Supporting Self-, Peer-, and Collaborative-Assessment in E-Learning: The Case of the PEer and Collaborative ASSessment Environment (PECASSE)

EVANGELIA GOULI, AGORITSA GOGOULOU,
AND MARIA GRIGORIADOU
University of Athens, Greece
lilag@di.uoa.gr
rgog@di.uoa.gr
gregor@di.uoa.gr

Self-, peer-, and collaborative-assessment aim at integrating learning and assessment and promoting the active engagement of learners in the assessment process. This article 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 of the work and results presentation, PECASSE supports (a) individual and collaborative elaboration of the activities, (b) review of the activities by one or group of learners, (c) collaboration of authors and/or assessors in synchronous and asynchronous way, (d) submission of the activities up to three rounds after assessors' comments, (e) evaluation of assessors, (f) grouping of learners and assignment of assessors following alternative strategies, and (g) a variety of strategies for setting the assessment scheme applied in the review process. The results from the evaluation of the environment revealed that PECASSE fulfils and facilitates self-, peer-, and collaborative-assessment in a successful way, promotes and enhances the learning process, and students have a positive attitude towards the environment and the assessment methods performed.

Assessment is central to the practice of education and many researchers assert that there is an intimate association between instruction, learning, and assessment (Pellegrino, Chudowsky, & Glaser, 2001). Traditional assess-

ment methods are controlled entirely by the instructor, who sets the assessment scheme, evaluates learners' performance and learning outcomes, and provides feedback to learners. Such methods can be represented at the left extreme of a continuum indicating the degree of autonomy for learner's learning (Harris & Bell, 1994). At the right end of this continuum, assessment methods such as self-, peer-, and collaborative-assessment can be represented, aiming to change place and function of the assessor. Self-, peer-, and collaborative-assessment aim to (a) lead towards a student-centred learning environment, where assessment is represented as a tool for learning, and (b) achieve goals such as lifelong learning, critical and reflective thinking, and evaluating oneself, which are difficult to attain with traditional assessment methods (Sluijsmans, Dochy, & Moerkerke, 1999). Moreover, self-, peer-, and collaborative-assessment could be considered as a fact of life outside of education and characterized as more "authentic" than other assessment methods. In this context, McConnell (2002) asserted that these assessment methods

> … help students move away from dependence on lecturers as the only or major source of judgement about the quality of learning, to a more autonomous and independent situation where each individual develops the experience, know-how and skill to assess his/her own learning. It is likely that this skill can be transferred to other lifelong learning situations and contexts. Equipping learners with such skills should be a key aspect of the so-called "learning society."

Self-assessment refers to the involvement of learners in making judgements about their own work, performance, and learning and aims to foster reflection for one's own work and responsibility of one's own learning (Sluijsmans et al., 1999). *Peer-assessment* (or peer-evaluation) refers to those activities in which learners judge and evaluate the work and/or the performance of their peers. Usually in peer-assessment, each learner assumes the role of an author who works out assignments as well as the role of an assessor and feedback provider who comments on peers' work. Peer-assessment is not only a tool to provide a peer with constructive feedback, which is understood by the peer, but above all, is a tool for the learner himself (Dochy & McDowell, 1997; Sitthiworachart & Joy, 2004).In *collaborative-assessment* (or co-assessment), learner(s) and instructor(s) collaborate to clarify objectives, negotiate details of the assessment process, discuss any misunderstandings that exist, and provide a mutually agreed assessment of the work or the performance of the learner(s).

Contemporary educational theory indicates that self-, peer-, and collaborative-assessment enable learners to (a) actively participate in the assessment process, (b) think more deeply, (c) develop important cognitive skills

such as critical thinking, evaluative abilities, teamwork, decision-making, self-monitoring and regulation, (d) see how others tackle/solve problems, (e) get inspiration from their peers' work, (f) learn to collaborate, criticise constructively, and suggest improvements, and (g) 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, Chang, Chiou, & Hou, 2005). However, learners require exerting more effort than in traditional assessment methods as they undertake multiple roles such as the role of the author and the assessor and have to be trained and understand their role in the assessment process. 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. Recent advances in computer and network technology enable the development of educational settings that implement effectively self-, peer-, and collaborative-assessment by eliminating communication restrictions such as time and place, ensuring the anonymity of authors and assessors, enabling the provision of immediate feedback and allowing instructors to monitor learners' progress at any time during the assessment process. Towards this direction, a number of web-based educational environments have been developed. However, the majority of the environments focus mainly on peer-assessment and support basic functions such as the uploading of assignments, the scoring/commentary of the work assessed and the presentation of the results to the authors.

In an attempt to elaborate and contribute to the realization of these assessment methods, we developed the web-based environment, referred to as PECASSE (PEer and Collaborative ASSessment Environment), which engages learners in self-, peer-, and collaborative-assessment activities. In addition to the basic functions of uploading activities and reviews, grading/commentary of the work and results presentation, PECASSE supports (a) individual and collaborative elaboration of the activities, (b) review of the activities by one or group of learners, (c) submission of the activities up to three rounds after assessors' comments, (d) evaluation of assessors, (e) collaboration of authors and/or assessors in a synchronous and asynchronous way, (f) grouping of learners and assignment of assessors following alternative strategies, and (g) alternative review methods (i.e., commentary letter or assessment form) and a variety of strategies for setting the assessment scheme.

The rest of the article is structured as follows. In the following section, an overview of the related work is presented focusing on the characteristics of the web-based systems that have been developed to support self-, peer-, and collaborative-assessment. Moreover, the design principles of the PECASSE environment are discussed. In the next section, the PECASSE environment is presented in detail. Then, the results from the evaluation of the environment are discussed. The last section discusses the main points of our work and the potential for further research.

REVIEW OF SYSTEMS SUPPORTING SELF-, PEER-, AND COLLABORATIVE-ASSESSMENT

The literature review of systems developed to support self-, peer-, and collaborative-assessment reveals that a variety of approaches have been adopted differing on the assessment methods supported, the domain/discipline applied, the characteristics of the authors' and assessors', the review process followed, and the facilities provided. More specifically:

- *Assessment method*: Most of the systems support only peer-assessment such as NetPeas (Lin, Liu, & Yuan, 2001), Peer Grader (Gehringer, 2001), and WebCoM (Silva & Moreira, 2003) or collaborative-assessment such as the system of Kwok and Ma (1999), while few systems support both self- and peer-assessment such as Web-SPA (Sung et al. 2005) and CPR (Chapman & Fiore, 2001). The SPARK system (Freeman & McKenzie, 2002) supports self- and peer-assessment but the specific system focuses on self- and peer-assessment of team contribution and not on the assessment of assignments/activities.

- *Domain*: The majority of the systems are discipline-independent and they have been applied mainly in computer science courses. The system of Sitthiworachart and Joy (2004) is discipline-dependent as it focuses on computer programming.

- *Authors and Assessors*: In most peer-assessment systems, learners act both as authors and assessors; in the SPARK system, learners act only as assessors, rating both their own and their team members' contribution during the performance of a task, while in the OPAS system (Trahasch, 2004), the learners may act only as assessors in case that the author is the instructor and the learners have to assess the learning material. The anonymity of authors and assessors is maintained by most of the systems (in WebCoM, the anonymity is not maintained), while few systems give learners the choice to use their given name or a pseudonym (e.g., in OPAS and Web-SPA). Moreover, authors can be either individuals (e.g., in NetPeas, Peer Grader, CPR and the system of Sitthiworachart & Joy) or groups (e.g., in WebCoM) or both (e.g., in OPAS

and Web-SPA). Only the WebCoM system supports a group of learners as assessors (but it does not support individual assessors) while the rest peer-assessment systems support only individual assessors. Regarding the assignment of assessors, the following strategies have been adopted: (a) random assignment by the system (e.g., in CPR), (b) random assignment by the instructor (e.g., in the system of Sitthiworachart & Joy and in WebCoM), (c) random assignment by the system and the instructor (e.g., in OPAS and Peer Grader), and (d) formation of learners in groups by the instructor and assessors of an author are the rest learners of the group (e.g., in NetPeas and Web-SPA).

• *Review process*: All the peer-assessment systems support the setting of the assessment scheme by the instructor. The system of Kwok and Ma (1999; as it is a collaborative-assessment system) enables learners to discuss the criteria and add new criteria or modify existing ones. The form of scoring is usually based on a marking scheme, or a measuring scale. Holistic feedback explaining the rating and/or written comments for each criterion/question and/or marking feedback is available to authors. The feedback is provided by the assessors or by the instructor (e.g., in SPARK).

