Supporting Self- Peer- and Collaborative -Assessment through a Web-based Environment

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Abstract. Self-, peer- and collaborative-assessment are three innovative methods aiming to integrate learning and assessment and promote the active engagement of learners in the assessment process and in knowledge construction. This paper presents a web-based environment, referred to as PECASSE, which supports these assessment methods. In addition to the basic functions of uploading learners' activities/reviews, grading/commentary and results presentation, PECASSE offers the options of individual and collaborative elaboration/review of the activities, collaboration of authors and/or assessors in synchronous and asynchronous way, submission of the activities up to three rounds after the assessors' comments, evaluation of assessors as well as facilities for grouping students, assigning assessors and applying multiple review methods. The results from a preliminary study are encouraging regarding the usefulness and the usability of the provided facilities and revealed the students' positive attitude to the PECASSE environment.

Introduction

Many innovative assessment methods such as self-, peer- and collaborative-assessment (or co-assessment), have been introduced in recent years aiming to enhance/promote learning and integrate assessment with instruction. *Self-assessment* refers to the involvement of learners in making judgements about their own work/performance and aims at fostering reflection on one's own learning and work (Sluijsmans et al. 1999). *Peer assessment* refers to those activities of learners in which they judge and evaluate the work and/or the performance of their peers. In *collaborative assessment*, learners and instructor collaborate in order to clarify objectives and standards/criteria, negotiate details of the assessment and discuss any misunderstandings that exist. Contemporary educational theory indicates that self-, peer- and collaborative- assessment enables learners to (i) actively participate in the assessment process, (ii) think more deeply, (iii) develop important skills such as critical thinking, teamwork, decision-making, self-monitoring and regulation, (iv) see how others tackle/solve problems, (v) get inspiration from their peers' work, (vi) learn to collaborate and criticise constructively, and (vii) reflect on the amount of effort they put into their work, and judge the appropriateness of the standards they set for themselves (Somervell, 1993; Sluijsmans et al. 1999; Sung et al. 2005). An overall overview of studies of self-, peer- and collaborative-assessment can be found in (Sluijsmans et al. 1999; Topping, 1998).

Self-, peer- and collaborative-assessment activities can be carried out in any educational setting using paper and pencil. However, this form of application poses constraints on the assessment process such as increasing teachers' workload of preparing and conducting the elaboration/review of the activities, impeding the provision of immediate feedback to learners (including scores/commentary of their work) and restricting the time and the location of the assessment process (Sung et al. 2005). The introduction of information and communication technology in the educational process results in the development of computer-based and web-based environments, which compensate these constraints, eliminate communication restrictions and enable the implementation of self-, peer- and collaborative-assessment in alternative forms.

The web-based systems, which implement these methods, support basic functions such as the uploading of assignments, scoring/commentary and the presentation of results. In particular, NetPeas (Lin et al. 2001) is a web-based peer assessment system, offering the options of anonymous assignment uploading, two- or three-cycles of peer assessment, provision of holistic or specific feedback accompanied with grades and complaint filing. In Peer Grader (Gehringer, 2001), which is a web-based system for peer review and peer grading: (i) students can submit their work (submit arbitrary sets of web pages), (ii) reviewers are assigned pseudo-randomly by the system or by the instructor, (iii) reviewers and authors can communicate via a shared web page, (iv) authors have a chance to submit revised versions in response to reviewers' comments, and (v) reviewers can assign a grade to each assessee's work. Grading is based on a rubric consisting of several questions that the reviewer must answer with a numeric score. OASYS (Ward et al. 2004) is a web-based self- and peer-assessment system used for marking short computer programming tests, which are comprised of multiple-choice questions marked automatically (self-assessment), and free response questions for anonymous peer assessment. Assessors evaluate the free response questions on three criteria and may (optionally) provide textual feedback. Based on OASYS, Sitthiworachart & Joy (2004) developed a web-based system for the peer assessment of complete programs in programming courses. Submissions of program code are checked automatically by the system and afterwards three peers grade the code based on criteria defined by the teacher. The quality of feedback provided by peers is reviewed and marked. A web-based Group Support System (GSS) (Kwok & Ma, 1999) was developed for the collaborative-assessment of students' projects. The GSS system supports tasks of discussion and negotiation through the functions of brainstorming (for the commentary of the suggested criteria), voting (for the agreement on the criteria and the formulation of the evaluation scheme) and weighting of the selected criteria. The abovementioned systems focus mainly on peer-assessment and most of them lack facilities for collaboration of learners, assigning assessors, and applying various review methods.

