

# Assessment-oriented Java development vs. Clickers' use in formal assessment of basic principles of dental radiology: the opinion of dentistry students

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## ABSTRACT

The integration of Information and Communication Technologies (ICTs) has generated a change in teaching methodologies at university level. The objective of this study is to check the effectiveness of interactive processes in summative assessment or learning-oriented assessment contexts using electronic self-assessment processes (Java application) versus the use of audience response systems (ARS) or “clickers” in the classroom, from the point of view of students' satisfaction measurement.

The sample for this study is composed by the students of the first year of the Degree on Dentistry of the School of Medicine of the University of Salamanca, and which was carried out by means of a questionnaire, where 1 stood for total disagreement and 7 for absolute agreement; together with an statistical analysis (Conbach alpha) that allows us to value the reliability of the answers obtained.

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Results reflect the students' answers to the questionnaire, as well as the relationship between the two systems. To conclude, there are certain coincidences when judging both assessment tools, but we also observe that there is a better predisposition towards Java system rather than to clickers. The job done by a coordinated interdisciplinary team formed by members of different areas has made it possible to build and validate interesting pedagogical materials, as well as to develop formative assessment strategies that could be generalized to other subjects in different degrees.

## Categories and Subject Descriptors

J.3 [Life and Medical Sciences]: Health.

K.3.2 [Computers and Education]: Computer and Information Science Education – *computer science education, self-assessment*.

## General Terms

Design, Verification, Languages, Experimentation, Human Factors.

## Keywords

Dental Radiology, Audience Response System, Clickers, Java, Formative Assessment, Computers-assisted Instruction, Educational Technology, Teaching Methods.

## 1. INTRODUCTION

The integration of Information and Communication Technologies (ICTs) within the European Space for Higher Education (EES)

has meant a radical change in teaching methodologies within tertiary education. Teachers have to develop a flexible formative action, focused on the student as the active participant of his/her own learning process, what also implies the need to carry out diverse in-class and autonomous activities with ICTs support.

On the other hand, the process of students' learning assessment constitutes the main part of quality training, in any educational context. The principal reason for assessment has to highlight the formative character of it, that is to say, with the new methodological change promoted by the EEES, summative assessment will have to attain the category that has not yet been conferred to it. Nowadays, reference to the concept of assessment, in a broad sense, tries to pay more emphasis on the formative aspect [1] than on the summative one, dwelling on the improvement of students' learning to facilitate and promote a necessary reflective attitude after the feedback received.

The use of ICTs in the educational context and in the students' assessment in particular, provides with numerous advantages such as promoting the development of tests, reducing the cost and marking time or enabling the storage and use of the results obtained. Among the different assessment strategies, in this work we pay special attention to two which can be designed and implemented by the use of ICTs: self-assessment through objective tests (Java application) and the formative assessment of students based on the use of audience response in the classroom (ARS).

The objective of this study is to test the efficiency of the interactive procedures described, in formative assessment contexts or learning-oriented assessment, from the point of view of satisfaction evaluation as an indicator of process' quality. In this sense, we come to the question. To what extent procedures and instruments which allow us to boost participation of students in the assessment process are successful from the student's perspective?

### **1.1 Self-assessment as a formative assessment strategy**

The term 'self-assessment' makes reference to the fact that the person assessing and the person assessed are coincident [2]. Self-assessment allows the students to carry out a series of activities and go back to them, what provides with a better knowledge of reality being assessed and directly affects the leaning improvement. The self-assessment method used in this study is that of an objective test, that is to say, a test with a series of items and several alternative answers among which the students choose the one they perceive as correct in each case.

#### *1.1.1 Java as a programming language for the design of self-assessment tools.*

Java is a programming language oriented towards to objects, created by Sun Microsystems in 1995. The underlying technology enables the use of thousands of applications and websites, which work thanks to this application being installed into the system. Java is quick, safe, reliable and runs into millions of personal computers all over the world and in millions of millions of devices, such as mobiles and TV sets [3].

When you download java software, you get the Server Java Runtime Environment (JRE). It is built by the Java Virtual Machine (JVM), the main categories of Java platform and support libraries. JRE is the part related to the execution of Java software

in the web. To summarize, JRE allows executing applets written in Java programming languages [3].

The Physical Medicine Unit of the Medicine Faculty at the University of Salamanca has developed a Java applet that allows its execution from a web navigator, and is aimed towards self-assessment of contents within the field of knowledge, adapting to the necessities of the final users, students. At the same time, our unit incorporated in this course an audience response system with the objective of seeking for alternatives to canonical classes and promoting students' participation. This study revolves around the idea of students' self-assessment in Basic Principles of Dental Radiology, a subject whose contents belong to Medical Physics, and the new teaching methodologies based in the use of these instruments.