• *Facilities*: (a) Grouping and Communication facilities. In Peer Grader and CPR, grouping facilities are not supported, while in other systems, the learners are grouped by the instructor (e.g., in NetPeas) or by the system (e.g., in Web-SPA) or by the learners themselves (e.g., in WebCoM). Several systems offer communication facilities by providing learners with a communication tool (e.g., discussion forum) such as in OPAS, Web-SPA and in the systems of Kwok and Ma (1999) and Sitthiworachart and Joy (2004). The communication is usually between the members of the group (e.g., in Web-SPA) and it is mainly restricted to the review process (e.g., in OPAS). (b) Additional facilities. Very few systems give authors the possibility to evaluate the work of their assessors such as the system of Sitthiworachart and Joy and Peer Grader. Also, in CPR and in Web-SPA, an authoring tool and a tool for monitoring learners' progress at any time of the assessment process, are provided.

The aforementioned review of literature reveals that most of the systems focus on peer-assessment, and there is a lack of a system that supports all the assessment methods (self-assessment, peer-assessment, and collaborative-assessment) and their possible combinations (e.g., peer-, and collaborative-assessment, self- and collaborative-assessment). In most systems, authors are individuals and just a few systems support group of learners as authors. Moreover, the possibility of assessors to be group of learners is limited. The grouping of learners (in systems that authors/assessors are group of learners) as well as the assignment of assessors is mainly done randomly; none of the

systems takes into consideration learners' individual differences such as knowledge level or ability to evaluate peers' work. Regarding the review process, alternative approaches for setting the standards of the review and the form of scoring are not supported by the abovementioned systems; the assessors do not have the possibility to set their own criteria/questions, enrich the criteria/questions set by the instructor and define the form of scoring.

Having as an objective to extend this line of research, we developed PECASSE, which is a discipline-independent web-based environment. The discriminative characteristics of PECASSE are: (a) the support of self-assessment, peer-assessment, collaborative-assessment and their combinations, (b) authors and assessors can be individuals or group of learners; learners can collaborate not only during the authoring process but during the review process as well; authors are anonymous while the anonymity of assessors is maintained with respect to their preference, (c) the grouping of learners and the assignment of assessors based on a variety of strategies and taking into consideration learners' individual differences, and (d) a variety of strategies for setting the assessment scheme applied in the review process. Furthermore, in PECASSE, the communication of authors/assessors can be synchronous or asynchronous, and authors have the possibility to evaluate the work of their assessors.

Design Principles of the PECASSE Environment

One of the primary concerns in the design of the PECASSE environment was to support all the three assessment methods (and their combinations), as self-, peer-, and collaborative-assessment do improve different aspects in the learning of learners (Sluijsmans et al., 1999). Especially, the combination of peer-assessment with self- and/or collaborative-assessment appears to eliminate or solve problems such as friendship marking (resulting in over-marking), decibel marking (where individuals dominate groups and get the highest marks), and parasite marking (where individuals fail to contribute but benefit from group marks; Pond, Ul-Hag, & Wade, 1995). PECASSE is designed to be used in any discipline and level of education (secondary or higher), having as a central constituent the concept of activity.

Towards the direction of taking advantage of the benefits gained from collaboration (e.g., exchange of ideas, argumentation, self-confidence, self-regulation), cultivating not only assessment skills but collaboration and social skills and providing learners with alternatives in the realization of the peer- and collaborative-assessment, PECASSE supports the collaboration of learners in multiple ways. In particular, PECASSE supports the collaboration of (a) learners during the authoring and the review process; the author and/or the assessor of an activity can be a group of learners, (b) authors and assessors to clarify any misunderstandings and make the best of the feedback received, (c) learners with the instructor in the context of the subject

matter, and (d) assessors who evaluate the same activity to share their doubts and opinions and decide, possibly in common, their evaluation policy. Moreover, the instructor may collaborate with one or more learners (constituting a group) in the context of collaborative-assessment or the training phase, where learners are becoming familiar with the assessment methods under consideration.

The group formation of learners in case of collaborative authoring or reviewing as well as the matching of authors and assessors (i.e., the formation of "authors-assessors" groups) are considered a key factor in learning benefits as the group's productivity is determined by how well the members work together (Martin & Paredes, 2004). Since individuals have different characteristics and traits, it is important to take them into account for successful group formation. Thus, in PECASSE, various strategies for learners' group formation and assignment of assessors are accommodated. In particular, the grouping of learners and the matching of authors and assessors can be done either randomly, or by the instructor or with respect to various learners' characteristics such as knowledge level, learning style and competence in assessing their peers' work. The instructor has the possibility to intervene in the results if s/he wishes so.

According to Orsmond, Merry and Reiling (2000), the success of self-, peer-, and collaborative-assessment should be judged by how much the learner develops during all the steps of the assessment process and subsequently during the review process. Strachan and Wilcox (1996) recommended that it is important to give learners an active role in the setting of the assessment scheme (an assessment scheme may include assessment criteria, questions, and a form of scoring) applied in the review process. The active involvement of learners in constructing the assessment scheme is seen as beneficial in helping them understand how they will be assessed by tutors (Elwood & Klenowski, 2002) and may help them to specify/clarify the steps to follow in the review process. However, sometimes mainly due to their inexperience in defining significant meaningful and common understanding assessment criteria, learners appear unenthusiastic for constructing the assessment scheme themselves (Orsmond, Merry, & Reiling, 2002). Having as an objective, to engage learners actively in the construction/setting of the assessment scheme as well as help them overcome their difficulties in its construction, PECASSE supports four different strategies: (a) the instructor defines the assessment criteria, the questions, and the form of scoring, that is the instructor sets the assessment scheme to help learners understand, which criteria are considered useful and are targeted to the underlying activity, and how the activity under review should be assessed, (b) the instructor defines a template of the assessment scheme and the assessor has the possibility to modify the proposed template by adding new criteria/questions and modify the form of scoring, (c) the assessor proposes the criteria/questions

and the form of scoring and collaborates/discusses with the instructor to result in an acceptable scheme, and (d) the assessor defines his/her own criteria and questions as well as the form of scoring.

THE PECASSE ENVIRONMENT

PECASSE is a web-based environment, which engages learners in self-, peer-, and collaborative-assessment activities and can be used for distance education or blended learning or distance learning modes of study (available at http://hermes.di.uoa.gr:8080/pecasse). In PECASSE, learners may act as:

- "*authors*" being able to submit their work/activity, which has been carried out either individually or collaboratively,
- "*assessors*" being responsible to evaluate (a) their own work in a brief way or according to specific criteria (self-assessment), and/or (b) their peers' work on their own or by collaborating with other learners (peer-assessment) and/or by collaborating with the instructor (collaborative-assessment),
- "*feedback evaluators*" being able to evaluate the quality of the feedback, provided by their assessors (Figure 1).
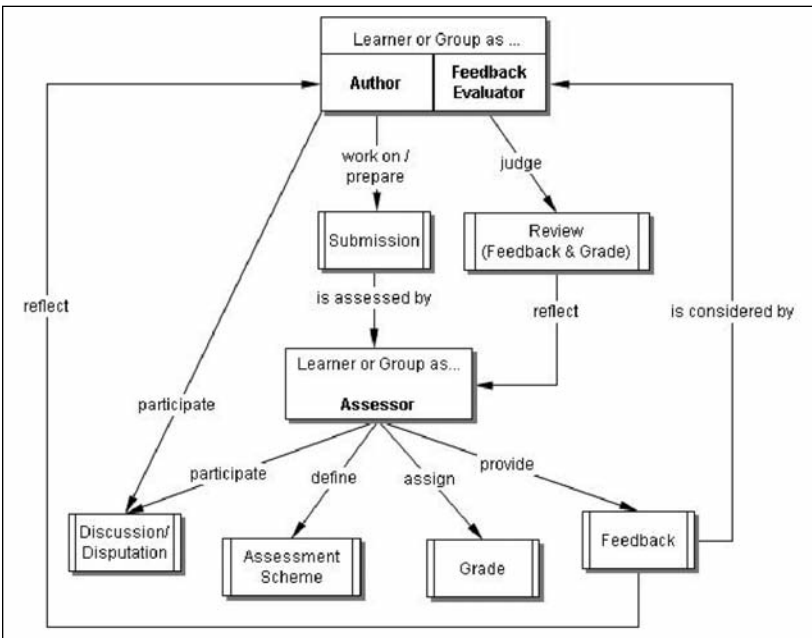

Figure 1. The roles of learners in PECASSE

In the following, the presentation focuses on the assessment process that PECASSE supports, the characteristics (model) of the learning activities and the interface of the environment that externalizes and represents the assessment process, and the characteristics of the activities. The presentation of PECASSE comes to an end by describing how the environment supports and implements the design principles concerning the grouping of learners and the assignment of assessors, the possibility of learners to collaborate and the alternatives in implementing the review process in terms of the setting of the assessment scheme and the degree of learners' active involvement.

