Using a Spreadsheet to Support e-Assessment

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Abstract: Some of the courses of the scientific area of Mathematics at ISCAP use multiple choice questions (MCQ) tests as a fundamental part of the assessment. The assessed topics include Differential and Integral Calculus, Algebra, Statistics, and Financial Mathematics. In the undergraduate programs of Accounting, Marketing and International Commerce, these courses are taught in theoretical-practical classes and their main objective is to provide the necessary support tools to other courses of these programs. On the other hand, these undergraduate programs, in particular Accounting, have many classes and many students, so MCQ tests have been an indispensable tool for both continuous and final exam assessment. The open source MOODLE platform, used through a local network intended only for continuous assessment, has been the support software for MCQ tests. In order to integrate student classifications so as to be more easily retrieved by all teachers, and in order to obtain them more quickly, an MS Excel™ spreadsheet was developed. This allows us to automate the whole process from collecting the students' answers, to obtaining their final classification and calculating important statistics. This paper describes the development process of this tool, which has proved extremely important in the e-assessment method already implemented. Therefore, some of the results presented show: (i) the substantial reduction in the time elapsed between the moment the tests were carried out by the students and the moment of the publication of the grades; (ii) the existence of automatic control in case of duplication of tests by the same student, (iii) the action of complementing MOODLE in the treatment of negative grades of students; (iv) the possibility of performing several statistical analysis that can be organized by class, by subject, by attendance regime to classes (nocturnal versus diurnal), and include comparisons with previous years and tables of frequencies of grades.

Keywords: e–assessment, MS Excel™, multiple choice questions, mathematics, higher education

1. Introduction

With the adaptation of the different undergraduate programs to the Bologna Process, some students did not attend the Mathematics courses in secondary education. These include a significant number of candidates who enrolled in ISCAP through the Special Application for Students over 23 Years who have not studied for many years, and therefore have even more learning difficulties.

On the other hand, a restructuring of the undergraduate programs reduced the weekly workload of the Mathematics curricular units and led to the need of articulating the Mathematics programs of study with those of the other curricular units, in order to provide, in real time, the mathematical bases required.

Thus, there was a need to develop new strategies and methodologies to help students and to compensate for the lack of mathematical knowledge and the reduction of the weekly workload of the curricular units of Mathematics. These new strategies focused on replacing the summative assessment (final exam), which is very common in most higher education schools, by a continuous and student-centered assessment using diversified assessment methods (Rod, Eiksund and Fjaer, 2010; Mora *et al.*, 2012; Llamas-Nistal *et al.*, 2013).

As Flores (2015, p. 1525) mentions, even after Bologna, some teachers continue to use only one final summative exam in one or two assessment periods to evaluate students. According to Redecker and Johannessen (2013), changes in educational practices and learning processes only become effective if we make changes in the way we evaluate students.

Thus, this article focuses on the presentation of an e-assessment tool that helps teachers to evaluate students throughout the semester and not only at the end. It is also intended to introduce a formative evaluation before each moment of continuous assessment.

However, with many classes and many students, we chose to use an electronic assessment tool based on the Moodle platform and on a bank of questions developed previously to generate the formative and summative tests in classes. Moodle platform is free and one of the most used Learning Management Systems (LMS) in the

world. The e-assessment has become more and more used during the last few years. Now it is possible to use e-assessment only without ever using paper (Stödberg, 2012).

The structure for the remaining of the paper is the following: first we discuss some related topics, then we present the method and tools, the results and the conclusion.

2. Related topics

In this section, related topics are introduced, namely e-assessment and Multiple-Choice Questions (MCQ).

2.1 E-assessment

When introduced in the learning process, Information and Communication Technologies (ICT) bring up new challenges and at the same time offer teacher tools that let them create differentiated learning opportunities for students. Similarly, in the assessment process, it becomes a useful resource, thus, its use turns out to be, somehow, unavoidable, arising the concept of e-assessment.

Bull and Danson (2001) present e-assessment as an umbrella term that is related to the application of ICT in the assessment process, including close-ended questions, as for instance MCQ or matching questions, but open-ended formats can also be available, such as portfolios or discussions, (Cook and Jenkins, 2010; Stödberg, 2012). Close-ended questions formats are the most used in e-assessment (Stödberg, 2012).

