

Multiple choice quiz on the internet

Robert Sporken^{*}, Fernande Frising^{*}, Laurence Dumortier[§]

^{}Unité de didactique de la physique, [§]Département éducation et technologie
Rue de Bruxelles, 61
B5000 Namur - Belgique*

Abstract

For some years we have developed multimedia tools for physics teaching and learning. These interactive simulations are mostly java applets and can be found on our web site (<http://www.sciences.fundp.ac.be/physique/didactique/>). They can be used in various settings: a traditional course, as self study-tools, or to prepare laboratory courses. We found the latter especially useful, as it is often difficult for students to prepare laboratory work based on printed material only. In order to promote active learning, we have written multiple choice questions to complete some of our applets. We have used PHP language to build dynamic html pages from a database. In this way, form and content are completely separate. The physics teacher does not need to know PHP. He can focus on questions and distracters. These tests also require students to calculate: for some questions, they have to introduce a numerical answer. Some questions from the database are included in the final exam.

1. Introduction

For some years we have developed multimedia tools for physics teaching and learning. They can be used in various settings: a traditional course, as self study-tools, or to prepare laboratory courses. We found the latter especially useful, as it is often difficult for students to prepare laboratory work based on printed material only. It is tedious to read the description of an apparatus. With computer-based resources, the apparatus can be presented in a more attractive way. Students can also revise theoretical aspects by using interactive simulations¹.

Despite interactivity, such tools may not produce the desired outcome if their use is superficial. In order to promote more efficient learning, we have decided to implement an interactive quiz². Multiple choice questions give students the opportunity to make the link between a formula and its verbal interpretation. Many students are deficient in this capacity. It is also essential that such tests can't be passed just by some mouse clicks. Many students need practice in handling formulas and figures. For some questions, they have to calculate and introduce a numerical answer.

We found some multiple choice quizzes by searching the internet. However, most are restricted to standard topics. Some universities web sites mention computer-based material for first-year students, but these self-learning and self-assessment tools are usually limited to registered students.

¹ Interactive simulations are mostly java applets and can be found on our web site (<http://www.sciences.fundp.ac.be/physique/didactique/multimedia.html>).

² See the address above – Click on the link “Testez vos connaissances (Test yourself)”

We have decided to build our own bank of questions. PHP language is used to make dynamic html pages from this database. In this way, form and content are completely separate. The physics teacher does not need to know PHP. He can focus on questions and distracters.

The first quiz that we have developed is relating to significant digits. It can be used by any student who attends an introductory physics laboratory course. The other quizzes (about alternating current circuits and X-rays) accompany laboratory courses for second-year physics and chemistry students. These students also follow a traditional lecture course in electricity, magnetism and introduction to modern physics.

Students are encouraged to use these resources on their own. Second-year students know that some questions from the database will be included in the final exam of the laboratory course.

2. Technical details

2.1. The application

The technical development of the quiz has been realized with the help of a team included in the department of education and technology, which is devoted to introduce information technology in university teaching and learning. We started from an application called « My_quiz_php ». This open source application, based on the scripting language PHP and MySQL databases, was developed by Stéphane Kupecky and is freely available on the internet³. With the help of the team, we modified the application to suit our needs. Specifically, we added support for inserting pictures in the choices and in the feedback; we improved the processing of the numerical answers (some answers are processed as strings of characters and other ones are processed as numerical values), and we added a second scoring model. Moreover, the teacher can now add pictures to the database without the help of the system administrator.

The application runs on a web server (Apache) with PHP and MySQL. To use the application, a teacher or a student only needs a computer connected to the internet with a browser. We have tested the application with I.E (version 6.0) and Mozilla Firefox.

The quiz is made of questions that may have unique or multiple answers as well as open ended questions. Questions and answers may have images in the content. There are two scoring models. In the first one, questions are weighted with 1, 2 or three stars and the student's total score is the sum of the stars. The second model uses the confidence marking; it gives the student the opportunity to discard some questions and to save marks with the answers for which he or she is absolutely sure.