The Assessment Process

In a conventional assessment process, the instructor usually assigns the activity/project, which is worked out, until the prespecified deadline, either by each learner individually or by a group of learners. The instructor grades the activity/project, annotates any comments/feedback and returns them back. Within this process, learners have the possibility to learn by doing the activity and reflecting on the instructor's feedback. In PECASSE, learners have the option to actively participate in the assessment process and learn from more sources (e.g., when analyzing/evaluating their peers' work). Figure 2 represents graphically, the assessment process followed in PECASSE and its constituent parts in terms of the functions/facilities supported. In particular, the assessment process involves the following steps and can be carried out in three consecutive rounds at most, that is Step 1, Step 2, and Step 3 can be repeated up to three rounds:

- *Step 1 – Authoring and Submission*: This step concerns the submission of the activity and its brief self-assessment. Authors work on the activity until the deadline. They can upload their work to the system as many times they wish until the deadline. Based on learner's login information, PECASSE automatically renames the submitted file to keep the author(s) anonymous and sets the directory for upload. In case of a collaborative activity, the moderator of the group has to upload the work. Following the submission, the author has to self-assess the submitted work by filling a brief form.

- *Step 2 – Reviewing*: After the deadline of the submission phase, assessors are informed of the activities they have to review. Until the deadline of the review process, assessors can upload their review as many times as they wish. The assessors have the option to be anonymous or eponymous with respect to their preference. In case the activity is reviewed by a group of learners, only the moderator is able to submit the review, while the rest of the members have access to the submitted review. The review is constructed either in an assessment form or in a commentary letter where assessors explain their marking and
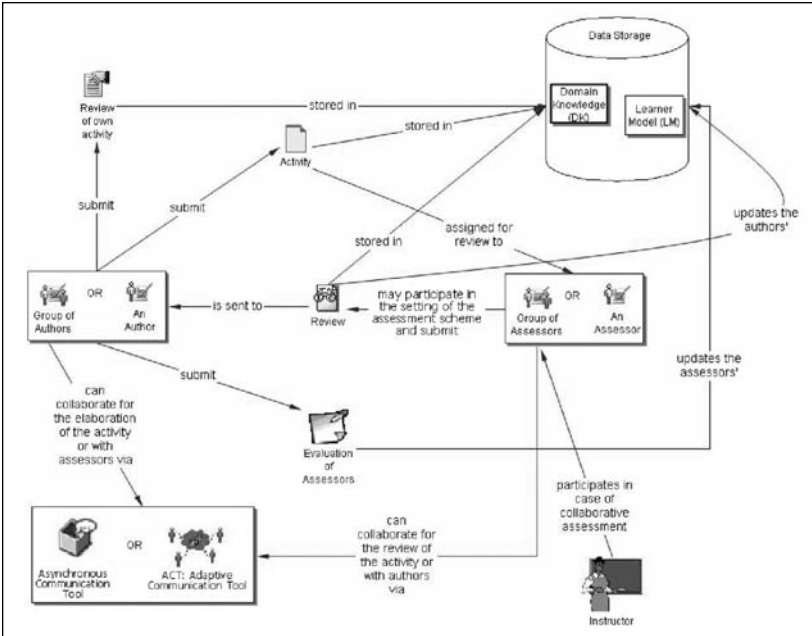
Figure 2. The assessment process followed in PECASSE

include useful feedback on how authors can improve their work. Different strategies can be followed for setting the assessment scheme with respect to the learning outcomes of the activity (see section entitled "How Assessors can Review an Activity"). In the case of collaborative-assessment, the instructor collaborates with assessors to clarify objectives and negotiate details of the assessment process. Also, the instructor may help/guide assessors during the marking and feedback process. The assessors (i.e., individual learner or group of learners) of the same activity may have the possibility to collaborate/communicate in synchronous or asynchronous way (see "Collaboration of Learners" section) to discuss/exchange their comments regarding the activity under review.

• *Step 3 – Feedback*: This step includes the provision of feedback to authors, the revision of the initial submitted work, and the evaluation of assessors. After the deadline of the review process, the activities accompanied with grades and/or comments are returned to authors. The "best" activities with respect to the grades assigned by the assessors and the instructor are published. Authors have the possibility to revise their work submitted to the Step 1, taking into account their assessors' comments and

after studying the "best" activities. Moreover, authors can communicate with assessors to clarify any nonunderstandable comments. Furthermore, authors are asked to evaluate their assessors for each review they received through an evaluation form; this process aims to motivate (a) assessors to examine closely the activities under review, make the grading process as fairly as possible and provide useful feedback, and (b) authors to reflec on assessors' comments and take them into account in the revision process. The evaluation form includes grading for the quality and usefulness of assessors' review as well as authors' agreement/justification for assessors' work, feedback, and grade.

Learning Activities Model

A learning activity serves a specific learning goal, which corresponds to fundamental concept(s) of the subject matter, and addresses specific learning outcomes. With respect to the learning outcomes, the activity may be (a) elaborated either individually or collaboratively (that is the "author" may be a learner or a group of learners), (b) reviewed by one learner or by a group of learners (that is the "assessor" is individual or group of learners), (c) carried out up to three rounds; for each round the deadline of the authoring and the review process are determined, and (d) accomplished following an assessment method, that is self-assessment, peer-assessment, collaborative-assessment, as well as their combinations self- and peer-assessment, self- and collaborative-assessment, peer- and collaborative-assessment, self-, peer-, and collaborative-assessment.

Regarding the review process of an activity, the following parameters are required to be specified: (a) the strategy for matching authors and assessors (see "Group Formation and Assignment of Assessors" section), and (b) the review method, that is assessment form or commentary letter. In case of an assessment form, the strategy for setting the assessment scheme as well as the structure and the elements of the form need to be specified (see section entitled "How Assessors can Review an Activity").

Regarding the collaborative elaboration or review of an activity, the following parameters need to be specified: (a) how many learners can collaborate (the group may consist of up to four learners and one member acts as the moderator of the group being responsible for the coordination of the group process and the submission of the work or the submission of the review), (b) the strategy for the group formation of authors or assessors (see "Group Formation and Assignment of Assessors" section), and (c) the way under which the members of the group will collaborate/communicate (see "Collaboration of Learners" section). In collaborative-assessment method, it is necessary to specify how learner(s) will collaborate with the instructor (see "Collaboration of Learners" section). Furthermore, it is necessary to specify (a) how authors will communicate with assessors after the review

process in order to discuss any misunderstandings, and (b) if the assessors of the same activity have the possibility to collaborate/communicate during the review process and in what way this is possible. All this information concerning the learning activities is designed and stored in the data storage and constitutes part of the domain knowledge of the PECASSE environment. The instructor is responsible to set and modify the required parameters of a learning activity.

The User Interface

To get into the environment, the learner has to enroll in the desired subject matter and submit information concerning his/her username, profession, and learning style (this information is kept in his/her learner model). Figure 3 presents the main screen of the environment after the learner's selection of a specific learning goal. More specifically, the learning goal of "Organizing a Lesson" in the context of the subject matter "Didactics of Informatics" and a set of five activities are presented. The first activity entitled "Educational Goals" is a collaborative one (see icon for author[s]), it is going to be assessed by one assessor (see icon for assessor[s]) and the collaborative-assessment method is followed (see icon for assessment method). The specific activity aims at training learners to define standards, assess their peers' work and provide useful feedback. Thus, the participation of the instructor during the review process is considered important and the collaborative-assessment method is followed. The second activity entitled "Educational
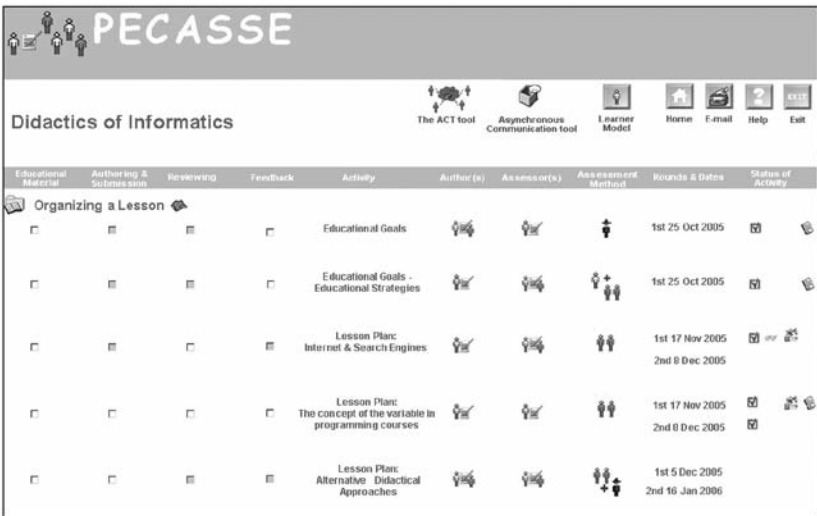

Figure 3. A screen shot of the main screen of the PECASSE environment

Goals – Educational Strategies" is an individual activity (see icon for author[s]), it is going to be assessed by a group of learners (see icon for assessor[s]) and the self- and peer-assessment method is followed (see icon for assessment method). For the third and fourth activities, the peer-assessment method is followed while peer- and collaborative-assessment methods followed for the fifth activity (see icons for assessment method). The status of the activities is as follows (as this is represented from the corresponding icons): the learner has received comments for the 1st and 2nd activity; regarding the 3rd activity, the learner has already submitted the activity for the 1st round, there are some pending activities for review and some that have already been reviewed; for the 4th 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 the initial work and s/he has already submitted the activity for the 2nd round.

