

ONLINE ASSESSMENT: SUPPORTING THE FORMATIVE ASSESSMENT OF COLLABORATIVE LEARNING ACTIVITIES

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ABSTRACT

This paper presents a Formative Assessment Support Model for Learning Management Systems that is focused on the continuous monitoring and regulation of learner participation throughout collaborative learning activities. The model provides a more effective support for formative assessment in two complementary ways: (i) by supporting the planning of learning activities to be assessed, as well as (ii) by supporting the educator's analysis and regulation of participations in these planned assessment activities, by means of helping the educator to retrieve and analyze relevant information for participation regulation according to the criteria defined at each learning activity assessment planning. A multi-agent system is the basis of the technological solution defined for the implementation of the proposed formative assessment support model and is briefly discussed at this work.

KEYWORDS

Distance education, formative assessment, collaborative learning, multi-agent systems.

1. INTRODUCTION

The Computer Mediated Communication (CMC) has introduced new possibilities to the Distance Education, making possible the adoption of pedagogical methodologies focused on collaborative learning activities. New possibilities has also been introduced to the online assessment, from traditional assessment based on cumulative question and tests to a more formative assessment aligned to these new pedagogical approaches.

The online formative assessment is based on the continuous monitoring and regulation of learner participation throughout the learning activities development in Learning Management Systems (LMSs), such as the development of individual or group projects, synchronous and asynchronous discussions, and so on. The formative assessment aims to support the learning process based on the adopted pedagogical approaches, and takes a central role in the learning actions, having as its main contribution the constructive regulation of the evolving learning processes.

This assessment approach has both informative and regulatory characteristics. In other words, it offers information to both actors in the teaching-learning process: to **the teacher**, who is informed of the actual effects of his/her pedagogic actions, allowing him/her to regulate his/her own actions as well as those of **the learner**; and to the learner, who becomes aware of his/her difficulties and possibly recognize and correct his/her own errors (Hadjji, 1997).

The experience in online courses based on collaborative learning activities and on the formative assessment of the participation on these activities has revealed that formative assessment is even more important in Distance Education where assessment presents some intrinsic difficulties, such as the absence of the face-to-face interactions feedback, the lack of teacher control over the assessment and the authentication problem (who is performing the assessment?). The informative and regulatory characteristics of this assessment approach have revealed themselves as a crucial importance to Distance Education, by helping the

learners' behavior perception and the problems identification, making possible more effective advice in the time of learning process, even at distance. Nevertheless, nowadays most LMSs does not present a set of features specially designed to effectively support this assessment approach. Thus, the educators need to take extra steps to monitor, to analyze and to advise the learning process. This scenario has been the main problem of formative assessment, at face-to-face as well as at distance practices.

This article presents a Formative Assessment Support Model for LMSs that aims to reduce the formative assessment costs and to promote the adoption of this assessment approach. This model has pedagogical basis on Perremoud's (1998) and Hadji's (1997) concepts and recommendations for formative assessment and on previous experiences in online formative assessment based on collaborative learning activities (Freire & Rocha, 2002) (Prado & Valente, 2002). The proposed model aims to map these recommendations onto the scope of Distance Education, considering the formative assessment of collaborative learning activities developed in LMSs. Our model provides effective support for formative assessment in LMSs, exploring the facility to register everything that transpires within the LMS so that computational technologies can be applied to extract and analyze that information which is relevant to the formative assessment according to the interests and pedagogic objectives of the educator.

We have been implementing and integrating this model in two LMSs: (1) TelEduc¹, a free and open source system that has been developed since 1997 at the State University of Campinas; and (2) Tidia-Ae² a free, open source and component based system that has been developed since 2004 by Brazilian universities funded by FAPESP (*The State of São Paulo Research Foundation*). These implementations have made possible an initial analysis of the model's effectiveness, flexibility and generality.