In the framework of developing a system to support self-, peer- and collaborative-assessment, we designed and implemented the PECASSE environment (PEer and Collaborative ASSessment Environment). In addition to the basic functions of uploading learners' activities and reviews, grading/commentary of activities and results presentation, PECASSE offers the options of (i) individual and collaborative elaboration of the activities, (ii) review of the activities by one learner or by a group of learners, (iii) submission of the activities up to three rounds after the assessors' comments, (iv) evaluation of the assessors, (v) collaboration of authors and/or assessors in synchronous and asynchronous way, and (vi) grouping learners, assigning assessors applying alternative review methods (i.e. letter or assessment form) and supporting different strategies for the construction/management of the assessment form. The results revealed from a preliminary study, are encouraging regarding the usefulness/usability of the provided facilities and the students' positive attitude to the PECASSE environment. The rest of the paper is structured as follows. In the following section, we present in detail the functionality of the PECASSE environment in terms of the functions supported and the facilities provided to learners. Afterwards, we discuss some results from a preliminary study that we conducted. The paper ends with the main points of our work and our near future plans.

The PECASSE Environment

PECASSE was developed in the context of the web-based adaptive learning environment, referred to as SCALE (Supporting Collaboration and Adaptation in a Learning Environment) (Grigoriadou et al. 2006) (available at http://hermes.di.uoa.gr:8080/scale), which follows the conceptual framework of the Activity Theory (Cole & Engeström, 1993) and supports the individualized learning, the collaborative learning and the assessment process. Besides SCALE environment, PECASSE can run as a standalone self-, peer- and collaborative-assessment environment (available at http://hermes.di.uoa.gr:8080/pecasse). In the context of the PECASSE environment, learners may act as

- "*authors*" being able to submit an activity, which has been elaborated either individually or collaboratively,
- "*assessors*" being responsible to evaluate (i) their own activity in a brief way or according to specific criteria (self-assessment), and/or (ii) the activities submitted by their peers on their own or by collaborating with other learners (peer-assessment) or by collaborating with other learners and the instructor (collaborative-assessment),
- "*feedback evaluators*" being able to evaluate the quality of the work/feedback, provided by their assessors.

The assessment process may be carried out in three consecutive rounds at most. Each round involves the following steps: (i) activity submission and brief self-assessment, (ii) review of the assigned activities and provision of feedback, (iii) collaboration of authors and assessors, evaluation of assessors and revision of the activity submitted to the 1st step. Figure 1 represents graphically the assessment process implemented through PECASSE and its constituent parts in terms of the functions/facilities supported, which are described analytically below.

