ONLINE ASSESSMENT THROUGH MOODLE PLATFORM

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Abstract

The differences between secondary education and Higher Education (HE) are numerous, both in terms of teaching methodologies and as well as evaluation/validation procedures.

Until a few years ago, the HE assessment practices were reduced, with some exceptions from practical/laboratory curricular units, to written exams, carried out on the same day and at the same time by all, or, at most, two frequencies (tests) over the course of the semester or year. With growing concerns in terms of learning outcomes and students' success, globalisation and the massification of education, several alternative models have been tested, both in terms of teaching/learning methodologies (flipped, project-based, "blended", among others) and assessment practices (portfolio, continuous, segmented, formative, and others). The fast development of electronic devices has been promoting the development and sharing of several digital educational tools and their use seem to be a good choice to promote actual students'/professors' interaction and corresponding socialization, even in some assessment tasks. In this particular case, online activities can be transformed into powerful self-assessment resources for students, stimulating reflection and promoting independent learning.

Moodle, as an open Learning Management System (LMS), has all the requisites and potential features to be a fine supporting tool to several activities, specifically to assessing ones.

In this paper, we will briefly describe Moodle potentialities, with some application examples based on literature review and present the work developed on several Mathematic curricular units from different schools of the Polytechnic of Porto, where Moodle is used as an online assessment tool, to promote a continuous/segmented model with specific and different activities designed for each course.

Keywords: Math, Higher Education, Assessment, Moodle, Quiz, Formative Assessment.

1 INTRODUCTION

Bologna Declaration scope and Generation Z entering HE seems an "explosive mixture" to which Higher Education Institutions (HEI) must foresee to adapt, motivate, challenge and inspire, since this is the first generation that was raised in the "smartphone area". From the "marketer" point of view there are numerous news referring interesting studies and reports ([1], [2], [3]) that contributes to keep in mind that generational features are distinct from preceding generations (even from "Millennials") and HEI must be aware of these "movements" and have the ability to deal with this global and real changes. As Turner states ([3], pp.111): "An unwillingness to take a different generation's frame of reference into account can contribute to misunderstanding, miscommunication, and discouragement." and this issue is much more relevant if we analyze the diverse features from distinct generations and their respective role in the educational process.

Table 1. Generation Classification and Role (Adaptation from [4])

Birth Years	Alphabetic Classification	Alternative Designation	Role
Not after 1945	Generation V	N/A	Retired
1946 - 1964	Generation W	Baby Boomers	Teachers
1965 - 1976	Generation X	Digital Immigrants	Teachers
1977 - 1994	Generation Y	Digital Natives	Teachers/Students
1995 - present	Generation Z	Net Generation	Students

Being in an HEI for almost thirty years (somewhere between Gen W and earlies Gen X), we were, and still are, conscious that our work routines must evolve and constantly adapt to all these differences in students' behaviors over time. With millennials and now with Gen Z, we felt an enormous necessity and the importance of dealing and promoting students' independence in constructing their own learning path, being there in an almost "24 hours base" to support and guide them. In this sense, Moodle as a LMS gave us a "work station" or an "online office" that allows the development of our support work having in mind the specific and general objectives and expected outcomes of our curricular units in Mathematics. Therefore, we try to constantly integrate technology into the educational process in a meaningful way, relying on its potentialities for e-assessment to help and enhance students' experience, providing a variety of learning opportunities. In that vein, this "directed" learning and assessment aims to offer students all the educational strategies they can adapt to their individual needs and, in terms of assessment, Information and Communications Technology (ICT) "offer the chance of providing personalized feedback on student's performance at any stage of the learning process and therefore guiding them in a more flexible and individualized way" ([5], pp. 35).

There is already an enormous amount of literature available on the use of ICT in HEI even specifically about online assessment in higher education [6], some with remarkable focus on its combination with flipped classroom methodologies and generally using Moodle LMS to develop and support all the work and investigation procedures and tasks (e.g. [7], [8], [9], [10], [11], [12], [13]).

From the wide range of core tools provided by Moodle [14], we can see in Fig. 1 the commonly most used, with the emphasis to the assessment ones.

Figure 1 Most used core tools from Moodle ([14], pp. 7)

Regarding the assessment tools and options (only around 14% of the global tools use), our focus here will be on the Quiz module and all its development phases regarding Mathematics' projects that support assessment development in several Math curricular units.