2.2. Administration of the quiz

The quiz is based on topics. There are three topics until now: significant digits, AC circuits and X-rays. For each topic, one can define the number of questions that will appear in the quiz, the scoring model, whether the questions will be selected at random or not. It is also possible to receive the scores by e-mail. This option has not been activated up to now. The user is simply authenticated by the IP number of the computer. Of course, one could modify the application to limit the access to registered students. In that case, they would be authenticated by a user name and password.

³ <http://stephkup.free.fr/quiz/descriptif.php3>

From the administration page, one can modify the configuration of a topic; one can also add, delete or modify questions in a topic.

2.3. Examples

Figure 1 is an example of a questions page. The question appears on the top of the frame. The left side is devoted to an optional picture (a “gif” file). Different choices are displayed in the center of the frame. Choices can be sentences or pictures. The maximum number of options is 5. The number of stars is also displayed if this scoring model has been chosen. For questions which require student to calculate, choices are replaced by a text field where the numerical answer has to be introduced.

When the “Correction” button is pressed, the form is sent to the server and PHP processes the data. A numerical answer is right if the difference with the expected value is less than 1 %. PHP generates a page whose presentation looks like the questions page (figure 2a, 2b). The question is rewritten on the top of the frame. Choices or numerical values entered by the user are displayed in the center of the frame. For a correct answer (figure 2a), an “OK” icon is displayed in the right side. Stars or marks obtained for this question are also shown. An exclamation mark (figure 2b) indicates a wrong answer. The correct answer is displayed in the right side and feedback (a text or a picture) is sometimes added.

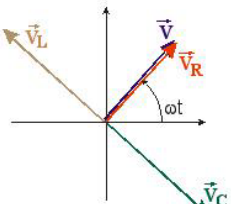
Question 2/10		
Voici le diagramme des phaseurs correspondant à un circuit R-L-C série. Les phaseurs \vec{V} , \vec{V}_R , \vec{V}_L et \vec{V}_C représentent respectivement la tension aux bornes de l'ensemble RLC et les tensions aux bornes de R, L et C.		
	<input type="checkbox"/> Un tel diagramme n'est pas possible puisque les phaseurs \vec{V}_L et \vec{V}_C sont plus grands que \vec{V} . <input type="checkbox"/> Ce schéma correspond à la fréquence de résonance (fréquence pour laquelle le courant est maximum) puisque \vec{V}_L et \vec{V}_C ont la même amplitude. <input type="checkbox"/> Ce schéma correspond à la fréquence de résonance puisque \vec{V}_R atteint la valeur maximum possible. <input type="checkbox"/> Ce schéma correspond à la fréquence de résonance puisque \vec{V}_L et \vec{V}_C sont en opposition de phase.	Coefficient : ★
Question 3/10		
Dans un circuit R-L-C série,		
<input type="checkbox"/> Le facteur de qualité est indépendant de la résistance.		

Figure 1 : An example of a “question” page about alternating current circuits.

Phasor diagram is given for an R-L-C series circuit. We use the symbols V , V_R , V_L and V_C for source voltage, voltage across R, L and C.

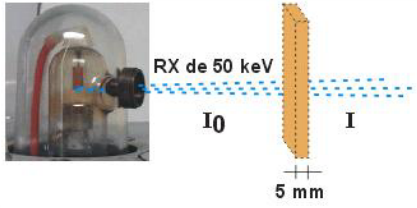
Four choices are given:

- 1- Such a diagram is not possible, as V_L and V_C are greater than V .
- 2- This diagram corresponds to the resonant frequency as V_L and V_C have the same amplitude.
- 3- This diagram corresponds to the resonant frequency as V_R reaches the maximum value.
- 4- This diagram corresponds to the resonant frequency as V_L and V_C are 180° out of phase.

Question 22/100


Un faisceau de RX de 50 keV est atténué par un matériau (ici 5mm d'os). Calculez le rapport I/I_0 , c'est-à-dire le nombre de photons transmis au delà du matériau par rapport au nombre de photons incidents.