Domain Knowledge - Assessment Activities

In order to get into the environment, the learner has to enroll in the desired subject matter and submit information concerning his/her username, profession, preferences, and learning style (all this information is kept in his/her learner model). Each subject matter includes a number of learning goals, which correspond to fundamental topics. Each goal is further analyzed to specific learning outcomes, which are realized through various activities. The activities may have different difficulty level and different degree of importance (i.e. weight) for the accomplishment of a goal, depending on the addressed learning outcomes. An activity may be elaborated either individually or collaboratively and may be reviewed by one learner or by a group of learners (Figure 2). Furthermore, an activity may be carried out up to three rounds; for each round the deadline, the degree of importance (i.e. weight) and the review method (i.e. letter or form) are determined. All this information concerning the subject matter, the learning goals, the learning outcomes, the activities and the characteristics of the activities is designed and stored in the data storage by the instructor and constitutes part of the domain knowledge of the PECASSE environment.
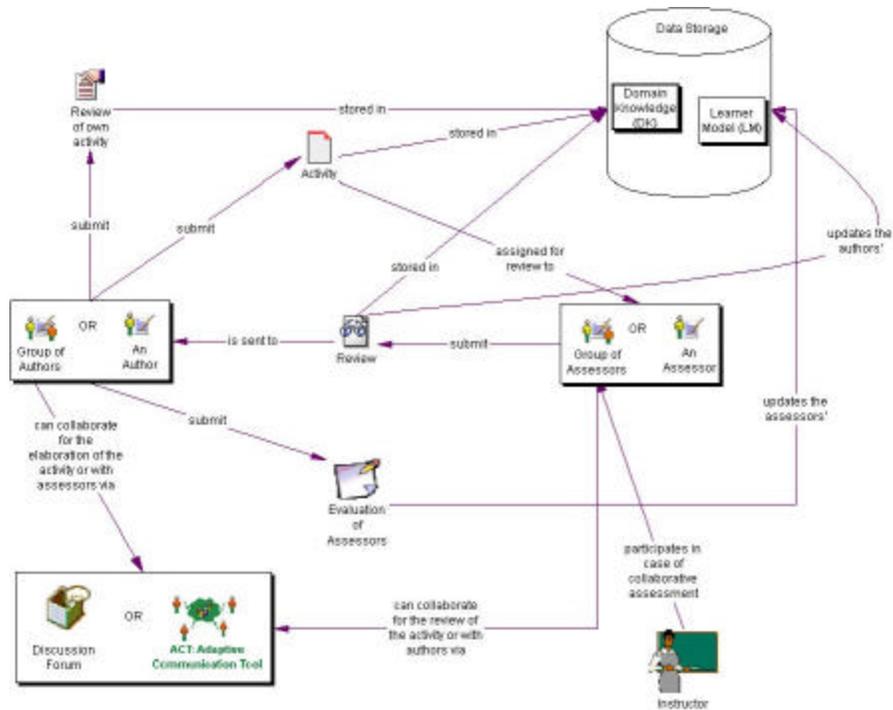
Figure 1: The assessment process implemented through the PECASSE environment.

Group Formation

For the elaboration or the review of an activity by a group, learners form groups up to 4 members; one member plays the role of the moderator being responsible for the coordination of the group process. The learners collaborate either having the same duties or undertaking specific roles (the roles are defined by the instructor after the group formation, according to the skills expected to be cultivated in the context of the activity). In case of collaborative-assessment, the group may consist of up to three learners and the instructor.

Collaboration of Learners

Collaboration may take place in PECASSE during (i) the elaboration or the review of an activity by a group of learners, or (ii) the collaborative-assessment of an activity, and/or (iii) the revision step of the assessment process where authors and assessors may discuss any misunderstandings. The communication may be either synchronous or asynchronous. The synchronous communication is implemented through the ACT tool (Gogoulou et al. 2005), which supports and guides learners' communication/collaboration by implementing the structured dialogue either through sentence openers or communication acts. The asynchronous communication is implemented through a discussion forum, which is created by the moderator; the moderator is responsible to define its usage (i.e. for the elaboration or the review of the activity or for the communication between authors and assessors). In the discussion forum, learners have the possibility to send their messages, classify them to different categories (e.g. group coordination, or review of the activity, or management of the assessment form/commentary letter or feedback provision), and characterize them to one or more of the following *discourse categories* (type of message): Proposal (P), Opinion (O), Question (Q), Reasoning (R), Clarification (C), Agreement (A), Disagreement (D), Motivation (M), Need (N) and Social Comments (S).