From the specific screen the learner has the opportunity to access his/her learner model, which is dynamically updated during learner's interaction with PECASSE in order to keep track of learner's "current state". Learners can see the information held in their learner model concerning their progress and communication. The externalization of the learner model aims to support the self-regulation and reflection processes. Furthermore, the learner can communicate with the instructor and his/her peers in the context of the subject matter in a synchronous (icon "The ACT tool") or asynchronous way (icon "Asynchronous Communication tool"). For each activity appearing in Figure 3, the learner has the opportunity to select the available steps of the assessment process with respect to the deadlines defined by the instructor. More specifically, the learner may select to see the educational material of the activity under consideration or to proceed with the 1st Step (Authoring and Submission), or the 2nd Step (Reviewing), or the 3rd Step (Feedback) of the assessment process.

Group Formation and Assignment of Assessors

The authoring, as well as the review of an activity, may be accomplished by a group of learners. Learners form groups up to four members; one member plays the role of the moderator. Regarding the assignment of assessors, 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 group formation of learners and the assignment of assessors (that is the construction of groups "authors-assessors") is facilitated by a group formation tool, referred to as OmadoGenesis (Gogoulou, Gouli, Boas, Liakou, & Grigoriadou, 2007). OmadoGenesis enables the following strategies: (a) random assignment by the system, (b) assignment by the instructor on the

basis of his/her preferences or learners' demands, and (c) assignment by the system on the basis of learners' individual characteristics. In any case, the instructor may intervene and restructure/refine the groups. The instructor defines the strategy that will be followed as well as the learners that will be grouped for a specific activity. For all the strategies, specific criteria are taken into account by the system such as a learner cannot exist in two different groups and an assessor cannot be assigned twice for the same work.

In case of the third strategy, the group formation of learners as well as the assignment of assessors is based on learners' model. The instructor selects learners' characteristics (up to four) that wish to be taken into consideration such as learner's learning style (as recorded during the enrollment of the learner), knowledge level (this is evaluated by peers or by the instructor or by both with respect to the activities that s/he has worked on), and competence-level in assessing peers' work (this is evaluated by authors or by the instructor or by both with respect to the activities that s/he has assessed), learner's communication with others (e.g., group members or authors or assessors or instructor). Then, for each selected characteristic, the instructor defines if the group members will have similar values (e.g., all the learners of the group will have high knowledge level; homogeneity of the group) or dissimilar (e.g., the group is consisted of learners who have low and high knowledge level; heterogeneity of the group). Afterwards, the instructor defines (a) the group size, that is the desired number of learners in a group and the desired number of activities for review, and (b) the algorithm that is going to be used and its parameters to find an optimal solution (for a description of the algorithms see (Gogoulou et al., 2007). After system's grouping, the instructor has the option to intervene and rearrange the group members in cases where conflicts are encountered and undesirable groups are formed.

Collaboration of Learners

Collaboration may take place in PECASSE during (a) the authoring and the review process of an activity by a group of learners (collaboration of the members of the group), (b) the collaborative-assessment of an activity (collaboration of assessor[s]) with the instructor), (c) the revision step of the assessment process (Step 3) where authors and assessors may discuss any misunderstandings, and (d) the review process (Step 2) where assessors of the same activity may collaborate to discuss their evaluation policy and their comments. Also, learners have the possibility to communicate between themselves or with the instructor in the context of the subject matter. The communication may be either synchronous or asynchronous. The synchronous communication is implemented through the ACT tool (Gogoulou, Gouli, & Grigoriadou, 2008), while the asynchronous communication is implemented through a discussion forum.

The ACT tool aims to promote the cultivation of cognitive and commu-

nication skills and guiding learners appropriately during their communication. ACT supports both the free and the structured form of dialogue; the structured dialogue is implemented either through sentence openers or communication acts. In case of the structured dialogue, ACT monitors and analyses the interaction at various levels and provides alternative and complementary representations of the interaction analysis results as well as proposes remedial actions to guide learners during their communication. As the ACT tool is a synchronous communication tool, a bulletin board supports the arrangement of the members' communication.

In the context of the asynchronous communication, the moderator of the group (in case of group of learners), or the instructor (in case of collaborative-assessment), or the author (in case of authors' and assessors' communication), or one of the assessors (in case of assessors' communication) is responsible to create a discussion forum and define its usage (e.g., for the authoring or the review of an activity or for 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). The categorization and the characterization of the messages aim to contribute to the production of interaction analysis indications, a facility that is under design/development.

How Assessors Can Review an Activity

With respect to the learning outcomes of the activity, two review methods may be applied; the provided review/feedback may be structured and recorded either in an assessment form or in a commentary letter. As the review process may emphasize on the grading of the activities and/or the commentary of the work, the assessment form or the letter may include only comments or assessment criteria, grades, and comments.

In case the assessment form is applied as a review method, various strategies can be followed for the setting of the assessment scheme and subsequently for the construction of the assessment form. More specifically with respect to the learning outcomes addressed by the activity: (a) the instructor may set up entirely the assessment form, or (b) the instructor may set up a template of the assessment form, which has to be enriched/modified by the assessors, or (c) assessors may define/construct entirely the assessment form. The first strategy is recommended for self- and peer-assessment, where assessors are inexperienced and aims at helping learners understand, which standards are considered useful and are targeted to the underlying

activity. The second strategy aims at guiding assessors towards the review by pointing out key criteria and potential aspects of a good activity, having simultaneously the possibility to extend the breadth and depth of the instructor-given form and participate more actively in the review process. The last 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 or in case that assessors have been trained on how to construct a form and have experience on assessing their peers' work.

The assessment form may include up to five sections; each section may be characterized as criteria or questions or comments section and may contain a number of elements. The structuring 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 work under review. Regardless of who is the constructor of the form (i.e., the instructor or the assessor), a number of attributes have to be determined, such as: (a) the sections, (b) which sections of the form are visible to authors and which are invisible, (c) how many elements the assessors have to define and how many elements may be defined optionally, and (d) for each element of the section, its visibility/invisibility to the author, its obligatory/optional completion with feedback, its weight (zero weight means the nongrading of the element), and the visibility/invisibility of the grade to the author. The grade of the activity is calculated by summing the product of each grade with the corresponding criterion weight. In Figure 4, a template of an assessment form is presented. The template 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 (it is visible to the instructor; in this way the assessor has the possibility to write more comments, which are only visible to the instructor). For the criteria section, the instructor has defined the weights and the attributes of the elements (i.e., all of them are visible to authors; the assessors have to give a grade for each one, the reason for their grade and their feedback), and the assessors have to define two more elements (criteria) and have the possibility to set up four more elements if they wish.

A STUDY FOR THE EVALUATION OF THE PECASSE ENVIRONMENT

Research Questions

The main focus of the study was to investigate/verify the functionality and effectiveness of the PECASSE environment in fulfilling and facilitating self-, peer-, and collaborative-assessment methods. Also, the study explored whether the process followed through the PECASSE environment promotes

Figure 4. A template of an assessment form provided for the review of an activity and an excerpt of the review form completed with grades and feedback

and enhances the learning process. In addition, the role of students as assessors and their attitude towards the review process are explored. In sum, this study was conducted aiming to investigate the following research questions:

- What is the students' opinion towards the PECASSE environment? Are the provided facilities useful, adequate, and usable?

- Is there any improvement on students' work after their interaction with the PECASSE environment? If yes, which are the possible reasons for this improvement?

• How students act as assessors and what is the students' opinion of the review process followed?

Subjects

The 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. Seventy-eight students ($n=78$) planned to participate in the study. As students' performance on the assessment task was part of the overall grade of the course (70%), a small number of students ($n=7$) dropped out the task. None of the students had performed any peer- or collaborative-assessment in the past.