### **1.2 Audience response systems in the classroom**

The most frequently used terms in literature to refer to the use of response commands in the classroom are "Audience Response Systems" (ARS) or "Clickers". The use of these devices is extending in the educational context and, more specifically, in the field of Health Sciences [4-14]. The teacher asks the questions while the system transmits, by means of radiofrequency or infrared, the students' answers, immediately showing the answers in the monitor screen.

In general, a positive attitude towards the use of clickers is observed both in students and teachers [14-17], except for the cases in which students perceive the system as a form of control or monitoring [14]. The advantages of its use refer both to those which have to do with the development of the class, such as those related to assessment or with the results of the learning process [15]. Nevertheless, in relation to this last aspect, it is complex to determine if benefits provided by ARS make them be an efficient learning tool [7][9][15].

On the other hand, there is an obvious agreement in literature about the efficiency of clickers in the formative assessment used to identify students' concept understanding [4][9][15][17], what allows us to adapt the teaching rhythm and level [17], improving, in this way, teaching quality [15]. Additionally, it can also be perceived as a continuous assessment tool along the course and as a summative assessment at the end of it, since each student's device records the partial results obtained along the continuous assessments [9][18].

## **2. METHODOLOGY**

The sample of students is formed by the students of the first year of dentistry using clickers along the year in the subject "Basic Principles of Dental Radiology" (N=28). Nowadays, the discipline provides students with the physical fundamentals of different diagnostic techniques, provides with the scientific basis for the understanding and development of modern technologies which have shaken up the odontological diagnosis and establishes the criteria for the correct use of physical agents used in dentistry. The Medical Physics Unit within Radiology area is in charge of this subject at the University of Salamanca.

### **2.1 Design, characteristics and implementation of the "Self-assessment test"**

The implementation of this test was developed after the necessity to create a simple self-assessment mechanism, which could be used from anywhere, and which allowed Medical Physics'

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students in our Faculty to carry out a monitoring of the topics studied in the different subjects of Medical Physics from the Medicine Degree and Basic Principles of Dental Radiology from the Dentistry Degree.

The appliance has multiple resources: images, texts, configuration files, class files (files containing the program code) and libraries, all of them grouped together in a same file (.jar), making it easy for the applet to be installed into a website. Students, when they access the tool, they find ten training tests with questions about the different thematic areas of the discipline (figures 1 y 2).



Figure 1: Main Screen of the "Self-assessment test"



Figure 2: Divided structure of the "Self-assessment test"

When you select the field of knowledge about which you want to do the test, a window with the data opens, as well as a display with live information about the result obtained by the student at any moment. The format of the questions is similar to that of the final examination of the subject: five possible answers, among which only one is correct. Nevertheless, there is the possibility to leave a question unanswered, to simulate the real context of an exam, where wrong answers take out marks while unanswered questions do not alter the result in any sense (figure 3). Once the test has been finished, a window is shown with the results of that part, also showing additional information about the questions that the student has wrongly answered (figure 4).

2.2 Use of clickers in the classroom

During the academic year 2012-2013 we started a new innovation Project, whose main objective was to test the efficiency of interactive procedures, by using clickers in the classroom, in

formative assessment contexts or in learning-oriented assessment. In this sense, we wanted to better know the impact that the use of these devices can have on the learning process and, on the other hand, value the satisfaction of students as a quality indicator. For this purpose, we got a set of 36 remote controls of "TurningPoint" by Turning Technologies that includes a particular software that installs an application within Microsoft Power Point (figures 5 y 6).