The focus of the present article is to present our formative assessment support model and briefly discuss some considerations about its implementation on TelEduc and TIDIA-Ae LMSs. The remainder of this text is organized as follows: section 2 presents the proposed formative assessment support model consisting of its stages and the main concepts and functionalities related to each stage; section 3 presents some considerations about the technological solution for the proposed model; the section 4 presents some related works and the section 5 presents the final considerations.

2. A FORMATIVE ASSESSMENT SUPPORT MODEL

Our model is based on Perrenoud's and Hadji's concepts of and recommendations for formative assessment. These are the current studies in the Assessment Research Area that most closely approximate our assumptions and practices in relation to learning assessment. The model aims to map these recommendations onto the field of Distance Education, considering the formative assessment of collaborative learning activities which constitute the pedagogic practice that has permeated a significant number of learning actions that has been developed since the Internet and CMC advent (Thorpe, 1998), (Freire & Rocha, 2002), (Prado & Valente, 2002), (Macdonald, 2003).

Hadji presents a methodological guideline for a more formative assessment based upon four major tasks: to stimulate (behaviors to be observed), to observe (these behaviors), to communicate (the results of their analysis and their final evaluation) and to remediate (the difficulties analyzed). Our formative assessment support model, based on these recommendations, aims to minimize the difficulties intrinsic to the formative assessment process by supporting the educator in these tasks. The model is divided into two phases (Figure 1): (i) **support for the Planning** of the learning activities which aims to stimulate the desired behaviors; (ii) and **support for Monitoring** of the participation in these activities, where the tasks of observation/interpretation of the stimulated behaviors, communication of the analyzed results, and the remediation of the observed difficulties take place. The main characteristics of the support proposed for these two phases are presented in the following subsections. A complete description of this model is presented in (Otsuka, 2006). The functional and non-functional requirements of this model are described in (Otsuka & Rocha, 2005).

¹ <http://teleduc.nied.unicamp.br>

² <http://www.tidia-ae.iv.fapesp.br/>

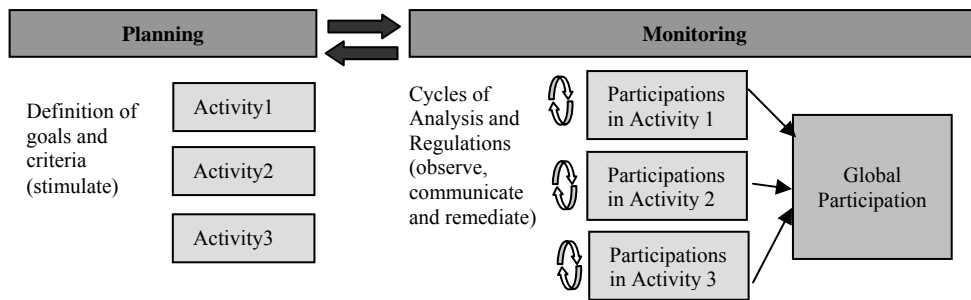


Figure 1. Phases of the Formative Assessment Support Model

2.1 Planning

In the planning phase the focus is on the support for the definition of a learning activity **goals** (behaviors that should be stimulated and abilities that should be developed) and **criteria** (what will be observed in order to verify if the learners are progressing in the direction of the planned goals).

It is important to call attention to the influence that assessment has on the student's focus of attention in a learning action, whether it be face to face or at a distance. According to Black & William (1998 *apud* Macdonald, 2004), "a significant body of research supports the view that the design of assessment is critical in determining the direction of student effort, and that the formative value of assessment is vital in providing a channel of communication between students and their mentors". Macdonald (2003) observes that the assessment must not only be appropriate to the content of the learning action but also has an important role in the support of the pedagogic approach adopted in the given action.

In order to facilitate the definition of assessment **criteria** and to promote the collaborative learning approach, we have defined a set of criteria from which the educator can select during assessment planning. The instructor can select a criterion and adjust it (setting criteria parameters – for example, the expected frequency of participation on an activity) as he/she plans the assessment of a learning activity. New criteria should also be allowed to be created by the educator during this planning. Table 1 presents a few of the criteria considered initially in order to facilitate the development of learning activities in the Discussion Forums, keeping in mind a collaborative learning approach. This is an initial set of criteria defined based on previous experience with collaborative learning-based courses and that must be refined and extended.