One possible approach to e-assessment is the development of specific environments for this purpose, which have the advantage of being designed and implemented accordingly to the necessities of the users (McGuire *et al.*, 2002; Botički and Milašinović, 2008; Gruttmann, Böhm and Kuchen, 2008; Dascalu and Bodea, 2010; Wilson *et al.*, 2011; Jordan, 2013; Llamas-Nistal *et al.*, 2013; Guo *et al.*, 2014; Vora and Shinde, 2014).

Another approach is the use of Learning Management Systems, which have the advantage of providing a wide range of tools specifically designed to allow the implementation of diversified e-assessment activities (Blanco and Ginovart, 2012; Mora *et al.*, 2012; Moscinska and Rutkowski, 2012; Salas-Morera *et al.*, 2012; Sorensen, 2013; Holmes, 2015).

Other possibility is the use of the so called Assessment Systems, which are developed specifically to elaborate and to present questions to the students, from banks of questions previously developed (Burrow *et al.*, 2005; Mathai and Olsen, 2013; Hauk, Powers and Segalla, 2015).

One of the great advantages of e-assessment is the possibility of easily assessing a large number of students, facilitating the teachers' work, allowing to save time and resources (Bull and Danson, 2001; Rust, 2001; Yorke, 2001; Botički and Milašinović, 2008; Blanco and Ginovart, 2012; Mora *et al.*, 2012; Moscinska and Rutkowski, 2012; Jordan, 2013). Several other advantages can be found in the literature, but we emphasize the celerity in obtaining the grades (Bull and Danson, 2001; Cook and Jenkins, 2010; Mora *et al.*, 2012; Redecker, 2013), the facility to store, edit, reproduce, recombine and reuse information (Cook and Jenkins, 2010; Redecker, 2013), and the capacity to automatically generate quality indicators and statistics (McAlpine, 2002).

It is recognized in the literature that e-assessment has some limitations. For instance, it presents some important organizational challenges, and initially a big effort can be needed to put the process up (Yorke, 2001; JISC, 2007; Green and Mitchell, 2009; Cook and Jenkins, 2010).

Many times, e-assessment is associated only with MCQ. Despite there are several possible formats for e-assessment questions, as stated above, MCQ are of particular relevance and have some peculiarities. In the following subsections, we present some aspects of MCQ.

2.2 Multiple-Choice Questions

A multiple-choice test consists of a collection of MCQ. A MCQ is "a question where the student is required to select a single correct answer from a range of available options." (JISC, 2006, p. 74)

MCQ are composed of 3 elements: (1) a stem that presents the problem and which can take the form of an incomplete sentence or a question; (2) the correct option or answer key; and (3) several distractors, which are incorrect alternatives (Clegg and Cashin, 1986; Burton *et al.*, 1991; Bush, 2015). The correct answer must be undeniably correct, whereas the distractors should be plausible for those that are not familiar with the necessary knowledge, but must be undeniably incorrect for those that already have it, becoming many times the most difficult part of the MCQ (Haladyna, 2004).

Bush (2015, pp. 4–7) presents eight different formats for MCQ:

- Traditional – "Select the option that seems to you the most likely to be correct for each question";
- Subset selection – "Select the option(s) that seem to you the most likely to be correct for each question; you may select up to three options per question";
- Distractor selection – "Select the option(s) that you think correspond to wrong answers; you may select up to three options per question";
- Strict ordering – "Answer each question by ordering the options according to how likely each one seems to you to be the right answer, where '1' indicates most likely and '4' indicates least likely;
- Repeated selection – "Answer each question by first selecting the option that you think seems most likely to be the right answer, or you may choose to give up. If your first selection is incorrect, you may either make a second selection or give up at that point. If your second selection is incorrect, you may either make a final selection between the two remaining options or give up at that point";
- Repeated distractor selection – "Answer each question by selecting all the options that you think correspond to the wrong answer, or you may choose to give up. If your first selection is incorrect, you may either make a second selection or give up at that point. If your second selection is incorrect, you may either make a final selection between the two remaining options or give up at that point";
- Partial ordering – "Answer each question by ordering the options according to how likely each one seems to you to be the right answer, where '1' indicates most likely and '4' indicates least likely. You may assign an equal rank to any of the options, so that your ranking could be any one of the following: (1–2–3–4), (1–1–3–4), (1–2–2–4), (1–1–3–3), (1–1–1–4), etc;
- Repeated subset selection – "Select the option(s) that seem to you the most likely to be correct for each question; you may select up to three options per question." If their first choice of option(s) does not include the right answer they could then be given a second chance, and then possibly a third chance.