Activity Submission

Until the deadline of activity submission for each round, the learner (or the moderator of the group) may upload his/her work anonymously as many times as s/he wishes. Based on learner's login information, PECASSE automatically renames the submitted file in order to keep the author(s) anonymous and sets the directory for upload. Following the submission, the author(s) (i.e. a learner or the moderator of the group) has to self-assess the submitted work by filling a brief form.
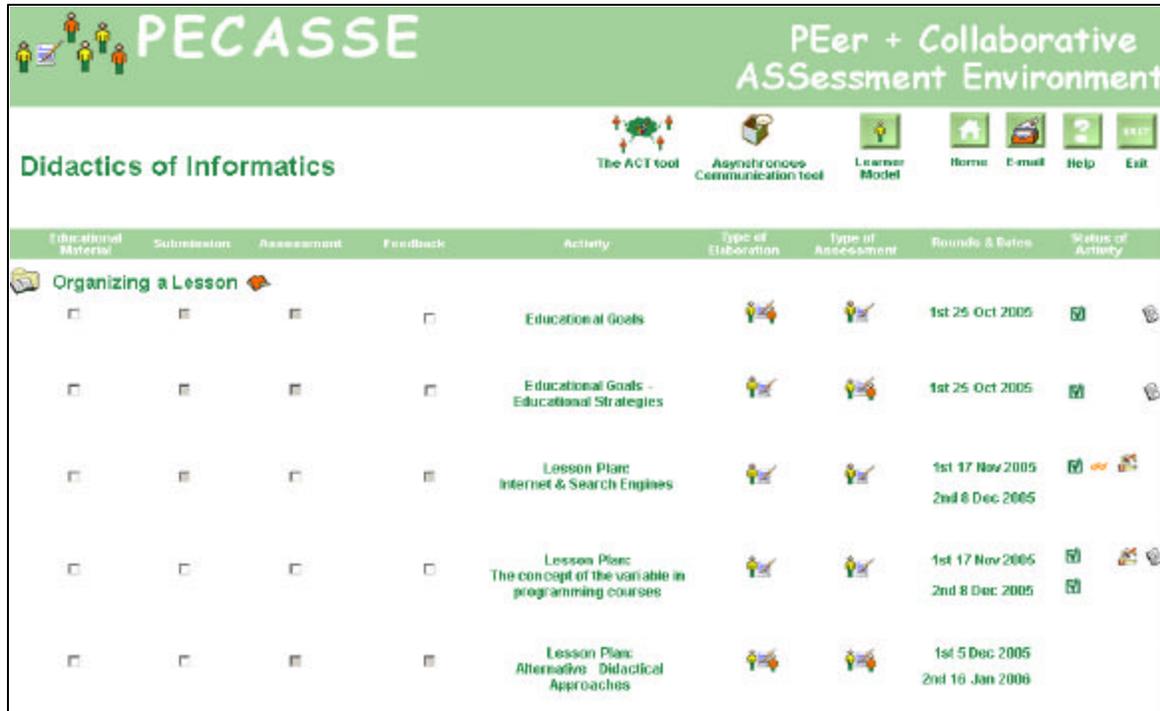
Figure 2: A screen shot of the PECASSE environment depicting the learning goal of "Organizing a Lesson" in the context of the subject matter "Didactics of Informatics" and a set of five activities. The first activity entitled "Educational Goals" is a collaborative one and is going to be assessed by one assessor while the second one is an individual activity and is going to be assessed by a group of learners. For the specific learner, the status of the third activity (as this is represented from the corresponding icons) is: the learner has already submitted the activity for the 1st round, there are some pending activities for review and some assigned activities have already been reviewed. For the fourth activity, the learner has already submitted the activity for the 1st round, s/he has reviewed all the assigned activities, s/he has received comments for his/her initial work and finally s/he has already submitted the activity for the 2nd round.

Assignment of Assessors

The assessor may be a learner or a group of learners or a group consisting of learners and the instructor. Although, there is no restriction for the number of activities that an assessor may review (in case of self-assessment, an assessor may be assigned to review his/her own work), usually each submission is reviewed by three or four assessors. The assessors are assigned either automatically by PECASSE (under development) or by the instructor or by both. The assignment process is based on different mapping strategies such as arbitrary assignment, assignment based on the topic of the activity and assignment based on learners' characteristics. In the second case, it is considered useful for assessors to review activities both with similar and different topic with the one they had worked on. Regarding learners' characteristics, PECASSE takes into account learners' proficiency (as recorded from assessors' reviews) and learners' ability as assessors (as recorded from the evaluation of assessors). These characteristics are stored in learner model, which is dynamically updated during learners' interaction with PECASSE in order to keep track of learners' "current state".