Table 1. Assessment criteria for participation in discussion forums

Behavior Analyzed	Criteria
Participation frequency	<ul style="list-style-type: none"> ▪ Frequency of messages posted in a forum activity ; ▪ Frequency of participant access to the forum activity. <i>PS: the expected frequency must be informed by the educator during the assessment planning.</i>
Involvement	<ul style="list-style-type: none"> ▪ Average relevance of the participant's posted messages <i>PS: this indicator is collected from the educator's assessment of the relevance of each message posted.</i>
Collaboration	<ul style="list-style-type: none"> ▪ Number of topics initiated by a participant; ▪ Number of participant answers to educators; ▪ Number of participant answers to students.

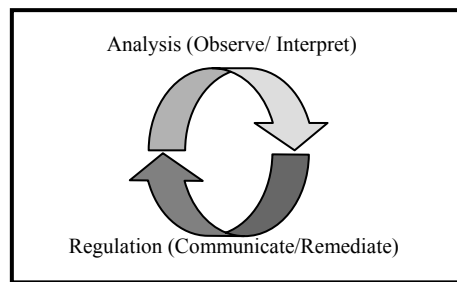
In addition, planning the dynamics of assessment is also supported, making possible the implementation of dynamics involving the learners as evaluators, by means of self-assessment and peer assessment support. Assessment dynamics which involve the learners as evaluators help students develop the ability to make judgments, a necessary skill for study and professional life (Brown *et al.* 1994). These two types of evaluation are often used in combination and peer assessment can improve the self-assessment, since by judging the work of others, students gain insight into their own performance.

The use of this assessment-planning model in TeleEduc LMS has demonstrated that it stimulates an earlier definition of assessment goals, criteria and dynamics, which invites the educator to think about his/her

pedagogical practice and provides a guideline for more focused actions from educators and learners in the planned assessment activity.

2.2 Monitoring

The monitoring phase focuses on continuous analysis and regulation of learner participations in planned assessment activities and should take place throughout the entire process of each activity development, and, in some cases, after its conclusion. The model structures the monitoring phase in continuous monitoring cycles consisting of participation analysis (involving the observation task) and of participation regulation (involving the communication and remediation tasks), based upon the criteria defined during the assessment planning of each activity.



Monitoring Cycle

A LMS must be carefully designed to support the educator in these monitoring cycles. Without this, it is very difficult for the educator to adequately analyze the participations (considering the planned goals/criteria) in time to provide feedback and to remediate the identified difficulties, given the tremendous volume of information rapidly accumulated in the system and the difficulty in perceiving and following all the relevant information. On the other hand, if carefully designed to support formative assessment, a LMS can have the advantage of being able to maintain registers of all participations which can be analyzed and interpreted with the help of computational techniques, facilitating the educator's task of observation and interpretation.

With the intention of reducing the educator's overload in this process, our model aims to provide support for the continuous monitoring of the participations, based upon the assessment criteria defined during the assessment planning of each activity. Considering that assessed activities may permeate the majority of the tools in a LMS, the support provided should consider the monitoring of activities developed in the various tools and should anticipate extending itself to the integration of new monitored tools as well.

In addition, it is preferable that the participation monitoring process be "autonomous". In other words, it should be executed without the constant intervention of the educator, thereby reducing his/her overload in the control of this process. Nevertheless, the educators should have easy access to the operational status of this autonomous process, in addition to its control (on demand), being able to initiate and configure/reconfigure its functioning at any moment.