2 ONLINE MATH ASSESSMENT THROUGH MOODLE QUIZ TOOL

Online assessment, also mentioned as e-assessment, technology-enhanced assessment, computer adaptive assessment, among many other designations may be referred as the global process where ICT are used to present all possible assessment activities or tasks and, at the same time, record and save all users/students answers [15] (as, for instance: papers, comments, contributions, test answers, etc).

When developing an on-line assessment, based on the Quiz Moodle tool, we must consider several fundamental and distinct phases: the Quiz objectives – based on MATH taxonomy (Mathematical Assessment Task Hierarchy) [16]; question design in accordance to the defined objectives; question bank editing per category – each with quite a few distinct, but equivalent, questions; quiz construction with questions randomly selected from a category inside the question pool. These are just a few among many other general and global issues to always have in mind in a Quiz construction (see [17], [18], [19], for specific support and tips).

Inside Quiz Moodle tool, the options and variations are numerous, and the first crucial choice is the question type (Fig. 2) that is more suitable for each course objectives (for more detailed descriptions see [20]).

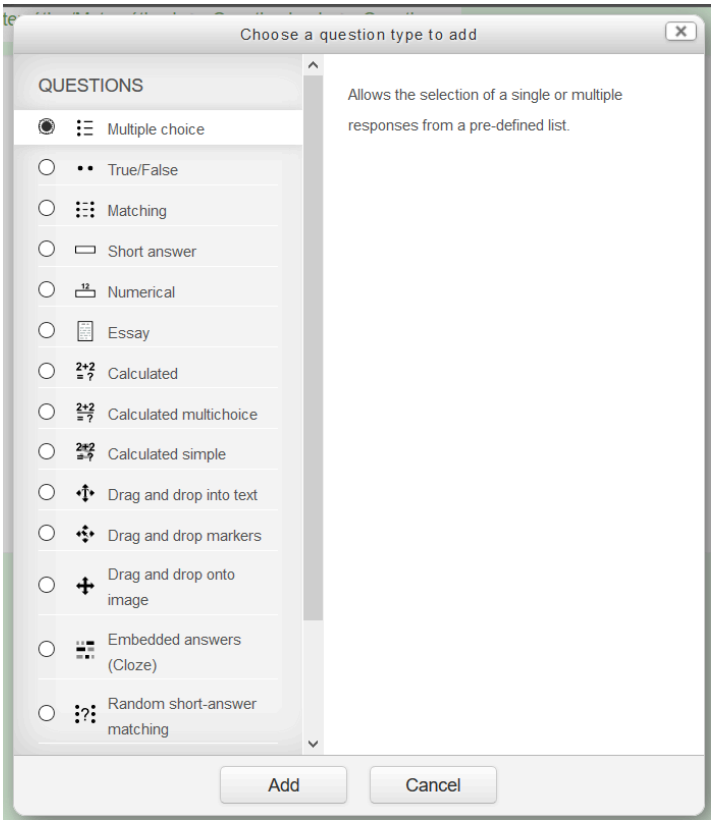

Figure 2 - Screen-shot from Moodle Question types

In our Math question banks, the most common question type is Multiple Choice (single or multiple-answer questions, that may include pictures, sound or other media in the question and/or answer options (by inserting HTML)), where we always weight individual answers and also present individual feedback with proposed step by step solution.

The second one is Embedded Answers (Cloze) questions that consist of a passage of text (in Moodle format) that has various answers embedded within it, including multiple choice, short answers and numerical answers. This type is more flexible and adjustable to several course objectives, however leads to a lot of stress in coding since we have to deal with mathematical text and symbols (usual relying on a LaTeX Moodle plug in) that sometimes conflicts with the embedded Moodle text format (see coding description options at [21]).

As mathematical aptitudes and tasks should be classified in different requested levels of mastery of knowledge, the MATH taxonomy seems to be more appropriate in Math area than the usual Bloom taxonomy [22]. This taxonomy uses eight different descriptors and, in respect to the assessment here described, we can see some examples on table 2.