The Review Process

Most of the web-based peer- and collaborative-assessment environments enable assessors to review activities with respect to specific criteria/standards defined by the instructor. Also, the review process is oriented to the grading of the activities and the feedback provided is usually answers to specific predetermined questions. In PECASSE environment, depending on the orientation of the review process and the learning outcomes of the activity, the review process may emphasize on the grading of the activities and/or the provision of useful feedback. The provided review/feedback may be structured and recorded either in an assessment form or in an assessment letter. The letter may include only comments or assessment criteria, grades, and comments. In case of an assessment form, different strategies may be followed for the construction of the form, based on the learning outcomes addressed by the activity. More specifically: (i) assessors may define/construct entirely the assessment form, or (ii) the instructor may set up entirely the assessment form, or (iii) the instructor may set up a template of the assessment form, which has to be enriched by the assessors. Regarding to Orsmond et al. (2002), assessors seemed unenthusiastic for creating assessment criteria themselves. To overcome this difficulty, the

first strategy is recommended in case of collaborative-assessment, where the instructor participates in the review process and can guide/help assessors in the construction of a complete/accurate form. The second strategy is recommended for self- and peer-assessment and may help learners to understand which criteria/standards are considered useful and are targeted to the underlying activity. The last strategy aims at guiding assessors towards the review by pointing out key criteria and potential aspects of a good activity and enabling them to extend the breadth and depth of the instructor-given form and participate more actively in the review process.

In PECASSE, an assessment form may include up to five sections; each section may be characterized as criteria section or questions section or comments section and may contain a number of elements. The structure of the assessment form in sections aims to encourage assessors to provide qualitative comments to their peers, reason/explain their quantitative evaluation and give feedback towards the improvement of the activity. Regardless of who is the constructor of the form (i.e. the instructor or the assessor), a number of attributes has to be determined, such as: (i) the sections, (ii) which sections of the form are visible to authors and which are invisible, (iii) how many elements the assessors have to define and how many elements should be defined optionally, and (iv) for each element of the section, its visibility/invisibility to the author, its obligatory/optional completion with feedback, its weight (zero weight means the non-grading of the element) and the visibility/invisibility of the grade to the author. For example, the template of the assessment form depicted in Figure 3, includes a criteria section with four elements, a questions section with three elements and a comments section with one element. The first two sections are visible to authors while the last section is invisible. For the criteria section, the instructor has defined four elements as well as their weights and their attributes (i.e. all of them are visible to authors and the assessors should grade the activity, complete their comments and reason their grade). For the specific section, assessors have to define two more elements (criteria) and have the possibility to set up four more elements if they wish so.

