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Peer assessment in MOOCs based on learners' profiles clustering

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Abstract— **Over the last several years, Massive Open Online Courses (MOOCs) have received significant coverage in the higher education literature. They are the most recent development in open online distance learning. Thus, the most challenging is designing an accurate method to evaluate and provide feedbacks, especially for open questions (especially Problem Situation), since the high number of learners. To tackle this problem, MOOCs use peer assessment techniques (known as peer grading) that suffer from a lack of credibility. In this paper, we present a new method for peer assessment in the Massive Open Online Courses, in order to improve the accuracy of grading results. Our proposition is divided into three (3) steps: clustering unit, assessment and treatment of the results. The clustering unit is the task of grouping learners with similar profiles. Clustering unit aims to group learners based on the parameters stored on learners' modeling within the MOOCs. After the clustering unit, the learners are required to grade a small number of their peers' tasks as part of their own task. Afterwards, the scores are dispatched for treatments where a synthesis is given for assessment. To assess the feasibility of the proposed peer assessment, we report here the results of the tests conducted on the developed prototype.**

Keywords— Massive Open Online Courses (MOOCs); Peer assessment; Assessment; Clustering of learners; E-learning; Feedback.

I. INTRODUCTION

Massive Open Online Courses (MOOCs) platforms have emerged as significant environments for online learning, that involve massively learners. Siemens and Al. declare MOOCs as the higher education buzzword for 2012 [1]. These MOOCs appear to be as much about the collective grasping of universities' leaders to bring higher education into the digital age [2]. Therefore, MOOCs have characteristic and challenges of their own, due mostly to the large number of simultaneous learners. One of these challenges is about learners' assessment. Indeed, individualized Problem Situation (PS) feedback cannot be delivered by using automated assessments. Today's, peer assessment (PA) is employed in MOOCs as an attempt to tackle this issue [3] [4] [5].

Peer assessment can be defined as the process whereby learners are involved in grading and giving feedback from the work of their peers. The use of PA has been recognized as one feature that affects the effectiveness of MOOCs. It encourages learners' involvement / responsibility, in the learning process, develops their capacity to reflect on and critically evaluates their own learning and skill development. However, PA has some challenges. Firstly, the use of PA may lead to uninformed people leading others who are similarly incapable [6]. Then, generally, learners may not have the necessary knowledge and experience to assess their peers' respective works. The third challenge is about the consistency or quality of the peers' respective feedbacks. Hence, some learners take the peer grading responsibility seriously and gave meaningful comments but majority are hardly engaged [7]. Finally, PA can increase a learner's workload. To reduce the impact of these challenges, we propose a new method for peer assessment in MOOCs that composed of three main (3) steps: clustering units, peer grading and treatment of the results.

In section II, we give the background knowledge about peer assessment, especially in MOOCs. Then, we present in section III our proposition that consists on peer assessment based on learners' profile clustering. Section IV displays the first evaluation and validation of our proposition. We conclude with a summary about our contribution and a view on our future works.

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II. BACKGROUND KNOWLEDGE ABOUT PEER ASSESSMENT

Student involvement in assessment appears to have been increasing in higher education. It typically takes the form of peer assessment (PA). In PA, students judge the work of their peers [8], and encourage them to take greater responsibility for their learning and to identify their strengths and weaknesses. In addition, peer assessment is mainly used to involve students directly in the learning process and may promote a personal responsibility, and motivation [9].