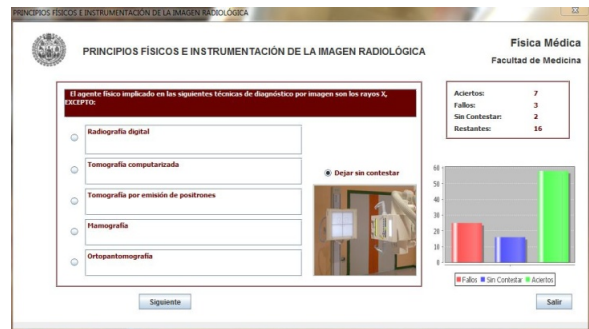


Figure 3: Test Window showing the different parts of the subject

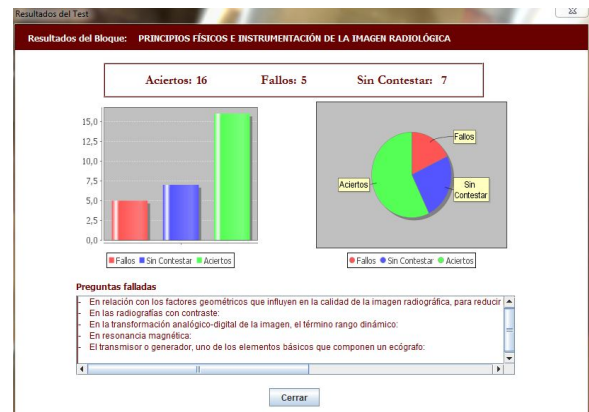
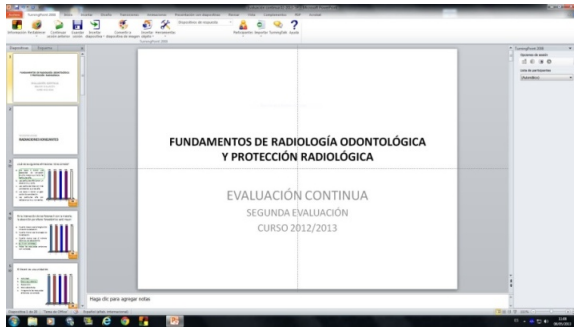


Figure 4: Results window in the test



Figure 5: "TurningPoint" radiofrequency sender and receiver



**Figure 6: TurningPoint Software integrated into Microsoft PowerPoint**

In practical terms, we used clickers as a form of formative assessment to improve the learning-teaching process, as the system provides with information, not only for the teacher, but also for the students, who can get to know their knowledge level in a specific topic. Furthermore, it can be used as a continuous assessment tool (summative assessment), but the influence on the final mark was only of a 5%.

The obtaining of these results, in relation to the perceptions and opinions of students was carried out in agreement to the methodology put forward by Lorena et al. [17], by means of a Likert scale questionnaire based on seven questions, being 1 the total agreement and 7 an absolute disagreement, as well as statistics (alpha de Cronbach) which allows valuing the reliability of the scales use.

### 2.3 Value of the students' satisfaction towards the self-assessment test and comparison to the assessment system based on clickers

The teaching innovation project we mentioned before in this article, based on the use of an audience response system used in the subject "Basic Principles of Dental Radiology", made it possible to introduce the students with the self-assessment application developed under a java environment, and with the aim of comparing both platforms. In this sense, to the satisfaction survey we had designed for the remote-based system a second part was added, making reference to the self-assessment test.

The information selected to be part of the aforementioned survey included the following aspects: Socio-personal background students (gender, age, parents' job, etc.), academic characteristics (grade of university entrance examination exams and Physics mark in the Pre-university course), together with the satisfaction survey towards the self-assessment test (1-7 scale), and a qualitative assessment through strong and weak/improvement suggestions.

## 3. RESULTS

The results now described come from the data obtained by the students actually participating in the survey carried out. The sample distribution, in terms of gender, shows a higher participation of women than men (64.3% vs. 35.7%). If we analyze the proportion of both genders, it is a repeated pattern across health science studies. On the other hand, being first year students, a 75% of them are under 19. At the same time, we have observed that a great majority of them are first year students of the Dentistry Degree (92.9%), with a high efficiency when accessing

the university, due to the high grade required to access (11.45 out of 14).

**Table 1. Basic descriptive aspects of the satisfaction survey**

Items	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)	7 (%)
01*	0	0	3,6	7,1	28,6	50,0	10,7
02*	0	0	3,6	7,1	28,6	42,9	17,9

01\* Very poor... Excellent

02\* Not very interesting... Very interesting

Once the teacher has explained the self-assessment tool to the students and they have visualized it, they were asked to value the application in relation to the learning process developed in the subject "Basic Principles of Dental Radiology". Table 1 shows the answers of students ranging between 1 (very poor) and 7 (excellent), and 1 (not very interesting) and 7 (very interesting). In table 2 we can see the relation between the two systems: the Java application "self-assessment test" and the audience response systems.

**Table 2. Relation between both assessment systems; Java application ad clickers**

Items	Java App.		Clickers		r
	Aver.	Tip. Dev.	Aver.	Tip. Dev.	
01*	5.57	.920	4.54	1.170	0.26
02*	5.64	.989	4.71	1.182	0.54

01\* Very poor... Excellent

02\* Not very interesting... Very interesting

Regarding the qualitative assessment that students have made based on the systems, and also in relation to strengths observed, we have spotted coincidences between both platforms, as in, for example, the summary of contents, the support to key-concept learning and how they affect the final knowledge of students, level and their preparation for the final exam. On the other hand, and making reference to Java self-assessment, students positively valued the possibility to use the tool at home in an anonymous way. The use of clickers was also positively valued regarding aspects such as the possibility to develop a daily follow-up of the contents dealt with in the classroom, the power to maintain students' attention in the classroom, since the teacher can ask them about the contents in the platform at any time, and the fact that it strongly favors the interaction between the teacher and students.

Improvement suggestions got about the "self-assessment test" basically refer to the convenience of raising the number of questions in the database of the test because, in general terms, they think that the application is well developed and useful for them. Nevertheless, the audience answer system creates some reservations among students, such as, for example, the occasional instability of software, the fact that it is used as a summative assessment procedure and, above all, the presence of a timer to answer the questions generates a certain stress feeling in the students.