Until the deadline of the activity review, assessors have the possibility to upload their review anonymously as many times as they wish. In case the activity is reviewed by a group of learners, only the moderator is able to submit the review while the rest members may have access to the submitted review. The assessment form is filled online, while in case of the assessment letter, PECASSE
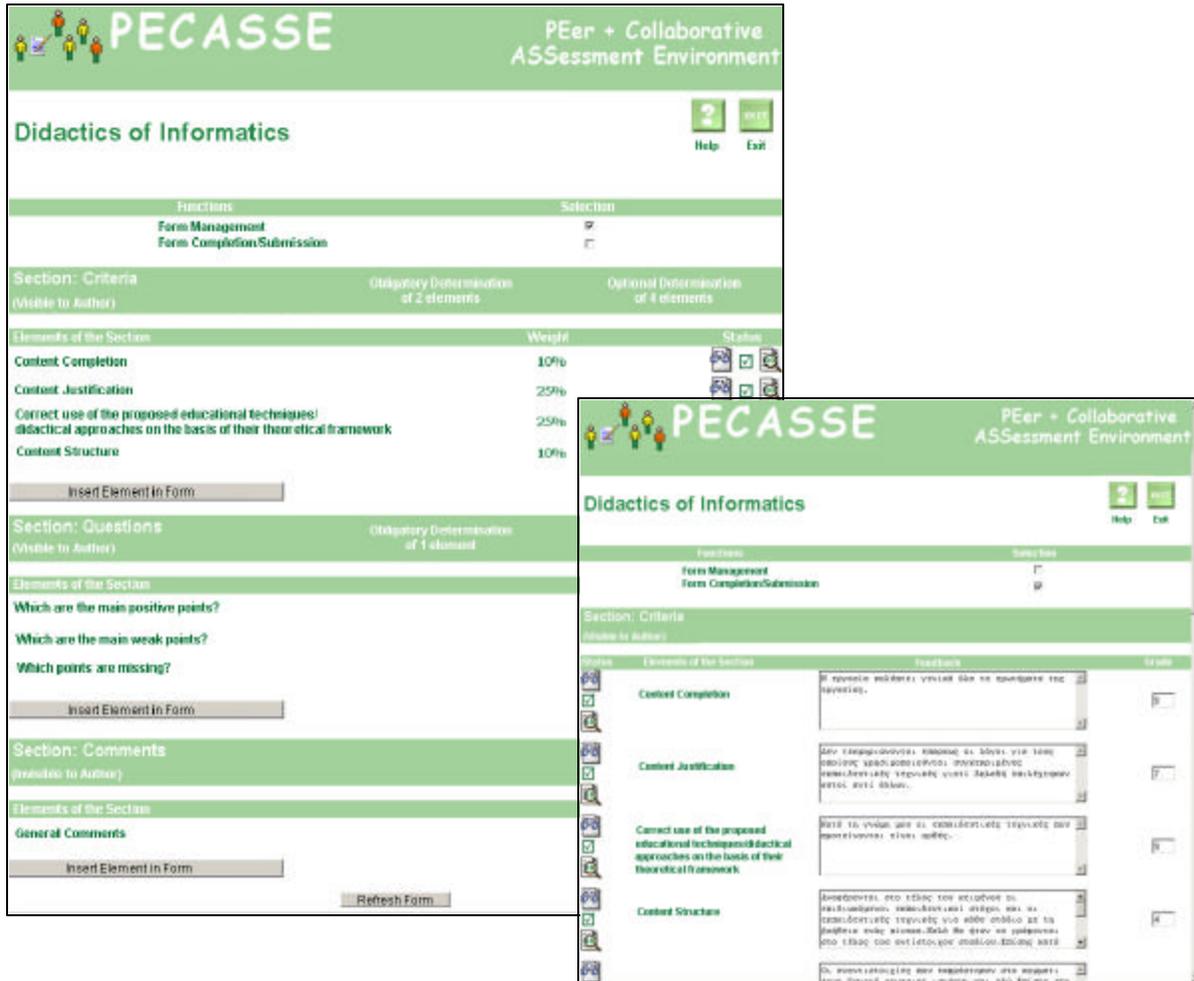

Figure 3: The template of an assessment form provided for the review of an activity and an excerpt of the review form completed with grades and feedback.

automatically renames the review file in order to keep the assessors anonymous and sets the directory for upload. The grade of the activity is calculated by summing the product of each grade with the corresponding criterion weight.

Revision of the Activity and Evaluation of Assessors

After the deadline of the activity review, authors receive the comments of their work; this step is inactive in case of self-assessment. They have the possibility to view, print or store their assessors' comments and collaborate with them through a discussion forum. The authors are asked to evaluate their assessors for each review they received through an evaluation form; this process aims on the one hand to motivate assessors to examine closely the activities under review, make the grading process as fairly as possible and provide useful feedback, and on the other to enable authors to reflect on the assessors' comments and take them into account in the revision process. The evaluation form includes authors' grading for the quality and the usefulness of assessors' review as well as authors' agreement/justification for assessors' work, feedback and grade.