Task and Materials

The students' task was to design a lesson plan for a specific topic; they had to determine the expected learning outcomes, the educational techniques/didactical approaches to be used, and the stages of the hypothetical lesson designed (the context of each stage, the time schedule, etc). Following, they had to self-assess their work and review their peers' work. After receiving feedback for their own work, students had to revise and resubmit their work and evaluate their assessors. All the submissions and reviews were carried out through PECASSE. The collaboration/communication of the students (authors and/or assessors) was accomplished by the asynchronous communication tool available in the environment. During the performance of the task, students had at their disposal, a brief description of PECASSE, guidelines for the elaboration of the activity, and a questionnaire concerning (a) the evaluation of the PECASSE environment, and (b) the students' attitude towards the assessment methods performed, and the review process followed.

Procedure

The study was conducted in two sessions: the first session followed the self- and peer-assessment method (SPA session) while the second session followed the self-, peer-, and collaborative-assessment method (SPCA session). Both sessions ran in parallel and lasted 9 weeks. The subjects were randomly assigned to two sessions: Group SPA ($n=35$) and Group SPCA ($n=36$). Authors and assessors of Group SPA were individuals while the students of Group SPCA were grouped in teams of three members (12 groups). The instructor was responsible for the group formation and the specification of the moderator of each group. In both sessions, assessors were assigned by the system randomly.

Three expert-assistants participated in the study, having the role of coach and expert. More specifically, they were responsible for the evaluation of students' activities, for keeping track of students' participation and for guid-

ing them during the accomplishment of the task. In the context of SPCA session, each of the three expert-assistants took four groups as his/her responsibility and acted as assistant/adviser of the group.

All the students, before their participation in the study, attended two training lessons (each lesson lasted 3 hours) that took place in a conventional classroom. The aim of the training was to introduce students to the concepts of assessment, standards, marking scheme, and useful feedback. The lessons were accompanied with in-class assessment tasks. The instructor was responsible for the introduction of the abovementioned concepts while the three expert-assistants participated in the lessons for helping students in the assessment tasks performed.

The assessment process was carried out in two rounds following the steps:

- 1st round-Authoring and Submission (duration: 2 weeks): half of the students of Group SPA worked on the topic "Internet and search engines" and half on the topic "The concept of variable in programming," while all students of Group SPCA worked on the topic "Alternative Didactical Approaches." Also, the students had to self-evaluate the submitted work in a brief way; students wrote shortly comments about their work and gave a rate.

- 1st round-Reviewing (duration: 2 weeks): in case of SPA, each student assessed two activities (one with the same topic and one with the different topic) while in case of SPCA, each group assessed three activities. For the review of the activities, the students of group SPA had at their disposal a template of an assessment form constructed by the instructor. Each assessor had to add two criteria and one question item in the corresponding sections and could additionally determine more sections or criteria or question items. The students of Group SPCA had to construct the assessment form on their own with the participation/ guidance of the expert-assistant. The review process was anonymous. Also, the expert-assistants assessed the authors' submitted work.

- 1st round-Feedback and 2nd round-Authoring and Submission (duration: 2 weeks): revision and resubmission of the work taking into account their peers' comments and evaluation of assessors' work.

- 2nd round-Reviewing and 2nd round-Feedback (duration: 3 weeks): evaluation by expert-assistants and provision of feedback.

Students were informed for the time schedule of each step through the environment. After the completion of the process, students were asked to fill and submit the evaluation questionnaire.

Data Collection

Quantitative data was collected in the form of grades awarded by (a) expert-assistants when grading authors' work (1st and 2nd round) and asses-

sors' work, and (b) authors when evaluating the work of their assessors. Moreover, qualitative and quantitative data was obtained through the evaluation questionnaire. Students' discourse by the asynchronous communication tool as well as the grades awarded by the assessors when evaluating their peers' work, were not examined in the study under consideration.

Data Analysis

Questionnaire. The main purpose of the evaluation questionnaire was to explore students' perception towards the PECASSE environment as well as students' attitude towards the assessment methods and the review process. The questionnaire consisted of Likert-scale type questions and open-ended questions. The Likert-scale type questions were questions or statements about (a) the usefulness, the adequacy, and the usability of the facilities provided in PECASSE (20 items; indicative item is "The possibility to keep your anonymity in the review process is considered as very useful"), (b) students' attitude towards the assessment methods performed (6 items; indicative item is "Do you believe that peer-assessment promotes/enhances the learning process?"), (c) students' attitude towards the realization of the assessment methods by the PECASSE environment (6 items; indicative item is "PECASSE fulfils the aims of the assessment methods performed"), (d) students' attitude towards the review process followed in PECASSE (14 items; indicative item is "Do you prefer to have an assessment form entirely constructed by the instructor?"). Students' answers could vary from 1 to 5 (1 indicates "Strongly disagree" or "Very negative attitude," 2 indicates "Disagree" or "Negative attitude," 3 indicates "Moderate," 4 indicates "Agree" or "Positive Attitude" and 5 indicates "Strongly Agree" or "Very Positive Attitude"). For some Likert-scale type questions, students were asked to justify their answers. The open-ended questions intended to stimulate students to express their opinion concerning the review process and the negative/positive aspects of the assessment methods as well as to make comments and suggestions for the improvement of PECASSE.

Means, standard deviations and percentage of students were used to describe the quantitative data. Students' responses for each item of the questionnaire were converted into "Disagreement" or "Negative Attitude" (responses of 1 and 2), "Moderate," (responses of 3) and "Agreement" or "Positive Attitude" (responses of 4 and 5). The percentage of students, appearing in section "Results," corresponds to the number of students who expressed their agreement or their positive attitude. The open-ended questionnaire responses as well as students' justifications to Likert-type questions were coded.

Achievement measures. The following dependent variables were obtained for each student or group of students: (a) an activity 1st round-average score assigned by two expert-assistants (1st round expert score), (b) an assessor's

work average score assigned by two expert-assistants (1st round review-expert score), (c) an assessor's evaluation score assigned by authors (1st round assessor's score), and (d) an activity 2nd round-average score assigned by two expert-assistants (2nd round expert score). In evaluating activities and assessors' work, both students and expert-assistants gave a score between 1 and 10 with 0.10 as a unit.

The Pearson correlation of the two expert-assistants grades for the 1st (initially submitted work) and the 2nd (revised work) round of Group SPA was 0.961 ($r=0.961$, $df=33$, $p<0.01$) and 0.947 ($r=0.947$, $df=33$, $p<0.01$) respectively, while for the 1st and the 2nd round of Group SPCA was 0.969 ($r=0.969$, $df=10$, $p<0.01$) and 0.970 ($r=0.955$, $df=10$, $p<0.01$) respectively. One may notice that for both groups (Group SPA and Group SPCA), the two experts' scores were highly correlated for the 1st and the 2nd round. Means, standard deviations and ranges were used to describe the quantitative data for experts' rating. Also, repeated measures analyses of variance on the two experts' average scores of the two versions of the activities (initially submitted and revised) were conducted to identify significant differences between the grades of the 1st and the 2nd round.

Also, students' work as assessors was evaluated by two expert-assistants in terms of the following criteria: (a) the assessment form constructed or enriched, (b) the problems/ weaknesses and the positive aspects of the work under review identified by the assessors, (c) the quality of feedback provided (correctness and adequacy) for each criterion and question item, and (d) the mark awarded for each criterion with respect to the feedback provided. Means, standard deviations and ranges were used to describe the quantitative data for experts' evaluation of assessors' work. Also, Pearson's correlation coefficient was used to explore the reliability of grades assigned by expert-assistants for each of the four mentioned criteria.

Results

1st Research Question: What is the students' opinion towards the PECASSE environment? Are the provided facilities useful, adequate, and usable?