Table 2. Classification examples – MATH taxonomy

Levels	**Question example**
Factual knowledge	Point out the only true statement: ☐ The quotient of two nonzero integers is a fractional number; ☐ A radical represents an irrational number; ■ The quotient of two nonzero integers is a rational number; ☐ All the statements are true.
Comprehension (recognition of formulas and situations)	In the plane, the equation $y+x^2=4$ defines a: ☐ Strait line; ■ Parabola ☐ Circumference ☐ Hyperbole
Routine use of procedure or algorithms	$2^{(4.\log_2 a)+1} = \ldots$: ■ $2a^4$ ☐ $4a+2$ ☐ a^4+2 ☐ $16a+2$
Information transfer (classification of math objects)	Point out the true statement: ☐ $\forall_{x\in\mathbb{Z}} : x\in\mathbb{R}$ ☐ $\exists_{x\in\mathbb{R}}\forall_{y\in\mathbb{R}} : x.y=y.x=y$ ☐ $\forall_{x,y\in\mathbb{R}} : x+y=y+x$ ■ All the statements are true.
Application in new situations (planning work, selection of methods)	The line $x=1$ and the parabola $y=(x-1)^2$ are: ☐ Intersect in 2 points; ■ Are normal at (1,0) ☐ Are tangent at (1,0); ☐ Never intersect
Justifying, proof, reasoning and interpreting	Here is an attempt to solve an inequality: $\frac{3x-1}{x+1}<2 \underset{(a)}{\Leftrightarrow} 3x-1<4(x+1)$ $\underset{(b)}{\Leftrightarrow} 3x-1<4x+4$ $\underset{(c)}{\Leftrightarrow} -x<5 \underset{(d)}{\Leftrightarrow} x<-5$ Which of the presented steps fail: ☐ None ☐ Only (a) ☐ Only (d) ■ (a) and (d) ☐ All
Implications, making conjectures, comparisons and finding pattern	If x and y are real numbers that verify $x<y$, point out the true statement : ☐ $x^2<y^2$ ■ $2x+a<x+y+a, \forall a$ ☐ $\frac{x}{y}<1$ ☐ $a.x<a.y, \forall a$ ☐ All the statements are true.
Evaluation	Point out the true statement: ☐ $\lim\limits_{x\to+\infty}\frac{2x-5}{3x-x^2}=\frac{2}{3}$ ■ $\lim\limits_{x\to 1}\frac{x^2-1}{x^2+x-2}=\frac{2}{3}$ ☐ $\lim\limits_{x\to+\infty}\left(1-\frac{2}{x}\right)^x=e^2$ ☐ $\lim\limits_{x\to+\infty}\left(1-\frac{2}{x}\right)^{\frac{2}{x}}=e^{-2}$

Another important issue, when developing a question bank in Moodle, is the questions validation since these should be in accordance to each taxonomic level set in the course objectives, trying to avoid too hard or too easy questions. Whenever a set of questions is launched, these should be submitted to a "piloting" process before entering a final specific category in the question pool, since, afterwards, assessment quizzes will be randomized, picking questions from pointed categories.

Finally, we must mention that the development of a "Question Bank/Pool", that as we already mentioned, randomly generates several different quizzes and tests, besides each question specific objective goal and before the respective validation, must be sectioned in several distinct stages, like, for instance:

- Questions collection and compilation;
- Proposed solution and questions resolution preparation;
- Scientific and pedagogical review of proposed step by step solution;
- Questions typing and cataloguing in categories and sub-categories on the Moodle platform;
- Proposed feedback and step by step solution typing questions in the Moodle platform.
- Question and answer review.

Notice that, since Math language is still treated, in Moodle platform, through a plugin that transforms LaTeX language into Math formulas (as images), any and all mathematical expressions (in the questions or in the proposed solution step by step) has to be typed using this programing language, what makes this work more delicate, time consuming and prone to editing errors.

3 FORMATIVE ASSESSMENT BASED ON MATACTIVA AND M100S PROJECTS QUESTION BANKS

For more than a decade we have been developing and promoting several Math projects and ventures in the Polytechnic of Porto (P.PORTO), our Institution (see [23-33]), and some, in particularly, based on its distinct Organic Units namely: School of Accounting and Administration (ISCAP), School of Hospitality and Tourism (ESHT), School of Media Arts and Design (ESMAD) and School of Management and Industrial Studies (ESEIG- extinct in July 2016).

The two biggest Projects are MatActiva from ISCAP (closed for ISCAP community) and Math "without" Stress (M100S) from P.PORTO (Math MOOC platform in Portuguese language) have quizzes and tests that rely on two enormous and distinct question banks with, currently and respectively, more than 1 700 and 600 questions with proposed solutions, along with several other sections like video-lectures, support texts, proposed exercises.