In the literature, other works can be found for MCQ. For instance, Haladyna et al. (2002), Haladyna (2004) and Burton and al. (1991) introduce several formats, but in our opinion they are variants of the traditional format presented in Bush (2015). Liu et al. (2011) present a format designated by Explanation Multiple-Choice Items, consisting of two different parts: the first part is a traditional MCQ, and the second part is a collection of six possible explanations for the choice that the students made previously.

The quality is important in the design and implementation of MCQ. There can be found several works approaching sets of guidelines that guide the construction of MCQ so that quality can be assured (Clegg and Cashin, 1986; Burton *et al.*, 1991; Haladyna, Downing and Rodriguez, 2002; Haladyna, 2004; Camilo and Silva, 2008; Azevedo, 2015).

3. Automatic grading of tests with MS Excel™ spreadsheet: Method and tools

This paper presents a relevant tool in the important phase of teaching and learning implemented with Excel. It was used during several academic years and proved to be efficient. Thus, we find it useful to share it with other researchers. At first, we developed a very basic Excel tool, but it evolved and became increasingly complete and complex, being an essential complement to Moodle for final assessment.

In recent years, we used two types of summative assessment: continuous and final. Regarding continuous assessment, the Excel tool is used as a complement to Moodle, integrating the grades obtained in the MCQ Moodle tests with the students' attendance and participation in the classes. Regarding the final assessment of students not yet approved or who wish to improve grades, the tests are carried out in paper format, are passed to Excel format and finally the scores are automatically generated by the Excel tool.

3.1 MS Excel™ to support paper format exams/tests in final assessment

We start by describing the general structure of the Excel tool we developed to support the assessment in our Math courses.

The first main objective of this tool is to grade the students automatically from their answers. Thus, we created in the first sheet of the Excel a table with the answer key, as shown in the left part of Figure 1. In fact, there are 4 answer keys (in different lines) for each of the 20 questions (in different columns) of the exam, since our final exams consist of 20 questions and 4 different versions (A-B-C-D) of each exam are prepared.

FIRST EXAM – Right choices

Version \ Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	B	D	A	C	C	B	D	A	A	B	D	A	C	B	B	A	D	D	D	C
B	D	B	B	A	A	C	C	D	C	A	B	D	B	C	D	B	A	A	B	D
C	A	C	C	B	D	A	B	B	D	C	C	B	D	A	C	C	B	B	A	A
D	C	A	D	D	B	B	A	C	B	D	A	C	A	D	A	D	C	C	C	B

Correction of Scores

Raw Scores	Corrected Scores
0.00	0
0.50	1
1.50	2
2.50	3
3.50	4
4.50	5
5.50	6
6.50	7
7.50	8
8.50	**10**
9.50	11
10.50	11
11.50	12
12.50	13
...	...

Figure 1: Answer keys per question and per version on final exam and grades correction table

The answer keys of each version are generated randomly using the "RANDBETWEEN" function of Excel, and then the tests are drawn according to these keys.

In Figure 1, a correction table of test scores is shown, on the right side. It can be applied if necessary (in the example, scores of 9 are transformed into 10). These are automatic changes that are carefully defined, whenever there is a need to adjust the grades of all the students.

Another goal of this tool is to generate global statistics on the performance of the group of students enrolled in our courses. In Figure 2, we present an excerpt from an Excel spreadsheet with a set of information, obtained from other spreadsheets in a way that we will explain later. We can say that this looks like a control panel with indicators that describe students' performance on the exam. Some of these statistical indicators are:

- frequency table of scores;
- number of students enrolled, assessed, approved and ratios among these indicators;
- number and percentage of students with right answers (R), wrong answers (W) and no answer (N) per question

TOTALS

First Exam (FE)

Score	Frequency
0	12
1	7
2	9
3	6
4	3
5	5
6	3
7	3
8	0
9	0
10	7
11	3
12	2
13	1
14	0
15	0
16	0
17	0
18	0
19	0
20	0

Statistics of students with right answers (R), wrong answers (W) and no answer (N) per question

	1	2	3	...	9	10	11	...	17	18	19	20
R	16	23	12	...	16	15	9	...	8	15	12	14
W	35	26	31	...	23	27	26	...	11	16	16	23
N	10	12	18	...	22	19	26	...	42	30	33	24
	61	61	61	...	61	61	61	...	61	61	61	61

	1	2	3	...	9	10	11	...	17	18	19	20
R	26.2%	37.7%	19.7%	...	26.2%	24.6%	14.8%	...	13.1%	24.6%	19.7%	23.0%
W	57.4%	42.6%	50.8%	...	37.7%	44.3%	42.6%	...	18.0%	26.2%	26.2%	37.7%
N	16.4%	19.7%	29.5%	...	36.1%	31.1%	42.6%	...	68.9%	49.2%	54.1%	39.3%