To explore students' perception towards PECASSE and the facilities provided, students' responses to the questionnaire were examined. In Table 1, students' responses to indicative questions items are presented. A considerable number of students believed that PECASSE fulfills the aims of the assessment methods performed (Table 1, item Q1), and facilitates and simplifies the execution of the steps of the assessment process (Table 1, item Q3). Although, most of the students found the possibility of using PECASSE in the instruction process at the university level or in secondary education, interesting and promising (Table 1, item Q4), they expressed anxiety to using PECASSE in secondary education (as recorded by their responses) due to the their inexpe-

Table 1

The Attitude of Students (Means [Standard Deviations] and Percentage of Students)
Towards the PECASSE Environment and the Usefulness/Usability of the Facilities Provided

	Indicative Question Items	Group SPA	Group SPCA
Q1	PECASSE fulfils the aims of the assessment methods performed	4.4 (0.6) – 96.6%	4.7 (0.7) – 91.7%
Q2	PECASSE contributes positively in the realization of the assessment methods in a useful/easy way	4.4 (0.7) – 93.1%	4.1 (0.8) – 75%
Q3	PECASSE facilitates and simplifies the execution of the steps of the assessment process	4.4 (0.8) – 86.2%	3.9 (0.7) – 75%
Q4	PECASSE can be incorporated effectively as an assessment/learning tool in the instruction process at university level or in secondary education	3.9 (0.7) – 75.9%	3.6 (0.7) – 50%
Q5	PECASSE can be characterized as a "pleasant" environment	3.8 (1.0) – 69%	3.9 (0.8) – 83.3%
Q6	The response time concerning the performance of the system is considered satisfactory	3.9 (1.1) – 62.1%	4.2 (0.7) – 83.3%
Q7	Time needed for acquaintance with the system in minimal	3.6 (1.2) – 58.6%	3.8 (1.0) – 75%
Q8	I am interested in elaborating more activities through PECASSE in the future	3.7 (0.9) – 58.6%	3.8 (0.6) – 66.7%
Q9	It is useful to keep my anonymity through the submission process	3.9 (0.9) – 58.6%	4.3 (1.1) – 75%
Q10	It is useful to have the possibility to keep my anonymity in the review process	4.5 (0.9) – 89.7%	4.3 (1.0) – 83.3%
Q11	It is useful to brief self-assess my own activity after its submission	3.3 (1.3) – 44.8%	3.3 (1.5) – 33.3%
Q12	It is useful to manage the assessment form during the review process	4.5 (0.9) – 93.1%	4.3 (1.2) – 83.3%
Q13	It is useful to have the possibility to enrich/construct the assessment form with my own elements	4.4 (0.7) – 89.7%	4.0 (1.3) – 75%
Q14	It is useful to have the possibility to evaluate my assessors	4.6 (0.7) – 86.2%	4.6 (0.8) – 83.3%
Q15	It is useful to have the possibility to collaborate/communicate with the other members of the group for the submission or the review of an activity (only in case the authors or assessors are group of learners)	-	3.9 (1.3) – 75%
Q16	It is useful to have the possibility to communicate with my assessors in order to clarify any misunderstandings	4.3 (0.8) – 83.3%	4.6 (0.7) – 91.7%

Q17	The participation of the instructor during the review process of the activities is useful (only for Group SPCA)	-	4.7 (0.5) – 100%
Q18	The possibility to have access to the "best" activities is useful	4.4 (0.8) – 83.3%	4.4 (0.9) – 91.7%
Q19	I am satisfied with the usability of the environment	3.9 (0.9) – 72.4%	3.5 (1.2) – 66.7%
Q20	The facility for the management/construction/enrichment of the assessment form is usable	3.9 (1.1) – 69%%	3.7 (1.2) – 58.3%
Q21	The facility for the completion of the assessment form with feedback and its submission is usable	3.9 (1.2) – 75.9%	4.1 (1.1) – 66.7%
Q22	The facility for receiving the reviews of my activity is usable	4.3 (0.9) – 82.8%	4.4 (0.8) – 83.3%

rience and the constraints posed by the Greek educational system. A considerable number of students were willing/pleasant to elaborate more activities through PECASSE in the future (Table 1, item Q8); the time and effort needed for the completion of the process are the main reasons for students' unwillingness (as recorded by their responses). Regarding the characteristics of the environment as well as the facilities provided, most of the students characterized PECASSE as a "pleasant" environment (Table 1, item Q5), and they were satisfied with its usability to a high degree (Table 1, item Q19).

As recorded on open questions of the questionnaire, most of the students (76%) asserted that approximately all of the system's functions/facilities were well organized, useful, and usable while a percentage of students (25%) suggested improvements for the management/construction of the assessment form, the definition of the moderator of the group by the group members, and the presentation/organisation of the messages in the asynchronous communication tool. Most of the students consider useful/helpful the expert-assistant's participation in the discussion forum as the continuous monitoring of the students' discussion and the immediate intervention of the expert-assistant can solve potential confusions. The possibility to (a) keep their anonymity or to review an activity eponymously (items Q9 and Q10), (b) manage and enrich/construct the assessment form instead of having an assessment form specified by the instructor (items Q12 and Q13), (c) assess their assessors and communicate with them (items Q14 and Q16), and (d) have access to the "best" activities (item Q18), stood high in most of the students favour. Regarding the evaluation of assessors, students believed that the specific facility is effective in motivating careful reviews.

As far as the self-assessment process is concerned, it appears that a significant number of students did not understand the importance of self-

evaluating their own activity (item Q11). Indicative comments for the specific facility were *"Self-evaluation is completely useless," "If I believed that my activity was incomplete or wrong, I avoided to submit it," "I didn't understand why I have to evaluate my activity," "I prefer to evaluate my activity after the review process of the other activities," "It was very hard to self-assess my activity, as I believed that I had done my best.*" One reason for students' reaction towards self-assessment may be that during the specific process, students didn't have at their disposal, the standards (criteria) for assessment that could help them to understand their weaknesses. The in-depth investigation of students' attitude towards self-assessment remains an open issue.

Indicative students' comments for PECASSE as these are recorded from their answers on open questions: "*Through conventional lessons or reading from books, we learn about collaboration and assessment in theoretical level. PECASSE shows us how we can really collaborate and learn more. Although I had problems with the deadlines (it was the first time that I tried to be on-time) and the demanding task, now I strongly believe that I would like to elaborate more activities with the PECASSE environment,*" "*Although the process followed through the PECASSE environment was time and effort consuming as well as high pressing, I believe that PECASSE realizes the process in an easy/useful way, offering us an interesting and alternative learning approach,*" "*PECASSE has all the appropriate usable facilities, which are considered necessary for peer-assessment. It excites your interest as it is different from other learning systems,*" "*It was very interesting and useful that we constructed and managed the assessment form. In order to construct the form and define the criteria as well as the questions, we studied in more depth the activities under review and in that way we understood the problems of our own work,*" "*The reviews that I received focused mainly on different aspects/problems of my work, which really needed revision. This gave me the chance to reconsider and revise more errors,*" "*The collaboration between the members of the group gave me the possibility to discuss my ideas and reconsider my beliefs*."

2nd Research Question: Is there any improvement on students' work after their interaction with the PECASSE environment? If yes, which are the possible reasons for this improvement?

To determine whether there is any improvement in students' performance (i.e., the revised work of students' after receiving feedback from their peers is scored higher than the initial submitted one), repeated measures analyses of variance on the two experts' average scores of the two versions of the activities were conducted (Table 2). The results show that the scores received for the two versions of the activities of Group SPA are significantly different ($F_{1,34}$=107.479, $p<0.01$); likewise, the scores for those of Group SPCA are significantly different ($F_{1,11}$= 18.464, $p<0.01$). From the results of

Table 2

Means (Standard Deviations and Ranges) for Expert-Assistants' Rating

	Performance Score for initial work	Performance Score for revised work
Group SPA (n=35)	6.40 (1.88) (2.30-9.15)	7.97 (1.25) (5.05-9.60)
Group SPCA (n=36, 12 groups)	6.37 (1.71) (3.25-8.70)	7.79 (1.00) (5.90-8.95)

Table 2, it becomes obvious that the expert-assistants gave significantly higher scores to the revised work than to the initial submitted one. Hence, it is reasonable to state that students' work demonstrated improvement after the assessment methods performed.

To investigate the possible reasons for the improvement in students' performance, students' answers to the questionnaire were examined. As recorded from students' answers, the revision of students' work was mainly influenced by (a) the useful comments/feedback provided by the assessors (Group SPA: M=4.2 (1.0) and 86.2% of the students, Group SPCA: M=4.3 (0.6) and 91.7% of the students), (b) the process followed as students had the chance to realize the problems of their own work when comparing it with the work under review (Group SPA: M=3.2 (1.4) and 55.2% of the students, Group SPCA: M=3.8 (1.0) and 58.3% of the students), and (c) the study in depth of the subject area that students had done as assessors in order to be able to assess their peers' work (Group SPA: M=4.4 (0.9) and 82.8% of the students, Group SPCA: M=3.93 (1.16) and 75.9% of the students). To this end, the majority of the students believed that the assessment methods performed, promote and enhance the learning process (Group SPA: M=4.3 (0.8) and 89.7% of the students, Group SPCA: M=4.3 (0.9) and 86.2% of the students). However, they characterized the process followed as effort and time consuming (Group SPA: M=4.3 (0.9) and 86.2% of students, Group SPCA: M=4.2 (1.0) and 75% of students).

3rd Research Question: How students act as assessors and what is the students' opinion of the review process followed?