PA looks to be an ideal tool for MOOCs to bring complex assignments and feedback to large number of learners. The essential parts of the PA on all MOOC platforms are a submission step, a peer assessment step, and a result step [10]. In the literature, we found different works about PA, the main ones are as follows:

- The Calibrated Peer Reviews (CPR) system [11] [12] that assigns weights to learners' ratings according to their relative degree of accuracy [4]. According to Staubitz and Al., Coursera determines a competency index for participants, which is used as a weight for the actual grading and edX requires participants to reach an accuracy threshold before they can proceed to PA [10].
- The Cloud Teaching Assistant System (CTAS) is proposed by Tim Vogelsang and Al in [13]. This work is introduced as an additional element to instructor grading, peer assessment and automated validation in MOOCs. This system is tested in Iversity that offers a CTAS for learners that have voted to pay for this option. Qualified teaching assistants - called Cloud Teaching Assistant (CTA) - are hired only for the purpose of reviewing and grading the submissions of a single MOOC assignment. CTAs are selected according to their expertise in the relevant subject as well as with the help of a criteria sheet defined in advance by instructors.
- Hoi K. Suen presents two other approaches at various stages of development of the PA in MOOCs: connectivist MOOCs (cMOOCs) -proposed by Siemens and others [14] - and the credibility index (CI) approach [4]. The idea of PA is moot within a cMOOC paradigm [4]. The techniques used in cMOOC can be applied in PA. cMOOC allows the learners to make connections with content, learning communities, and other learners in order to create and construct knowledge [15]. The CI approach is an attempt to improve the accuracy of peer feedback in MOOCs by modifying and refining the CPR method [16] [17]. Whereas the CPR method considers only the inaccuracy of the peer rater, the CI approach takes into consideration the accuracy of the rater, the consistency of the rater, and the transferability of the level of accuracy between contexts and assignments [4].

Many MOOCs have provided learners classification to form the most heterogeneous groups, based only on their backgrounds and knowledge [10] [17]. These groups are called upon to resolve open-ended questions in the form of Problem Situations (PS authentic [18] to acquire disciplinary competencies. However, the diversity of learners' knowledge most often provides feedback that does not reflect reality. To remedy this problem we propose an approach that takes into account other parameters including the number of certificates obtained and preferences.

III. PEER ASSESSMENT BASED ON LEARNERS' PROFILES CLUSTERING

This paper presents a proposition about peer assessment, which is a continuation for our precedent works about evaluation in MOOCs [19]. In this section, we first give an overview of the context and the assumptions on which this work is based. Then, we present the peer assessment process proposed.

A. Context and hypotesis

The design methodology of the proposed MOOC system separates the MOOC engineering tool from the MOOC platform. The MOOC engineering tool is the process of presenting the MOOC content and design by using the pedagogical resources and computer graphics technologies [20]. The MOOC platform includes a learner's modeling for learners' gradual assessment, guided by a pyramid of pedagogical activities. These activities are organized in four levels in a pyramid - according to an increasing order of difficulty. Two assessment methods are proposed: automated assessment and peer assessment. The automatic assessment method concerned the activities (closed, semi-open and open questions (exercises)) of the first three levels of the assessment pyramid [19]. In this paper, we focus on PA process of the PS activity located at the top of the pyramid. To solve these situations, only the learners having succeeded in the activities of the first three levels are concerned. Thus, these learners are supposed to have enough knowledge and are therefore able to participate in PA. Furthermore, in the context of the proposed MOOC system, we consider the following hypothesis:

- Hypothesis 01 : Only learners who have successfully completed low-level pyramid activities, are concerned with the resolution of PSs and then by PA.
- Hypothesis 02: Each PS must be built in the module of the MOOC engineering, accompanied by a critized and normative evaluation grid with an associated scale.
- Hypothesis 03: All learners are expected to hold before each PS resolution the evaluation grid of this last. The evaluation grid is displayed with the PS statement [21].
- Hypothesis 04: A deadline for the PS submission is fixed.

Below, we give an example of authentic PS in a MOOC that we entitle "Software Quality Assurance" (see Fig. 01) with the evaluation grid (see Fig. 02). The PS is about software development with testing. On the PS grid, we distinguish the general and specific criteria - each one has its scores and comments.

General criteria that we can find in all discipline. For example "identifying keywords of PS and the sequence of

ideas", as shown in Fig. 02, is a general criteria. Specific criteria depend on the PS itself. For example "implementation of the linguistic entity search module" (see Fig. 02), is a specific criteria.