Continous Assessment (CA)

Approved	13		
Assessed	61		
Dropout	6		
Approved/Assessed		21%	
Approved/Enrolled		2%	
Assessed/Enrolled		9%	
TOTAL Enrolled	694		

Approved (only enrolled in FE)	8
Assessed (only enrolled in FE)	34
Dropout (only enrolled in FE)	2
Approved/Assessed (only enrolled in FE)	24%
Approved (enrolled in CA)	5
Assessed (enrolled in CA)	27
Dropout (enrolled in CA)	5
Approved/Assessed (enrolled in CA)	19%

Figure 2: Excerpt from an Excel spreadsheet with statistical data

This control panel collects information from other spreadsheets each referring to a class and named by the class notation used in ISCAP, for example C11D1. Figure 3 shows part of one of these sheets whose rows refer to each student in the class and whose columns contain the following information for each student:

- student number
- student name;
- test version;
- the student answers to each exam question;
- information on the student number of right answers, wrong answers and unanswered questions;
- raw score and corrected score, as previously described.

In addition it also includes global statistics about the class such as the ones in Figure 2.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	AT	AU	AV	AW	AX	AY
1		C11D1 - [redacted]																													
2					Answers to questions																										
3	NUMBER	NAME	REGIME	Ver.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		R	W	U	Ctd	Raw Score	Corrected Score
4	[redacted]		C																							#N/A	#N/A	20	#N/A	-	-
5	[redacted]	s	F																							#N/A	#N/A	20	#N/A	-	-
6	[redacted]		F																							#N/A	#N/A	20	#N/A	-	-
7	[redacted]	es	C	A	D	D	A		C	B			A	C			C	B			D					8	2	10	20	7.3	7
8	[redacted]		F	B	D	B	B		C	C	C	D	C	A	A	D	B	C	C					B		11	4	5	20	9.7	10

Figure 3: Excerpt from the Excel sheet of a class

To facilitate the introduction of the students' responses in the spreadsheet, there is a paper form, like the one shown in Figure 4, that students have to fill out with their answer choices. These answers are manually placed by the teachers in the appropriate spreadsheet, starting with the version of the exam that the student does not know because it is encoded in the questions sheet.

Answers Form:

In each question, write the correct option (A, B, C ou D).

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Figure 4: Form for the student to write the answers

With this data structure, you can automatically obtain all the indicators and statistics in the Excel spreadsheets referred to above. The main functions and formulas of Excel that are used are basic arithmetic formulas, simple and combined "IF" function, "VLOOKUP", "ISERROR", "FREQUENCY" and COUNTIF functions.

3.2 MS Excel™ to support Moodle in continuous e-assessment

In the continuous evaluation system, three MCQ tests are usually performed. They are generated randomly from a bank of questions developed in Moodle. However, since Moodle, even the most recent version, does not meet our statistical needs, the Excel spreadsheet has become indispensable.

The structure of the spreadsheet supporting final exams, which we described in subsection 3.1, is the basis of this new sheet, but now Moodle performs the grading of the tests automatically, so we do not need the sheet with the answer keys presented in Figure 1.

The "Control Panel" sheet (Figure 2), is now the first element of this tool and includes the following statistical information organized by test and by attendance regime to classes (nocturnal versus diurnal), that is, obtained for each of the tests and for all together, and also for the day and night students and for the totality of the students together:

- frequency table of scores;
- number of students enrolled, evaluated, approved and ratios among these indicators;
- number and percentage of students with right answers (R), wrong answers (W) and no answer (N) per question.

The complexity of our assessment system includes an incentive component to attendance and participation in classes, so we need to define in this Excel sheet a table (Figure 5) to quantify this evaluation component.

	Global Parameters	
	Missed classes (lower limit)	Bonus
	0	1.00
	2	0.75
	4	0.50
	6	0.00

Figure 5: Table to grade class attendance

In addition to the three continuous assessment tests, we introduced in the last year the possibility of the students who have completed all the tests and failed to pass to take a make-up test that replaces one of the three tests. The choice of the test is made by the student and Excel automatically controls who can take the make-up test (Figure 7 and Figure 8). One of the problems that has not yet been solved by Moodle, is to correct the negative grades to zero. However, this problem is fixed in Excel. For this purpose, a different spreadsheet was created for each of the continuous assessment tests and for each of the make-up tests, as shown in Figure 6. After exporting Moodle data to Excel, the negative grades are corrected, and each student's record in the corresponding class spreadsheet (Figure 7) is automatically updated.