To investigate students' role as assessors as well as their attitude towards the review process, the following were examined: (a) students' work as assessors, evaluated by two expert-assistants, (b) students' work as assessors' regarding the construction/enrichment of the assessment form, (c) students' responses to the questionnaire regarding the strategies that may be followed for the construction of the assessment form, (d) the evaluation of assessors' work by the authors, and (e) students' responses to the questionnaire regarding the feedback received from their assessors and their role as assessor.

As mentioned earlier (see "Data Analysis" section), students' work as assessors was evaluated by two expert-assistants in terms of specific criteria. In Table 3, the results from the experts' evaluation are presented in terms of the four criteria posed (first four rows). The final evaluation (Table 3, last row) of assessors' work results from the marks awarded to each of the four criteria with different weights (i.e., 0.2, 0.4, 0.3, and 0.1 respectively). The agreement (Pearson's correlation coefficients) between the two expert-assistants' scores is presented in Table 3; the experts' scores on each criterion were significantly related.

From experts' evaluation is obvious that most of the students constructed or enriched the assessment form successfully (Table 3, first row) including a number of significant, relevant and clear-stated criteria and question items and defining appropriately the attributes of the form/elements. Moreover, the high experts' evaluation for the quality of feedback (Table 3, third row) and the mark awarded to each criterion (Table 3, fourth row) indicates that (a) students provided satisfactory quality review, explaining the problems identified and suggesting further improvements of the work, and (b) the grades assigned were in line with the feedback provided. The main problem focuses on the ability of students to identify all the advantages and mainly the weaknesses of the work under review (Table 3, second row). This may be mainly due to the inexperience of the students in assessing others' work; further investigation of the possible reasons is required.

Furthermore, the examination of students' work as assessors (Table 3, last row) and their performance of the revised work (Table 2, last column) results in a relationship between these two variables (Group SPA: $r=0.468$, $p<0.01$, Group SPCA: $r=0.696$, $p<0.05$). It appears that students, who acted better as assessors and spent more efforts in reviewing their peers' work, had better results in their final performance and the review process may help them in improving their own work. This is in keeping with previous findings (Tsai, Lin, & Yuan, 2002; Sitthiworachart & Joy, 2004) that the more feedback quality students provided, the better their own performance became.

Regarding the construction/enrichment of the assessment form, all the students of Group SPA defined the required elements (criteria and question items) and their corresponding attributes while 46% of the students (16 out of 35 students) defined more criteria and question items (one or two) than the required ones. This result is interesting and encouraging as it indicates the positive attitude of students to actively participate in the review process and in the setting of the assessment scheme applied. Regarding the students of Group SPCA, 50% of them (6 groups out of 12) constructed a form with three sections while the rest groups constructed a form with two sections. All the groups defined a section with criteria and weights in order to be able to assign grades and the rest sections had either question items (e.g., What are the advantages of the work? Is it possible to achieve the goals of the lesson plan described?) and/or

Table 3
Means (Standard Deviations and Ranges) for Experts' Evaluation of Assessors' Work

| | Expert-1 | Group SPA (*n*=35) | | Group SPCA (*n*=36, 12 groups) | | |
		Expert-2	Correlation	Expert-1	Expert-2	Correlation
Assessment Form	9.11 (0.61) (8.00-10.0)	8.72 (0.47) (7.50-9.50)	r=0.828**	8.24 (1.66) (5.00-9.50)	8.15 (1.46) (5.20-9.50)	r=0.963**
Weaknesses/ Positive Aspects Identified	7.06 (1.17) (5.00-9.00)	6.53 (1.17) (4.20-8.70)	r=0.913**	6.65 (1.64) (3.30-8.50)	6.42 (1.20) (4.10-8.20)	r=0.966**
Feedback Quality	8.55 (1.30) (5.00-9.70)	8.13 (1.18) (5.00-9.20)	r=0.958**	7.63 (1.91) (3.00-9.30)	7.45 (1.45) (4.10-9.10)	r=0.990**
Mark awarded	9.23 (1.01) (6.00-10.0)	8.91 (0.70) (6.50-9.50)	r=0.919**	8.38 (1.13) (6.00-9.80)	8.19 (0.94) (6.50-9.50)	r=0.959**
Final Evaluation	8.13 (0.90) (5.50-9.38)	7.69 (0.80) (5.65-8.69)	r=0.972**	7.43 (1.63) (3.82-8.95)	7.25 (1.25) (4.60-8.82)	r=0.988**

** Correlation is significant at the 0.01 level (2-tailed)

comments/proposals for possible revisions of the work. It appears that the majority of the students had an active role in the assessment form construction, exploiting the structure, and the facilities provided by PECASSE. Also, the assessment forms constructed by most of the students were highly evaluated by the expert-assistants (Table 3, first row, last column).

Regarding the strategies that may be followed for the construction of the assessment form, students' answers (Group SPA and SPCA) to the questionnaire reveals that (a) 41.7% of the students prefer to have an assessment form constructed entirely by the instructor as in that way the review process is easier and more objective; it is important to mention that 50% of the students were against this option, (b) 83.3% of the students prefer to have at their disposal, a template of an assessment form and have the option to add more elements and define their attributes; none of the students was against this option, (c) 33.3% of the students prefer to construct the assessment form on their own while 41.7% of the students feel uncomfortable with this option as they believe that they do not have enough experience for setting the assessment scheme and constructing the assessment form; 89.7% of the students agree in constructing the form on their own under the guidance/help of the instructor and none of the students was against this option. Regarding the participation of the expert-assistant in the review process, students of Group SPCA (a) considered his/her assistance crucial to formulating a comprehensive and objective assessment form, (b) characterized as high his/her participation/contribution to the review process (M=4.6 (0.9) and 91.7% of the students) and (b) characterized his/her role as encouraging, guiding, cooperative, willing and necessary.

The majority of the authors were satisfied with the feedback they received and the marks awarded by their assessors. More specifically, students suggest that the feedback they received was useful (Group SPA: M=4.4 (1.0) and 89.7% of the students, Group SPCA: M=4.4 (0.7) and 93.1% of the students) and helped them to revise their initial work. This is in line with the mark authors awarded to their assessors (Group SPA: 7.79 (1.6), Group SPCA: 7.45 (1.78)), indicating that assessors' review was of satisfactory quality. In particular, 60.61% of the authors (Group SPA and SPCA) were satisfied with the mark awarded to their work (only 11.11% of the authors were dissatisfied), 63.64% of the authors consider that their assessors did a very good work, and 58.59% of the authors agree with the feedback received (only 18.18% of the authors disagree). Finally, a considerable number of assessors (75%) stated that it would be useful, before undertaking the specific role, to participate in a training session through the PECASSE environment in order to overcome any difficulties and be more confident for their reviews.

DISCUSSION AND CONCLUSIONS

PECASSE provides a web-based assessment environment for learners to criticize others' work, review and revise their own ideas/work, collaborate with the instructor and their peers, and share their ideas. Compared to similar systems, the development of the PECASSE environment contributes and extends this line of research. More specifically, the discriminative characteristics of the PECASSE environment are: (a) the support of self-assessment, peer-assessment and collaborative-assessment as well as their combinations with respect to the learning outcomes of the activity under consideration, (b) the options offered for the definition of authors and assessors, that is the author and/or the assessor of an activity could be an individual or a group of learners, (c) the variety of strategies offered for the assignment of assessors and the group formation of learners, taking into account learners' individual differences, and (d) the variety of strategies offered for the setting of the assessment scheme applied in the review process.

The study for the evaluation of PECASSE showed that the majority of the participant-students were satisfied with the usefulness and the usability of the available facilities and the realization of the assessment methods in PECASSE. Also, most of the students asserted that PECASSE promotes and enhances the learning process. This is in keeping with the results revealed from experts' evaluation (1st and 2nd round), indicating that the quality of students' work improves after their involvement in the assessment process. However, students characterized the process followed in PECASSE as time and effort consuming. In line with other researches in the area (Sluijsmans et al., 1999), the majority of the students had a positive attitude towards peer-assessment, asserting that they had received a great benefit from assessing their peers' work. More specifically, they commented that their involvement in peer-assessment made them work at a deeper level of understanding and they benefited both from the experience and the wide range of comments they received. In the context of the collaborative-assessment, most of the students characterized the role of the expert-assistants as necessary, guiding, and encouraging. Moreover, they consider that the assistants' participation gave them the possibility to share a good mutual understanding of the assessment scheme through discussions and negotiations. Regarding self-assessment, most of the students did not understand the importance of self-evaluating their own activity.