This PS involves writing tests with JUNIT in an integrated Java environment. The objectives are:
1. A synthesis about SCRUM method and JUNIT.
2. Write a package that search an "entity" language in a text. It involves in input the searched entity (a word, a sequence of words, a name or a date) and searching it in documents taken from an OPEN LINKED DATA or from blogs, for example. Then, classify documents that "find" the entity in order of the occurrence of the entity in each document.
3. Test the program with JUNIT.
4. Generate documentation with JDOC.

Part 01
Prepare a PDF document that summarizing your work for the 4 points above.

Part 02
Develop the portable software application from one machine to another and deployable.
The deliverable is: A user manual as well as the .zip code of the application

Fig. 1. Example of an authentic PS statement

Criteria	List of criteria	Score	Reviews / Comments
General criteria	• Understanding of the problematic, • Identification of the SP keywords, • The use of terms related to the domain,		…… ……
Specific criteria	Part 01: • General structure of the PDF : Introduction, Conclusion and References, • Synthesis about SCRUM method, • Understanding of JUNIT, • Presentation of the application realized, • Presentation of the development environment Part 02: • Mastery of Java environment, • Implementation of the linguistic entity search module, • Creation and use of database and / or documents used, • Implementation / use of test classes (Using JUNIT), • Generation of documentation with JavaDoc.		…… …… …… …… …… …… …… …… ……

0	1	2	3	4	5
Low	Insufficient	passable	medium	good	excellent

Fig. 2. Example of a PS evaluation grid

For each PS, a deadline for submission is fixed and a process for forming groups of learners is initiated by the system. Missing a deadline has different consequences across the MOOC platforms. On Iversity platform, for example, no points are awarded if any deadline has been missed. Coursera awards no points if participants missed the submission deadline, but only penalizes the final assessment grade by 20% if the evaluation deadline has been missed [10].

B. Formation of learners' groups

The classification process we propose has the role of grouping learners based on the parameters stored on learners' modeling within the MOOCs. This process will operate in two steps (see Fig. 03):

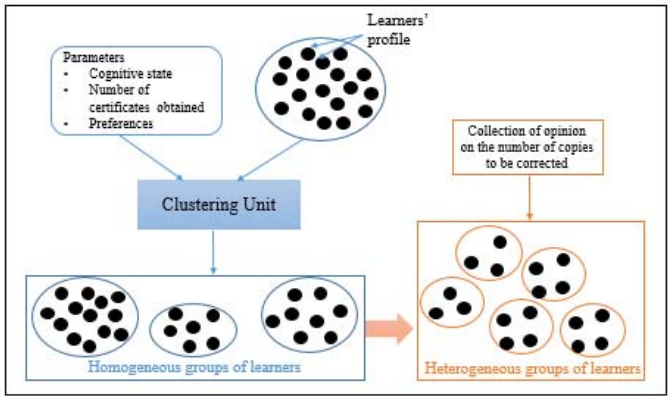

Fig. 3. The Proposed Learners' Classification Process

In a first step, the system proceeds to classify learners using the clustering technique in homogeneous groups according to the following three parameters:

- The *cognitive state* that contains the knowledge acquired during the activities (closed, semi-open and open questions) of the first three levels of the pyramid. These data will be used to calculate the MOOC acquisition value [19], which is calculated with (1).

$$MOOCacqui = \alpha\ Level_1 + \beta Level_2 + \gamma\ Level_3 \quad (1)$$

Where :
MOOCacqu : MOOC acquisition
Level1 : MOOC acquisition for the first level with a coefficient of importance α=1/6.
Level2 : MOOC acquisition for the second level with a coefficient of importance β=1/3.
Level3 : MOOC acquisition for the third level with a coefficient of importance γ=1/2.