	1st TEST CONTINOUS ASSESSMENT					Note: Students who take th	
NUMBER	NAME	Moodle Score	1st Test Score	CLASS		Raw Score	Frequency
[redacted]	[redacted]	5	5.00	C13D1		0	128
		-0.33	0.00	Q11N		1	91
	PES	1.67	1.67	Q11D2		2	104
		5	5.00	C13D1		3	69
		2.67	2.67	C13D1		4	45

Figure 6: Table with scores

The spreadsheet of each class (Figure 7) contains in each line all relevant information of a student, namely partial scores (of each test), conditional final score (before make-up test) and final score (after make-up test) and controls whether a student can take the make-up test. In addition, various class statistics are generated which are the basis of the global statistics already mentioned above and presented in Figure 9.

								Without Make-up Test			Scores of Make-up test				With Make-up Test	
Assessment type	T1	T2	T3	Raw Score	Missed classes	Bonus	Score with bonus	Rounded Score	Make-up test	MUT1	MUT2	MUT3	Raw Score	Score with bonus	FINAL SCORE
C	5.00	7.00	6.67	**18.67**	0	1.00	19.67	**20**	-	-	-	-	-	-	**20**
C	1.33	4.33	6.67	**12.33**	3	0.75	13.08	**13**	-	-	-	-	-	-	**13**
F	-	-	-	-	100	0.00	-	-	-	-	-	-	-	-	-
C	2.00	2.33	3.67	**8.00**	1	1.00	9.00	**10**	-	-	-	-	-	-	**10**
C	0.00	1.00	5.33	**6.33**	0	1.00	7.33	**7**	Can do it	1.67	-	-	**8.00**	9.00	**10**
C	1.33	2.33	2.67	**6.33**	1	1.00	7.33	**7**	Can do it	-	-	2.33	**6.33**	7.33	**7**
C	1.67	4.67	4.67	**11.01**	7	0.00	11.01	**11**	-	-	-	-	-	-	**11**

Figure 7: Excerpt from the Excel sheet of a class

For the spreadsheet of the 3rd test, in order to be easy and quick to publish the corrected score and students can do the make-up test, we collect information of each class spreadsheet and we publish all students ordered by name; thus it is not necessary to publish each class spreadsheet with this information. After students take the make-up test, we also collect the final score to be easily published (Figure 8).

	3rd TEST CONTINOUS ASSESSMENT						
NUMBER	NAME	Moodle Score	3rd Test Score	Corrected Score	Make-up test	CLASS	FINAL SCORE
[redacted]	[redacted]	4.00	4.00	5	Can do it	C17D	5
		2.33	2.33	10	-	C17D	10
		7.00	7.00	16	-	C17D	16
	A	4.33	4.33	7	Can do it	C17D	12
	AS	-0.33	0.00	3	Can do it	Q11D2	4

Figure 8: Table with scores in 3rd test and other scores

TOTALS		DIURNAL		NOCTURNAL	
Score	Frequency	Score	Frequency	Score	Frequency
0	47	0	30	0	17
1	36	1	20	1	16
...	...	...	...	...	...
19	6	19	5	19	1
20	17	20	13	20	4
Approved	259	Approved	194	Approved	65
Assessed	470	Assessed	331	Assessed	139
Enrolled	572	Enrolled	402	Enrolled	170
Approved/Assessed	55.1%	Approved/Assessed	58.6%	Approved/Assessed	46.8%
Approved/Enrolled	45.3%	Approved/Enrolled	48.3%	Approved/Enrolled	38.2%
Assessed/Enrolled	82.2%	Assessed/Enrolled	82.3%	Assessed/Enrolled	81.8%
Approved by make-up test	34	Approved by make-up t	21	Approved by make-up	13
1st test		1st test		1st test	
Assessed	465	Assessed	345	Assessed	120
...	...	...	...	...	...
3rd test		3rd test		3rd test	
Assessed	347	Assessed	267	Assessed	80
1st Make-up test		1st Make-up test		1st Make-up test	
Assessed	30	Assessed	19	Assessed	11

Figure 9: Excerpt with some statistics

The main functions of Excel that are used are basic arithmetic functions, “IF”, “ISERROR”, “FREQUENCY”, “COUNTIF”, “ISNA”, “ISNUMBER”, “ISTEXT”, “MAX”, “LOOKUP”, “VLOOKUP”, “INDIRECT”, “INDEX” e “MATCH”.