As far as students' role as assessors is concerned, the quality of their work was rather high. Most of the students managed to construct the assessment form including a number of new and correct-defined criteria and question items, apply the criteria in a successful way and provide quality feedback. Moreover, most students suggested that the feedback they received from their peers was valuable for the revision of their initial work. Students also

consider that the template of the assessment form (SPA session) and the sup-
port provided by expert-assistants (SPCA session) helped them to design
their own assessment form, provide useful feedback and cope with their role
as assessors. The major problem of the review process was the difficulties
that students encountered in identifying all the problems and weaknesses of
the work under review. Probably, this is due to students' limited experience
in designing and evaluating lesson plans. In the future, we intend to use
additional subjective measures such as interviews to analyze students' per-
spectives and clarify the specific problem.

Two important issues revealed from the particular study that are worth-
while to discuss further are: the need for instructor/assistant participation in
the whole process and the training of students before undertaking the role
of assessor. There is the belief that the workload of the instructor in peer-
assessment is reduced in the context of a web-based assessment environ-
ment such as PECASSE, which offers all the necessary facilities for imple-
menting such an assessment method. This is partly true, as we believe that
the role of the instructor in a web-based assessment environment is changed
from manager to coach of the process and his/her participation in the whole
process is essential. As other researchers stress (Salmon, 2002; Prins, Slui-
jsmans, Kirschner, & Strijbos, 2005), the students need to feel the instruc-
tor next to them and have the opportunity to discuss with him/her any prob-
lems revealed. Moreover, the instructor should be active in the whole
process, keep track of students' participation, take initiatives when prob-
lems encountered and encourage students to reflect on their work (as
authors and assessors) in interaction with other students. Most of the stu-
dents commented that the support provided by the expert-assistants was
very helpful and necessary, and gave them more confidence in the fairness
of the process. PECASSE offers the necessary facilities for the active
involvement of the instructor into the process; moreover, an authoring tool
for helping instructors to design self-, peer-, and collaborative-assessment
activities is under development.

Despite the positive results derived from the use of the PECASSE envi-
ronment for the realization of self-, peer-, and collaborative-assessment, in
our opinion, successful implementation of these assessment methods
depends greatly on the training of the students before their involvement.
Although, in the context of this study, a training session preceded, many
students encountered difficulties in the review process and they suggested
that a more extended training would be helpful. A possible reason may be
the form of the training session, which was classroom-based (not through
PECASSE). A direction for further research includes the use of PECASSE
as a training environment.

Our future plans include the investigation of a number of
issues/questions that were not examined in this study. The first issue relates

to the self-assessment method and its combination with peer- and/or collaborative-assessment. Open questions to be investigated are: should the self-evaluation process precede or follow the peer-/collaborative-assessment process; would it be better to provide learners with an assessment form or assessment guidelines to self-assess their own work? Second, in the current study, students were engaged in a two-round peer-assessment and their work improved from the 1st to the 2nd round. It would be interesting to further investigate a three-round peer-assessment and the differences of students' performance and their work as assessors among the three rounds. Third, in the current study, the review process was qualitative and quantitative. As the PECASSE environment offers the possibility to the assessor to define a qualitative and/or quantitative assessment scheme with respect to the outcomes of the activity, it will be interesting to examine the application of a qualitative scheme (not marking) for one or two rounds aiming to motivate students to focus on the provision of feedback and a quantitative scheme for the last round. Finally, the analysis of students' discourse through the available communication tools would reveal interesting results about authors' and/or assessors' collaboration and interaction as well as their collaboration with the expert-assistants.

In conclusion, PECASSE could be a valuable tool of instructor's assessment toolbox, aiming to foster a learning approach to assessment and help students develop the experience and skills to make judgments on their own and each others learning and in this way to become a key aspect of the so-called "learning society."

References

Chapman, O., & Fiore, M. (2001). *Calibrated peer review: A writing and critical thinking instructional tool*. The white paper: A description of CPR. Retrieved November 4, 2006, from http://cpr.molsci.ucla.edu/

Dochy, F., & McDowell, L. (1997). Assessment as a tool for learning. *Studies in Educational Evaluation, 23*(4), 279-298.

Elwood, J., & Klenowski, V. (2002). Creating communities of shared practice: The challenges of assessment use in learning and teaching. *Assessment and Evaluation in Higher Education, 27*(3), 243–256.

Freeman, M., & McKenzie, J. (2002). Implementing and evaluating SPARK, a confidential web-based template for self and peer assessment of student teamwork: Benefits of evaluating across different subjects. *British Journal of Educational Technology, 33*(5), 553-572.

Gehringer, E. (2001). Electronic peer review and peer grading in computer-science courses. *Proceedings of the 32nd SIGCSE Technical Symposium on Computer Science Education*, (pp. 139-143), Charlotte, NC.

Gogoulou, A., Gouli, E., Boas, G., Liakou, E., & Grigoriadou, M. (2007). Forming Homogeneous, Heterogeneous and Mixed Groups of Learners. *Proceedings of the 11th International Conference on User Modeling: Workshop on Personalisation in e-Learning Environments at Individual and Group Level (PING2007)* (pp. 33-40), Corfu, Greece.

Gogoulou, A., Gouli, E., & Grigoriadou, M. (2008). Adapting and Personalizing the Communication in a Synchronous Communication Tool. *Journal of Computer Assisted Learning, 24*, 203-216.

Harris, D., & Bell, C. (1994). *Evaluating and assessing for learning. New York: Kogan Page.*

Kwok, R., & Ma, J. (1999). Use of a group support system for collaborative assessment. *Computers & Education, 32*, 109-125.

Lin, S., Liu, E., & Yuan, S. (2001). Web-based peer assessment: Feedback for students with various thinking styles. *Journal of Computer Assisted Learning, 17*, 420-432.

Martin, E., & Paredes, P. (2004). Using learning styles for dynamic group formation in adaptive collaborative hypermedia systems. *International Workshop on Adaptive Hypermedia and Collaborative Web-based Systems (AHCW'04)* held in conjunction with the *International Conference on Web Engineering (ICWE 2004)*, (pp. 188-198), Munich, Germany.

McConnell, D. (2002). The experience of collaborative assessment in e-learning. *Studies in Continuing Education, 24*(1), 73-92.

Orsmond, P., Merry, S., & Reiling, K. (2000). The use of student derived marking criteria in peer and self assessment. *Assessment and Evaluation in Higher Education, 25*(1), 23–37.

Orsmond, P., Merry, S., & Reiling, K. (2002). The use of exemplars and formative feedback when using student derived marking criteria in peer and self-assessment. *Assessment and Evaluation in Higher Education, 27*(4), 309-323.

Pellegrino, J., Chudowsky, N., & Glaser, R. (2001). (Eds). *Knowing what students know: The science and design of educational assessment*. Washington DC: National Academy Press.

Pond, K., Ul-Hag, R., & Wade, W. (1995). Peer-review: A precursor to peer assessment. *Innovations in Education and Training International, 32*, 314-323.

Prins, F., Sluijsmans, D., Kirschner, P., & Strijbos, J-W. (2005). Formative peer-assessment in a CSCL environment: A case study. *Assessment and Evaluation in Higher Education, 30*(4), 417-444.

Salmon, G. (2002). Mirror, mirror, on my screen…Exploring online reflections. *British Journal of Educational Technology, 33*(4), 379-391.

Silva, E., & Moreira, D. (2003). WebCoM: A tool to use peer review to improve student interaction. *Journal of Educational Resources in Computing, 3*(1), 1-14.

Sitthiworachart, J., & Joy, M. (2004). The evaluation of students' marking in web-based peer assessment of learning computer programming. *Proceedings of the International Conference on Computers in Education, (ICCE 2004)*, (pp. 1153-1163), Melbourne, Australia.

Sluijsmans, D., Dochy, F., & Moerkerke, G. (1999). Creating a learning environment by using self-, peer- and co-assessment. *Learning Environments Research, 1*, 293-319.

Somervell, H. (1993). Issues in assessment, enterprise and higher education: The case for self, peer- and collaborative assessment. *Assessment and Evaluation in Higher Education, 18*, 221-233.

Strachan, I., & Wilcox, S. (1996). Peer and self assessment of group work: Developing an effective response to increased enrolment in a third year course in microclimatology. *Journal of Geography in Higher Education, 20*(3), 343–353.

Sung, Y-T., Chang, K-E., Chiou, S-K., & Hou, H-T. (2005). The design and application of a web-based self- and peer-assessment system. *Computers & Education, 45*, 187-202.

Topping, K. (1998). Peer assessment between students in colleges and universities. *Review of Educational Research, 68*(3), 249-276.

Trahasch, S. (2004). From peer assessment towards collaborative learning. *Proceedings of the 34th ASEE/IEEE Frontiers in Education Conference*, (pp. Vol. 2, F3F-16-20), Savannah, GA.

Tsai, C-C., Lin, S., & Yuan, S-M. (2002). Developing science activities through a networked peer assessment system. *Computers & Education, 38*, 241-252.