μ^* , le coefficient d'atténuation massique = $0.424 \text{ cm}^2/\text{g}$
 ρ , la masse volumique = $1.92 \text{ g}/\text{cm}^3$



Vous avez répondu :

0.67



Vous gagnez :
★ point

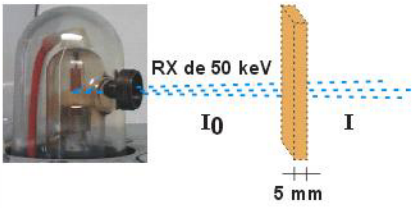
Figure 2a : An example of a "correction" page. In this question, an X-ray beam is passing through an absorber of a given thickness. The student has to calculate the ratio of the intensity of the transmitted beam to the intensity of the incident beam. The mass attenuation coefficient and the density of the absorber are given. The student has introduced a numerical value (0.67) in a text field.

He receives the correction: "You answered 0.67. It's OK. You save 1 star".

Question 22/100


Un faisceau de RX de 50 keV est atténué par un matériau (ici 5mm d'os). Calculez le rapport I/I_0 , c'est-à-dire le nombre de photons transmis au delà du matériau par rapport au nombre de photons incidents.

μ^* , le coefficient d'atténuation massique = $0.424 \text{ cm}^2/\text{g}$
 ρ , la masse volumique = $1.92 \text{ g}/\text{cm}^3$



Vous avez répondu :

0.8



La bonne réponse est :
0.666
 $\frac{I}{I_0} = e^{-0.424 \times 1.92 \times 0.5} = 0.666$

Figure 2b : For a wrong answer, the student receives the correction : "You answered 0.8. The correct answer is 0.666." Here, the feedback is a "gif" file which contains a formula.

3. Designing questions

We tried to respect some basic rules in order to writing relevant questions: all distracters need to be plausible and most of them have to be based on common student misunderstanding or misconceptions.

Figure 3 shows questions regarding significant digits. For question 6, a student who would confuse rules for multiplication and addition would choose distracter 3. For question 16, a student can discard distracters 2 and 3 only if he remembers that zeros between nonzero digits and zeros to the right are significant. For these questions, feedbacks can be simply the rule that is applied.

For other topics, it is more difficult to create distracters. Figure 1 shows a question regarding alternating current circuits. Some students keep in mind the model of circuits with only resistors. They can not imagine a phase difference between voltage and current. Then they can not understand that the voltage across L or C (in a RLC series circuit) can be large although source voltage is quite small. This common difficulty has motivated the distracter 1. Other students know results for particular frequencies but they can not handle formulas to predict results at any frequency. For example, most of students know that V_L and V_C are 180° out of

phase at the resonant frequency. But, although they know the formulas $\bar{V}_C = \frac{-j}{\omega C} \bar{I}$ and $\bar{V}_L = j\omega L \bar{I}$, they forget this is also true at any frequency. That is the reason why we have written the distracter 4.

Question 6/100		
Si les nombres suivants (3.54 et 4.7) sont le résultat d'une mesure, comment présente-t-on le résultat de leur produit 3.54 * 4.7 ?		
<input type="checkbox"/> 16.638 <input type="checkbox"/> 16.64 <input type="checkbox"/> 16.6 <input type="checkbox"/> 17	Coefficient : ★	

Question 16/100		
Quelles sont les mesures comportant 2 chiffres significatifs?		
<input type="checkbox"/> 0.0012 <input type="checkbox"/> 1.002 <input type="checkbox"/> 1.200 <input type="checkbox"/> 1.2 <input type="checkbox"/> 1.12	Coefficient : ★	

Figure 3 : Questions regarding significant digits.

*Question 6 : 3.54 and 4.7 are measurements. How would you write the final result of the multiplication 3.54 * 4.7 ?*

Question 16 : Which measurements include 2 significant digits ?

For this question (and for most of questions of this topic), the feedback is a link to interactive simulations. We hope that students will take advantage of a wrong answer. Perhaps they had simply looked at the simulations before answering the quiz.