4. Results

With this tool we were able to reduce the time to grade the tests and the exams. This conclusion is documented in interviews with teachers who participated in this e-assessment process:

“the automatic process of obtaining the student grades represents a great saving of time; *In the matter of the time that one has to spend on course is more about creative aspects and less about 'minor' aspects like those of correcting tests”* (Azevedo, Oliveira and Beites, 2017, pp. 139–140)

The students also mentioned this feature in a survey: Faster grading (Azevedo, 2017, pp. 160–170).

Besides the grading system is error free – "There are no errors in the correction” (Azevedo, 2017, pp. 160–170) – and we have been able to manage fraud more efficiently, for example, by eliminating the possibility of duplicate tests of the same student.

The global indicators obtained and statistical analysis developed are also fundamental for evaluating the courses and help you make decisions to improve less positive aspects. We can also compare results from different years and analyze the impact of certain measures.

As an example, we present the result of the last three years in Figure 10. We can see that the number of students with a positive score (greater than 50%) is clearly lower than in the following two tests, the students scored better in the 3rd test, and the students who take the second make-up test are less successful than those who take the other make-up tests.

year N-2				year N-1				year N			
1st test		>=50%		1st test		>=50%		1st test		>=50%	
Assessed	508	157	31%	Assessed	518	152	29%	Assessed	465	171	37%
2nd test				2nd test				2nd test			
Assessed	437	142	32%	Assessed	450	145	32%	Assessed	387	163	42%
3rd test				3rd test				3rd test			
Assessed	375	182	49%	Assessed	382	152	40%	Assessed	347	169	49%
Approved/Assess	41.1%	Before Make-up test		Approved/Ass	39.8%	Before Make-up test		Approved/Assessed		47.8%	Before
1st Make-up test				1st Make-up test				1st Make-up test			
Assessed	44	14	32%	Assessed	41	13	32%	Assessed	24	7	29%
2nd Make-up test				2nd Make-up test				2nd Make-up test			
Assessed	52	12	23%	Assessed	47	13	28%	Assessed	38	8	21%
3rd Make-up test				3rd Make-up test				3rd Make-up test			
Assessed	38	10	26%	Assessed	49	18	37%	Assessed	30	12	40%
Assessed/Enrolled		81%		Assessed/Enrolled		77%		Assessed/Enrolled		82%	
Approved/Assess	52%	After Make-up test		Approved/Ass	54%	After Make-up test		Approved/Assesse	55%	After Make-up	

Figure 10: Statistical data obtained with spreadsheet Excel

5. Conclusion, limitations and future work

In general, this tool is a powerful aid in evaluating students, both during the semester and during the final assessment process. As far as we know there are no similar works.

Despite some initial doubts, the development of the process of continuous evaluation using computational tools counted on the increasing adhesion of all the teachers and had a very positive impact in all of them. This statement is documented in Azevedo, Oliveira and Beites (2017, pp. 139–140):

> *"All teachers reported a very positive opinion about the type of assessment implemented and unanimously agreed that this was a good assessment system."*

This Excel tool is a complement to Moodle that is fundamental to our teaching activity. It automatically provides a set of useful statistics for teachers to analyze and seek to improve outcomes.

With regard to limitations, ISCAP does not yet allow scores to be automatically transferred from the spreadsheet to the Online Secretariat for publication.

As future work, we intend to expand the statistical analysis and allow the inclusion in the worksheet of other evaluation parameters, such as homework and other student projects.

References

Azevedo, J. (2015) 'e-Assessment in Mathematics Courses with Multiple-choice Questions Tests', in *Proceedings of the 7th International Conference on Computer Supported Education (CSEDU 2015)*. Lisboa, pp. 260–266. doi: 10.5220/0005452702600266.

Azevedo, J. M. (2017) *Avaliação sumativa em matemática no Ensino Superior com recurso a questões de escolha múltipla: uma abordagem utilizando a metodologia investigação-ação*. Universidade da Beira Interior.

Azevedo, J. M., Oliveira, E. P. and Beites, P. D. (2017) 'How Do Mathematics Teachers in Higher Education Look at E-assessment with Multiple-Choice Questions', *Proceedings of the 9th International Conference on Computer Supported Education*, 2(Csedu), pp. 137–145. doi: 10.5220/0006324801370145.

