Ze względu na dużą różnorodność quizów, mogą one być zarówno zabawą, jak i spektakularną formą powtórzenia materiału. Stanowią znakomite urozmaicenie zajęć i dzięki temu aktywizują do działania. Ponadto, wykładowca ma natychmiastową informację zwrotną. Może dzięki niej ocenić stopień zrozumienia danego tematu i wraz z grupą omówić problematyczne odpowiedzi. Z pewnością, możliwości quizów mobilnych w odniesieniu do matematyki nie zostały wyczerpane i warto zgłębiać ich tajniki.

**Słowa kluczowe:** quizy mobilne, m-learning, odpowiedź zwrotna.