Some teaching experiences, supported by these and other connected Moodle platforms have been settled by some of the team members (see, for example, [33]) and were held in ISCAP, ESMAD and ESHT, where some degrees comprise, at the first years, courses of Quantitative Methods or General Mathematics. These courses aim is to deepen and consolidate Math skills and competences acquired during high school, specifically of Science courses and Technologies (for ESMAD degrees in the field of Web Technologies, Information Systems and Game Design) and Socio-economic Sciences (for ISCAP and ESHT degrees in the Management field). Based and seconded by own and several other's experiences ([30], [34-36]), even at a College-level ([37]), blended and flipped strategies were developed, trying to make good use of the new technological advances, encouraging students' participation and engagement through digital and technological resources (trying to take advantage of students' digital skills), among several other stratagems and schemes, that went further beyond teachers' scientific and academic training.

Moodle pages were built for each course, in a Topic Format division, containing all types of support materials, composed of the following main sections:

- General Information and Discussion Forum;
- Past Exams and Tests;
- Forms and Formulas;
- Supporting Texts;
- Proposed Application Exercises;
- Other resources – Videos, Quizzes and Links.

The sections: Supporting Texts and Proposed Application Exercises were divided in several subsections by revision and syllabus item.

Concerning the quizzes, students could have multiple attempts at each one of them. This can help to transform the quiz taking process into a real formative assessment contributing to students autonomy as it is transformed into an educational activity. Since all quizzes are randomized, students will get a new version in each attempt. Feedback was provided for each question, allowing the students to see one (of the possible) proposed solution, step by step, as showed in Fig.3. The Pools of Questions are

categorized separately by learning items (modules) and each section has four subsections, namely: Easy, Medium, Difficult and Public Tests/Exams.

Figure 3 - Screenshots of the Multiple-Choice Questions with General Feedback from M100S bank

In short, there were two main lines of work, supported by online materials available in the distinct platforms: ESHT/ESMAD/ISCAP Moodle and M100S platform. In the first one, all resources, contents and their respective adjustment and modification were completely and directly manageable, as well as students monitoring. However, in MOOC platform, even with an "editor teacher" profile, the adjustments were very limited, always depending upon P.PORTO staff availability.

For any specific subject, the use of each resource – video/text/quiz – was calendarized and subsequently worked on presential sessions through problems, exercises and tasks, individually and in group.

Based on Moodle Platform reports there were some interesting and quite unpredictable results since students seem more reluctant in using "new" resources than what was expectable. It must be noticed that, essentially freshmen, were very insecure and dependent on the traditional face-to-face lesson, relying essentially on Supporting Texts and Proposed Exercises. Despite the degree students are enrolled in, their behavior was not significantly distinct - when introducing a subject, students tend to "work" a little bit "more" – there were some access "peaks" when starting a "new" subject but this "movements" slows down afterwards.

In a short survey, at the end of the semester, students were asked to "Rate the importance of having each of the following resources as a valid contribute to your learning process" in a 1 to 6 points (Likert Scale), where 1 meant "not-important" and 6 "very important" and quizzes were on "the top" 88,5% of positive feedback

4 FINAL COMMENTS

Formative assessment seems a good resource to engage students into a Math course, always a problematic one when not in Mathematic degrees. Through all the semester, and all the evaluation tasks, we could observe that students seemed much more engaged in the global teaching/learning process, constantly connected to Moodle system, both for practice and assessment purposes through all the quizzes and on-line training tests available.

This formative assessment had a global positive feedback from the students, that pointed as an important and crucial asset, that has contributed to "stay focused" (and not leave) when things did not run for the best, the fact that all the questions had a proposed step by step solution, that helped them to understand wat went wrong in an "autonomous way".

From a global point of view, we may state that formative e-assessment feedback from students and lecturers enrolled exceeded our expectations. The experience allowed us to track each students' learning process and throughout the whole duration of the course. Additionally, we could also obtain the students' practice and assessment data through reports such as logs, live logs, activity participation and course participation, using the available Moodle Learning Analytic tools or supplements/plugins as Gismo.

However, implementing a robust and good e-assessment, at least in Mathematic area, is very time consuming and far from being an easy task as, we hope, we have transmitted in this short paper. We

must agree with that "…Moodle quizzes are a consistent and reliable tool for formative e-assessment…" ([10], pp.368).

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