Formative Evaluation of PECASSE

An empirical study was conducted aiming to investigate (i) usability issues regarding the facilities provided, (ii) the extent that PECASSE fulfils and facilitates the peer-assessment process, and (iii) the attitude of students towards the review process (peer-assessment) and the PECASSE environment. The empirical study took place during the winter-semester of the academic year 2005-2006 in the context of the undergraduate course of "Didactics of Informatics" at the Department of Informatics and Telecommunications of the University of Athens. Forty-two students were planned to participate in the study, which lasted nine weeks in total. The working sheet provided to students included (a) a brief description of PECASSE, (b) the activity, and (c) a questionnaire concerning the evaluation of the PECASSE environment. More specifically, the activity was carried out in two rounds according to the following steps (i) submission of the activity (duration: 2 weeks), (ii) review by peers (duration: 2 weeks), (iii) revision of the activity and resubmission of the activity taking into account assessors' comments (duration: 2 weeks), (iv) assessment by the instructor (duration: 3 weeks), and (v) provision of feedback. It is worthwhile to mention that although forty-two students were initially planned to participate, forty-one students completed the first step of the process, thirty-eight students completed the second step, while at the end thirty-five students revised and resubmitted the activity.

In the context of the activity, the students had to design a lesson plan for a specific topic (half of them worked on the topic "Internet and search engines" and the rest worked on the topic "The concept of variable in programming"); they had to determine the expected learning outcomes, the educational techniques/didactical approaches to be used and the stages of the lesson (the context of each stage, the time schedule, etc). At the end of the 1st step, once students submitted their work, they self-evaluated and gave mark to their own work. In the 2nd step, the students were assigned two activities to assess: one addressing the same topic as their own and the second one addressing the alternative topic. The review process was carried out through an assessment form. The sections/elements of the form were partly determined by the instructor; the students had to determine a specific number of elements (e.g. they had to determine two criteria in the section of criteria) and they could also determine additional elements (e.g. they could determine up to six elements in the section of questions, if they wished so). During the 3rd step, the students received two anonymous reviews for their activity and evaluated their assessors with respect to the evaluation/feedback they received.

Upon the completion of the 3rd step, students were asked to fill and submit the questionnaire concerning the evaluation of the PECASSE environment; the questionnaire included both closed questions asking students to justify their answers and open questions enabling students to express their opinion and make comments and suggestions. Some of the results concerning the usefulness and the usability of the provided facilities are presented in Table 1. The range for all the question items was from 1 to 5. From the results, it is obvious that the students found most of the provided facilities useful and usable. The analysis of the students' justifications to closed questions or their answers to open questions, suggest improvements for the management and the completion of the assessment form and the management of multiple windows within the environment. Moreover, students consider useful to have access to activities that received high grade or positive comments and they wish to be able to review an activity anonymously or eponymously.

Question Items	Mean	SD
1. The possibility to manage the assessment form is considered as … 1=not useful, 5=useful a lot	4,45	0,87
2. The possibility to enrich the assessment form with your own elements is considered as … 1=not useful, 5=useful a lot	4,41	0,68
3. The possibility to self-assess your own activity is considered as … 1=not useful, 5=useful a lot	3,31	1,34
4. The possibility to keep your anonymity through the submission/review process is considered as … 1=not useful, 5=useful a lot	3,86	0,92
5. The possibility to evaluate your assessors is considered as … 1=not useful, 5=useful a lot	4,59	0,73
6. The facility concerning the submission of the activity is considered as … 1=not usable, 5=very usable	4,38	0,68
7. The facility concerning the enrichment of the assessment form is considered as … 1=not usable, 5=very usable	3,93	1,13
8. The facility concerning the completion of the assessment form with feedback and its submission is considered as … 1=not usable, 5=very usable	3,93	1,16
9. The facility concerning the review of your activity is considered as … 1=not usable, 5=very usable	4,34	0,86

10. Do you consider that PECASSE is a "pleasant" environment?	1=not at all, 5=a lot	3,83	0,97
11. In which degree, are you satisfied with the usability of PECASSE?	1=not at all, 5=a lot	3,90	0,86

Table 1: Results concerning the usefulness and the usability of the facilities provided in PECASSE.