Blanco, M. and Ginovart, M. (2012) 'On how moodle quizzes can contribute to the formative e-assessment of first-year engineering students in mathematics courses', *RUSC Universities and Knowledge Society Journal*, 9(1), pp. 354–370. doi: 10.7238/rusc.v9i1.1277.

Botički, I. and Milašinović, B. (2008) 'Knowledge assessment at the faculty of electrical engineering and computing', in *Proceedings of the International Conference on Information Technology Interfaces, ITI*. Cavtat, pp. 111–116. doi: 10.1109/ITI.2008.4588392.

Bull, J. and Danson, M. (2001) *Assessment series N.º 14 - computer-assisted assessment (CAA)*. York: Learning and Teaching Support Network (LTNS).

Burrow, M., Evdorides, H., Hallam, B. and Freer-hewish, R. (2005) 'Developing formative assessment for postgraduate students in engineering', *European Journal of Engineering Education*, 30(2), pp. 255–263. doi: 10.1080/03043790500087563.

Burton, S., Sudweeks, R., Merrill, P. and Wood, B. (1991) *How to prepare better multiple-choice test items: guidelines for university faculty*, *Brigham Young University Testing Services and The Department of Instructional Science*. Available at: http://testing.byu.edu/info/handbooks/betteritems.pdf.

Bush, M. (2015) 'Reducing the need for guesswork in multiple-choice tests', *Assessment & Evaluation in Higher Education*, 40(2), pp. 218–231. doi: 10.1080/02602938.2014.902192.

Camilo, H. and Silva, J. A. P. da (2008) *Os testes de escolha múltipla (TEM)*, *Essências EDUcare*. Departamento de Educação Médica da Faculdade de Medicina - Universidade de Coimbra.

Clegg, V. L. and Cashin, W. E. (1986) *Improving multiple-choice tests*. Kansas State University: Center for Faculty Evaluation & Development.

Cook, J. and Jenkins, V. (2010) *Getting started with e-assessment*. Available at: http://opus.bath.ac.uk/17712/1/Getting_started_with_e-assessment_14Jan2010.pdf.

Dascalu, M. and Bodea, C. (2010) 'Challenges in building e-assessment services from project management knowledge perspective', *International Journal of Global Management Studies Professional*, 2(1), pp. 35–50.

Flores, M. A., Simão, A. M. V., Barros, A. and Pereira, D. (2015) 'Perceptions of effectiveness, fairness and feedback of assessment methods: a study in higher education', *Studies in Higher Education*, 40(9), pp. 1523–1534. doi: 10.1080/03075079.2014.881348.

Green, A. and Mitchell, C. (2009) 'E-assessment: opportunities and challenges for the sports marketing and educator', in *Proceedings of the 2nd International Conference of Teaching and Learning (ICTL 2009)*. Kuching, pp. 1–9.

Gruttmann, S., Böhm, D. and Kuchen, H. (2008) 'E-assessment of mathematical proofs: chances and challenges for students and tutors', in *2008 International Conference on Computer Science and Software Engineering (CSSE 2008)*, pp. 612–615. doi: 10.1109/CSSE.2008.95.

Guo, R., Palmer-Brown, D., Lee, S. W. and Cai, F. F. (2014) 'Intelligent diagnostic feedback for online multiple-choice questions', *Artificial Intelligence Review*, 42(3), pp. 369–383. doi: 10.1007/s10462-013-9419-6.

Haladyna, T. M. (2004) *Developing and validating multiple-choice test items - third edition*. 3rd edn. Mahwah, New Jersey: Lawrence Erlbaum Associates. doi: 10.1177/0146621605280143.

Haladyna, T. M., Downing, S. M. and Rodriguez, M. C. (2002) 'A review of multiple-choice item-writing guidelines for classroom assessment', *Applied Measurement in Education*, 15(3), pp. 309–333. doi: 10.1207/S15324818AME1503_5.

Hauk, S., Powers, R. A. and Segalla, A. (2015) 'A comparison of web-based and paper-and-pencil homework on student performance in college algebra', *PRIMUS: Problems, Resouces, and Issues in Mathematics Undergraduate Studies*, 25(1), pp. 61–79. doi: 10.1080/10511970.2014.906006.

Holmes, N. (2015) 'Student perceptions of their learning engagement in response to the use of a continuous e-assement in a undergratuate module', *Assessment & Evaluation in Higher Education*, 40(1), pp. 1–14. doi: 10.1080/02602938.2014.881978.