## 4. CONCLUSIONS

In general terms, as we mentioned in the introductory part of this article, we can observe a positive attitude towards the students' use of clickers in the classroom, although we have also perceived

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that some students tend to reject this system because they see it as a monitoring instrument, since it allows to carry out a detailed tracking of class attendance and enables the teacher to store the results obtained in subsequent assessment processes carried out along the year. Nonetheless, in relation to the self-assessment test, the positively value the fact that they can use the tool at any time and place, and anonymously. In conclusion, there is a certain relation when valuing both assessment tools, but we also observe that there is a better predisposition towards Java system than to clickers. The different opinions expressed by our students have provided us with reliability and validity evidences about the assessment tools used. The coordinated tasks carried out by a team of teachers from different areas has made it possible to build and validate pedagogical materials of a high value, as well as to develop formative assessment strategies which can be extrapolated to other subjects in different degrees.

## 5. REFERENCES

- [1] Olmos, S. and Rodríguez, M.J. 2011. Perspectiva tecnológica de la evaluación educativa en la universidad. *Teor Educ* 23, 1, 131-157.
- [2] Lukas, J.F. and Santiago, K. 2004. *Evaluación educativa*. Madrid: Alianza.
- [3] Oracle. (n.d.-a). *What is Java*. [http://www.java.com/en/download/faq/whatis\\_java.xml](http://www.java.com/en/download/faq/whatis_java.xml)
- [4] De Gagne, J.C. 2011. The impact of clickers in nursing education: A review of literature. *Nurs Educ Today* 31, e34-e40.
- [5] Duggan, P.M., Palmer, E. and Devitt, P. 2007. Electronic voting to encourage interactive lectures: a randomized trial. *BMC Medical Education* 7, 25.
- [6] Patterson, B., Kilpatrick, J. and Woebkenberg, E. 2010. Evidence for teaching practice: The impact of clickers in a large classroom environment *Nurs Educ Today* 30, 603-607.
- [7] Nelson, C., Hartling, L., Campbell, S. and Oswald, A.E. 2012. The effects of audience response system on learning outcomes in health professions education. A BEME systematic review: BEME Guide No. 21. *Med Teach* 34, e386-e405.
- [8] Tregonning, A.M., Doherty, D.A., Hornbuckle, J. and Dickinson, J.E. 2012. The audience response system and knowledge gain: A prospective study. *Med Teach* 34, e269-e274.
- [9] Kenwright, K. 2009. Clickers in the Classroom. *TechTrends* 53, 74-77.
- [10] Cain, J., Black, E.P. and Rohr, J. 2009. An audience response system strategy to improve student motivation, attention, and feedback. *Am J Pharm Educ* 73, 2, Article 21.
- [11] Cain, J. and Robinson, E. 2008. A primer on audience response system: Current applications and future considerations. *Am J Pharm Educ* 72, 4, Article 77.
- [12] Pileggi, R. and O'Neill, P.N. 2008. Team-Based Learning using an audience response system: An innovative method of teaching diagnosis to undergraduate dental students. *J Dent Educ* 72, 1182-1188.
- [13] Stoddard, H.A. and Piquette, C.A. 2010. A Controlled Study of Improvements in Student Exam Performance With the Use of an Audience Response System During Medical School Lectures. *Acad Med* 85, 10 Suppl., s37-s40.
- [14] Thomas, C.M., Monturo, C. and Conroy, K. 2011. Experiences of Faculty and Students Using an Audience Response System in the Classroom. *CIN-Comput Inform Nu* 29, 396-400.
- [15] Kay, R.H. and LeSage, A. 2009. Examining the benefits and challenges of using audience response systems: A review of the literature. *Comput Educ* 53, 819-827.
- [16] Caldwell, J.E. 2007. Clickers in the Large Classroom: Current Research and Best-Practice Tips. *CBE-Life Sciences Education* 6, 9-19.
- [17] Blasco, L., Buil, I., Hernández, B. and Sese, F.J. 2012. Percepciones y resultados del estudiante derivados del uso de los sistemas de mandos de respuesta en clase. *EduTec, Revista Electrónica de Tecnología Educativa* 40. [http://edutec.rediris.es/Revelec2/Revelec40/percepciones\\_resultados\\_estudiantes\\_sistemas\\_mandos\\_respuestas\\_clase.html](http://edutec.rediris.es/Revelec2/Revelec40/percepciones_resultados_estudiantes_sistemas_mandos_respuestas_clase.html)
- [18] Bruff, D. 2009-10. Multiple-choice questions you wouldn't put on a test: Promoting deep learning using clickers. *Essays on Teaching Excellence* 21, 3.