Question Items	Mean	SD
1. Do you think that PECASSE fulfils the aims of peer assessment? 1=not at all, 5=a lot	4,45	0,57
2. Do you think that peer assessment can be realized in a useful/easy way through the PECASSE environment? 1=not at all, 5=a lot)	4,38	0,73
3. Do you think that the use of PECASSE contributes positively in the realization of the peer-assessment process? 1=not at all, 5=a lot	4,41	0,73
4. Do you think that the use of PECASSE simplify the steps of the peer-assessment process? 1=not at all, 5=a lot	4,45	0,83
5. In the future, do you want to elaborate/review more activities through the PECASSE environment? 1=not at all, 5=a lot	3,69	0,97
6. Do you believe that PECASSE can be used effectively as an assessment tool in secondary education or at university level? 1=not at all, 5=a lot	3,97	0,78
7. How useful was the review/feedback received from your assessors? 1=not useful, 5=very useful	4,38	0,98
8. In which degree, the comments of your assessors influenced the revision of your activity? 1=very low, 5=very high	4,17	0,97
9. In which degree, the activity under review, addressing the same topic with the one you worked on, influenced the revision of your initial activity? 1=very low, 5=very high	3,21	1,40
10. In which degree, the activity under review, addressing different topic with the one you worked on, influenced the revision of your initial activity? 1=very low, 5=very high	2,48	1,15

Table 2: Results concerning the facilitation of peer assessment through PECASSE and the attitude of the students to the review process and the PECASSE environment.

Furthermore, we asked students if they believe that the peer-assessment process promote and enhance the learning process. The average response was 4,28 on a scale of 1 (not at all) to 5 (a lot) with a standard deviation 0,75. However, 86,2% of the students characterized the process as time and effort consuming. In Table 2, results concerning the extent that PECASSE fulfils and facilitates the peer-assessment process as well as the attitude of the students towards the review process and the PECASSE environment are presented. The range for all the questions items was from 1 to 5. A considerable number of students believed that PECASSE fulfils the aims of the peer-assessment process, facilitates the execution of the steps and contributes positively in the realization of the process in a useful/easy way. Also, 76% of the students believed that PECASSE can be incorporated effectively as an assessment tool in the instruction process and about 60% of the students were willing/pleasant to elaborate more activities through PECASSE in the future. Only 7% of the students were reluctant to use PECASSE mainly due to the time and effort needed for the completion of the process. As far as the review process is concerned, a considerable number of students (approximately 89%) were satisfied and considered that the feedback they received was useful and helped them to revise their initial activity. 56% of the students agreed that the activity under review, addressing the same topic with the one they worked on, influenced considerably the revisions they made to their initial activity, while only 21% of the students were influenced in a high degree by the review of the activity addressing different topic. A lot of students claimed that they realized a lot of mistakes in their own activity during the review process. Regarding the evaluation of the assessors the average mark was 7,79 with standard deviation 1,6, indicating that students provided satisfactory quality review.

Conclusions and Future Plans

In this paper, we presented PECASSE, which implements self-, peer- and collaborative-assessment in a web-based educational setting by offering facilities for group formation, collaboration of learners, activity submission, review process, assignment of assessors, revision of the activity and evaluation of assessors. The use of the environment in the context of a preliminary study showed that students consider useful the various facilities the environment supports (e.g. the enrichment of the assessment form, the evaluation of the assessors) and they believe that PECASSE can support effectively the peer-assessment process. It seems that students realize the educational benefits of getting involved to such a process. Our future plans include the improvement of the facilities provided according to the students' suggestions and the development of the facility concerning the assignment of the assessors by the PECASSE environment.

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