- The *number of certificates* obtained in MOOCs already followed. A certificate is issued to the learner in a given MOOC if he/she has completed the two main conditions: reaching the overall threshold attached to each PS in the MOOC and have already assessed the other learners' copies in the MOOC.
- The preferences informed by the learner through a form or inferred during his / her learning by simple feedback. The preferences considered concern verbal learning and visual learning. Verbal learning refers to oral explanation and written explanation. Visual learning involves graphic resources, demonstrations, videos, images and other visual aids.

In a second step, another classification will be established based on the number of copies that each learner will have to correct. Because homogeneous groups are not creative. This classification consists in distributing all the learners of the homogeneous groups formed in groups of K (4 to 10) learners the most heterogeneous possible. The number of learners per group depends on the complexity of the PS and the number of copies that each learner can correct (see Fig. 03). Thus, each heterogeneous group will contain learners with different profiles. To get a certification, each member of the diverse group is called to correct anonymous copies of other group members. We think that PA with heterogeneous peers will have a positive impact on the scores and feedback to be provided to learners. It seems that these notes and feedbacks will be complementary in all formed groups.

A. Assessemnt process

Once the heterogeneous groups have been formed, the PA process is started. This process is divided into three consecutive steps: assessment of the works, treatment of results followed by possible dialogues (see Fig. 04).

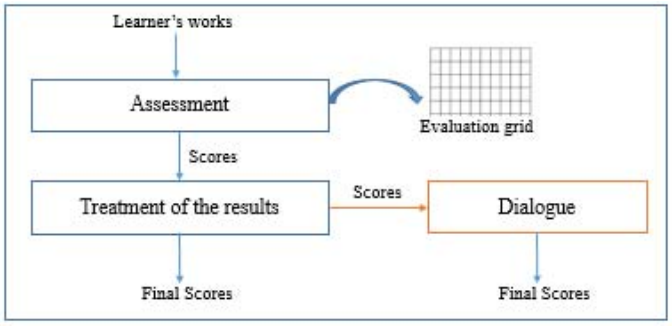

Fig. 4. Global view on the peer assessment process

1) Assessment

Each learner in a given heterogeneous group is called to correct copies (works) of other learners of his/her group during a given period. This period can range from four (4) to fifteen (15) days, depending on the difficulty of PS. To correct a PS, learner has the corresponding evaluation grid. He is called to give scores and appreciations on the work. These feedbacks (Scores / Appreciations) - Awarded by peers - are an extremely important part of the assessment step. It has been shown that, in some cases, learners react better and become more fully engaged with the feedback they receive from their peers than with feedback from their tutors.

2) Treatment of the results

Once the deadline for PA has expired, the treatment of the results is started. In this step, the final score of each PS is calculated based on the scores given by the learner's peers based on the criteria in the evaluation grid. The complexity coefficients of the criteria are used in this calculation. However, we give the possibility to calculate weighted scores based on parameters such as the number of copies corrected, the cognitive state of the learners, etc. This process is similar to that one proposed in Calibrated Peer Reviews (CPR) system.

Several levels of certification can be generated according to the final score obtained by the learner. Furthermore, the issuance of a certificate to a learner is conditioned by the correction of all the copies he has had to correct.

3) Dialogue

A collective discussion space is open for all unsatisfied learners. The aim is to make a collective decision and to find a common agreement to decide the final score. The actors involved are: unsatisfied learners, correctors (learners), the experts and / or the mentors. All the feedback are taken into account for the construction of other PSs for the next MOOC sessions.

IV. EXPERIMENTATION

A first prototype was developed for the first three levels of the assessment pyramid at our university [19]. In order to evaluate the new prototype, we restarted a test - for the case of PS - with a group of four (4) students - among those who successfully completed the activities of the first three levels. Each student was asked to correct the three (3) other students respective works. In Fig. 05, we can see that OK in green means that the learner has corrected the copy of the first learner. He/She has two other copies to correct. The PS treated by these students - along with its evaluation grid - is the same already presented in Fig. 02. Fig. 06 illustrates the space dedicated to the assessment itself.