JISC (2006) *E-assessment glossary (extended)*, *Joint Information Systems Committe*. Available at: http://www.jisc.ac.uk/media/documents/themes/elearning/eassess_glossary_extendedv101.pdf (Accessed: 15 September 2014).

JISC (2007) *Effective practice with e-assessment: an overview of technologies, policies and practice in further and higher education*, *Joint Information Systems Committe*. Available at: http://www.jisc.ac.uk/media/documents/themes/elearning/effpraceassess.pdf (Accessed: 15 September 2014).

Jordan, S. (2013) 'E-assessment: past, present and future', *New Directions*, 9(1), pp. 87–106.

Liu, O. L., Lee, H.-S. and Linn, M. C. (2011) 'An investigation of explanation multiple-choice items in science assessment', *Educational Assessment*, 16(3), pp. 164–184. doi: 10.1080/10627197.2011.611702.

Llamas-Nistal, M., Fernández-Iglesias, M. J., González-Tato, J. and Mikic-Fonte, F. A. (2013) 'Blended e-assessment: migrating classical exams to the digital world', *Computers & Education*, 62(1), pp. 72–87. doi: 10.1016/j.compedu.2012.10.021.

Mathai, E. and Olsen, D. (2013) 'Studying the effectiveness of online homework for different skill levels in a college algebra course', *PRIMUS: Problems, Resouces, and Issues in Mathematics Undergraduate Studies*, 23(8), pp. 671–682. doi: 10.1080/10511970.2013.782479.

McAlpine, M. (2002) *A summary of methods of item analysis*. Leicestershire: The CAA Centre TLTP Project.

McGuire, G. R., Youngson, M. A., Korabinski, A. A. and McMillan, D. (2002) 'Partial credit in mathematics exams - a comparison of traditional and CAA exams', in *Proceedings of the 6th CAA Conference*. Loughborough: Loughborough University, pp. 223–230.

Mora, M. C., Sancho-Bru, J. L., Iserte, J. L. and Sánchez, F. T. (2012) 'An e-assessment approach for evaluation in engineering overcrowded groups', *Computers & Education*, 59(2), pp. 732–740.

Moscinska, K. and Rutkowski, J. (2012) 'Rethinking e-assessment in a core engineering course', in *Global Engineering Education Conference (EDUCON)*. 2012 IEEE, pp. 1–4. doi: 10.1109/EDUCON.2012.6201136.

Redecker, C. (2013) *The use of ICT for the assessment of key competences*. Luxembourg: European Union. doi: 10.2791/87007.

Redecker, C. and Johannessen, Ø. (2013) 'Changing assessment - towards a new assessment paradigm using ICT', *European Journal of Education*, 48(1), pp. 79–96. doi: 10.1111/ejed.12018.

Rod, J. K., Eiksund, S. and Fjaer, O. (2010) 'Assessment based on exercise work and multiple-choice tests', *Journal of Geography in Higher Education*, 34(1), pp. 141–153. doi: 10.1080/03098260903062039.

Rust, C. (2001) *Assessment Series n.º 12 - a briefing on assessment of large groups*. York: Learning and Teaching Support Network (LTNS).

Salas-Morera, L., Cubero-Atienza, A. J., Redel-Macías, M. D., Arauzo-Azofra, A. and García-Hernández, L. (2012) 'Effective use of e-learning for improving students' skills', in Babo, R. and Azevedo, A. (eds) *Higher Education Institutions and Learning Management Systems*. Hershey, PA: IGI Global, pp. 292–314. doi: 10.4018/978-1-60960-884-2.ch014.

Sorensen, E. (2013) 'Implementation and student perceptions of e-assessment in a chemical engineering module', *European Journal of Engineering Education*, 38(2), pp. 172–185. doi: 10.1080/03043797.2012.760533.

Stödberg, U. (2012) 'A research review of e-assessment', *Assessment & Evaluation in Higher Education*, 37(5), pp. 591–604. doi: 10.1080/02602938.2011.557496.

Vora, S. S. and Shinde, S. A. (2014) 'A service oriented approach for an e-assessment system', *International Journal of Engineering Research & Technology*, 3(5), pp. 1468–1474.

Wilson, K., Boyd, C., Chen, L. and Jamal, S. (2011) 'Improving student performance in a first-year geography course: examining the importance of computer-assisted formative assessment', *Computers and Education*, 57(2), pp. 1493–1500. doi: 10.1016/j.compedu.2011.02.011.

Yorke, M. (2001) *Assessment series n.º 1 - assessment: a guide for senior managers*. York: Learning and Teaching Support Network (LTNS).