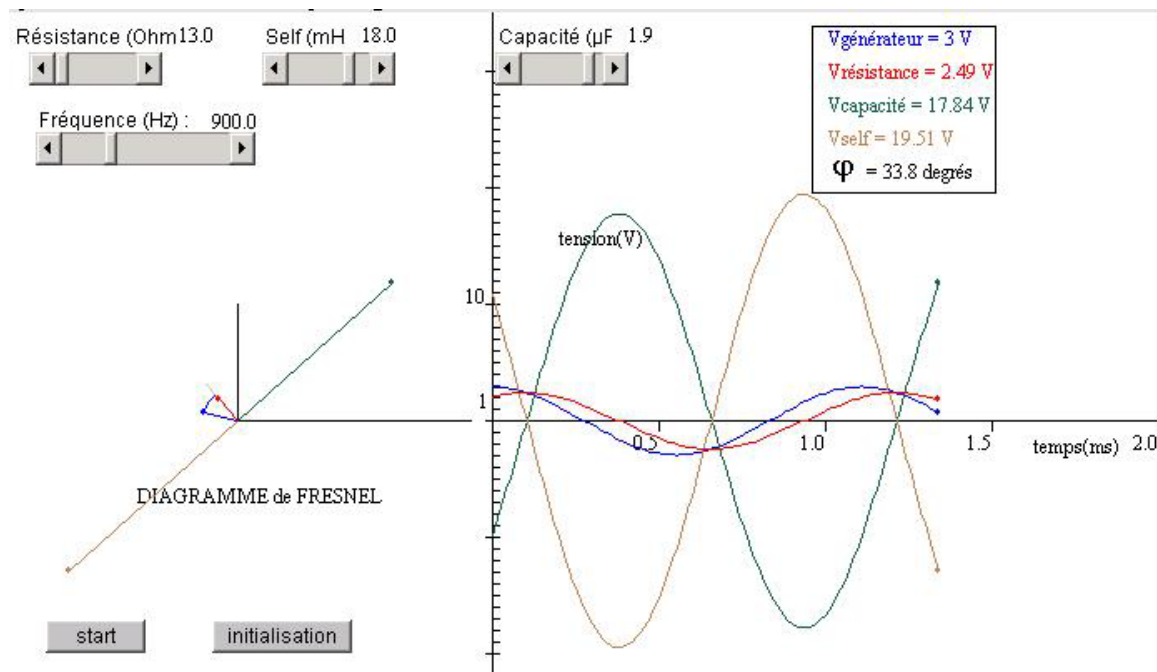


Figure 4 : This applet shows the phasor diagram and the instantaneous voltages in a RLC series circuit.

The user can adjust the values of the resistance, the capacitance, the inductance and the frequency. When the “start” button is pressed, the phasor diagram rotates and the vertical projection of the phasor provides the instantaneous voltage.

The applet corresponding to the question of Figure 1 is given in Figure 4. A dynamic graphical representation of time-dependent values should help students to give a meaning to the equations. Every simulations page includes comments that suggest which parameters

could be changed to make interesting observations. Students are then asked to take the time to adjust those parameters and to make links between formulas and graphical representations.

4. Discussion

We do not control the use of the multiple choice quiz during the year. But second-year students receive four questions from the database in the final exam of a laboratory course. These questions count for 20% of the laboratory course grade.

We did not realize a quantitative assessment of the effectiveness of this method as the group of second-year students is too small. If we had to correlate the lecture course final grade with the use of this quiz, we should perform a study for a larger group. However, we noted a qualitative improvement. Students have a better understanding of the experimental material: this is obvious for the X-ray lab. Furthermore, they establish more links between the lecture course and the laboratory course. With the quiz relating to AC circuits for instance, students get used to manipulating formulas and phasor diagrams. Then, they refer to these tools more easily to make predictions or to justify measurements.

If we decided to use these quizzes to evaluate a learning process, we could modify PHP code to record all the results. In addition to a statistical analysis of the scores, we could extract information for each question. The distribution of answers can give a measurement of the degree of understanding of certain concepts. The quality of the questions could also be studied. This quality can be indicated by the proportion of high-scoring students who give a wrong or a right answer. We could then discard or rewrite questions that are not relevant.

5. Conclusions

With the quiz, we have enhanced the computer-based learning material by adding a self-assessment tool. Although we did not realize any quantitative evaluation, positive feedbacks have been given by students as well as by teaching assistants. The choice of PHP language connected to a questions database allows us to modify this teaching material easily.