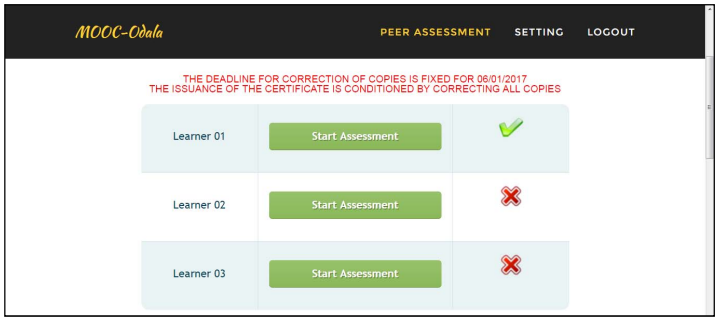

Fig. 5. View of learner space

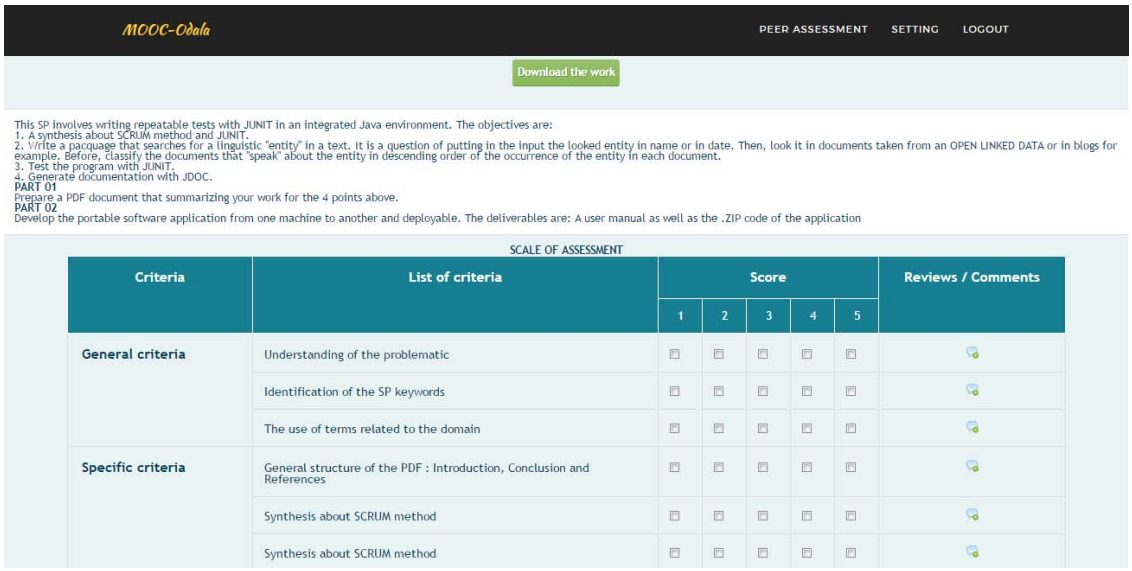

Fig. 6. Space dedicated to the assessment

We have verified the feasibility of the developed prototype. The tests show that all the functionalities are feasible. We are currently working on experiments with larger number of students in a MOOC context.

V. CONCLUSION

Peer assessment is used in MOOCs to assess several learners' works particularly as responses to authentic PS. These PSs can be an appreciated way of providing more relevant formative feedback. These feedbacks are key parts of the educational process. In this paper, we have proposed a new method for peer assessment based on learners' profiles clustering. We have started with a more sophisticated method for a non-predictive learners' classifying. This clustering allows us to have more significate groups. It allows giving complementary feedback in all constituted heterogeneous groups. In addition, to properly access the work of their peers, we have proposed transparent marking system by using normative and criteria based evaluation grid. This latter includes general and specific criteria. In a future work, we will consider to improve the peer assessment method proposed in this paper. We will also develop a prototype and an experiment with massive real MOOC users.

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