Our model previews support for the monitoring cycles at three levels of participation granularity: (i) of each participation in learning activities; (ii) general participation of each learner and of the class over the development of each learning activity; (iii) global participation of each learner and the class in the set of learning activities which make up a learning action (that constitutes the learning profiles). Based upon these three monitoring levels, support schemes were proposed for three groups of activities that were identified: continuous asynchronous activities (with continuous participation, like Discussion Forum), asynchronous activities based on assignments (with participations based on assignments releases, like Portfolio), and synchronous activities (like Chat). For example, the following monitoring support scheme is suggested for continuous asynchronous activities:

1. **Monitoring of each participation:** in this case the system should provide support for the identification of new participations and participations without feedback. Due to the enormous number of participations that usually occur in this type of activity, there should be support for providing specific feedback for each participation (for example, feedback on the degree of relevance of each message posted in the discussion forum). It should also be possible to remediate identified problems in a given participation through commentaries whenever necessary. Support to communication analysis is also required;

2. **Periodic monitoring of learners' participations over the course of an activity:** at this monitoring level, the system should provide support for a periodic analysis and regulation of learners' participations in a learning activity over an analyzed period. The periodic observation makes possible the learners' participation evolution monitoring. At this monitoring level, the system must offer support for a detailed regulation of the learners' participation considering the analyzed period, based on the assessment criteria defined at the activity planning;
3. **Monitoring of each learner or class global participation in a set of activities:** the system should provide support for the observation of participations of each learner or class in all of the activities (assessed or not) that make up a learning action over the course of the development of this action. At this level, it should be possible to observe the global progress of each learner (and of the class) in each type of activity, in activities on a given topic, the participation profile based on the participation indicators, the collaboration indicators, and/or the beneficial involvement indicators. This monitoring level is based on the consolidation of learners' participation indicators collected at each learning activity monitoring (level 2).

These monitoring cycles make possible continuous feedback to the educator and to the learners in order to support an important formative assessment requirement: to inform the educator and learners about possible problems, in time to enable a formative regulation or auto-regulation of this process. In addition, we ensure some form of feedback, even though the teacher does not provide it.

3. IMPLEMENTATION

Considering the flexibility, extensibility and autonomy requirements, a technological support based on Interface Agents and Multi-Agent Systems (MAS) was proposed. The Interface Agents makes possible an autonomous and flexible support, attending the different needs/interests of the educators in different educational contexts. The MAS arose out of the need to provide monitoring in various tools in the LMS, these possibly being distributed and varied in nature, and out of the need to propose a solution easily extendable to the formative assessment of learning activities developed in new tools. A system architecture for the MAS was designed based on two types of agents:

- (i) **Activities Monitoring Agents (AMA)** that are responsible for the ongoing monitoring of participation in a set of learning activities that constitute a learning action, by means of ongoing collection and consolidation of student participation indicators in each learning activity, according to the criteria defined at each learning activity planning. The system may have $1..n$ **AMA**, where n is the number of current courses in the LMS;
- (ii) **Analyzer Agents (AA)** that are responsible for the analysis of the participation indicators collected by the previously described agents, according to the monitoring criteria established by the educator during activity planning and the rules defined in its knowledge base. The system has one **AA** responsible for each monitored tool. Details of the MAS design and implementation are not in the scope of this paper and are discussed in (Otsuka, 2006).

A prototype of the defined MAS was initially implemented and integrated into the TelEduc LMS, making possible planning and monitoring activities in Discussion Forums and Portfolios. The formative assessment in other tools may be implemented by means of the implemented MAS extension. Some functionalities implemented in TelEduc LMS are presented in Figure 2 and maps some monitoring requirements of our model. For example, at any moment, the educators and learners can consult a summary of any assessment activity participations for each learner (Figure 2a), showing the number of participations, last grade, and status of participation (colored circles indicating problems, warnings and qualities occurrences) in the last analysis. A detailed description of participation analysis can also be consulted at any moment with the indicators collected by agents and the consolidated analysis (Figure 2b). The participation analysis is updated periodically, making possible the participation evolution analysis by means graphs and reports (Figure 2 c-e).

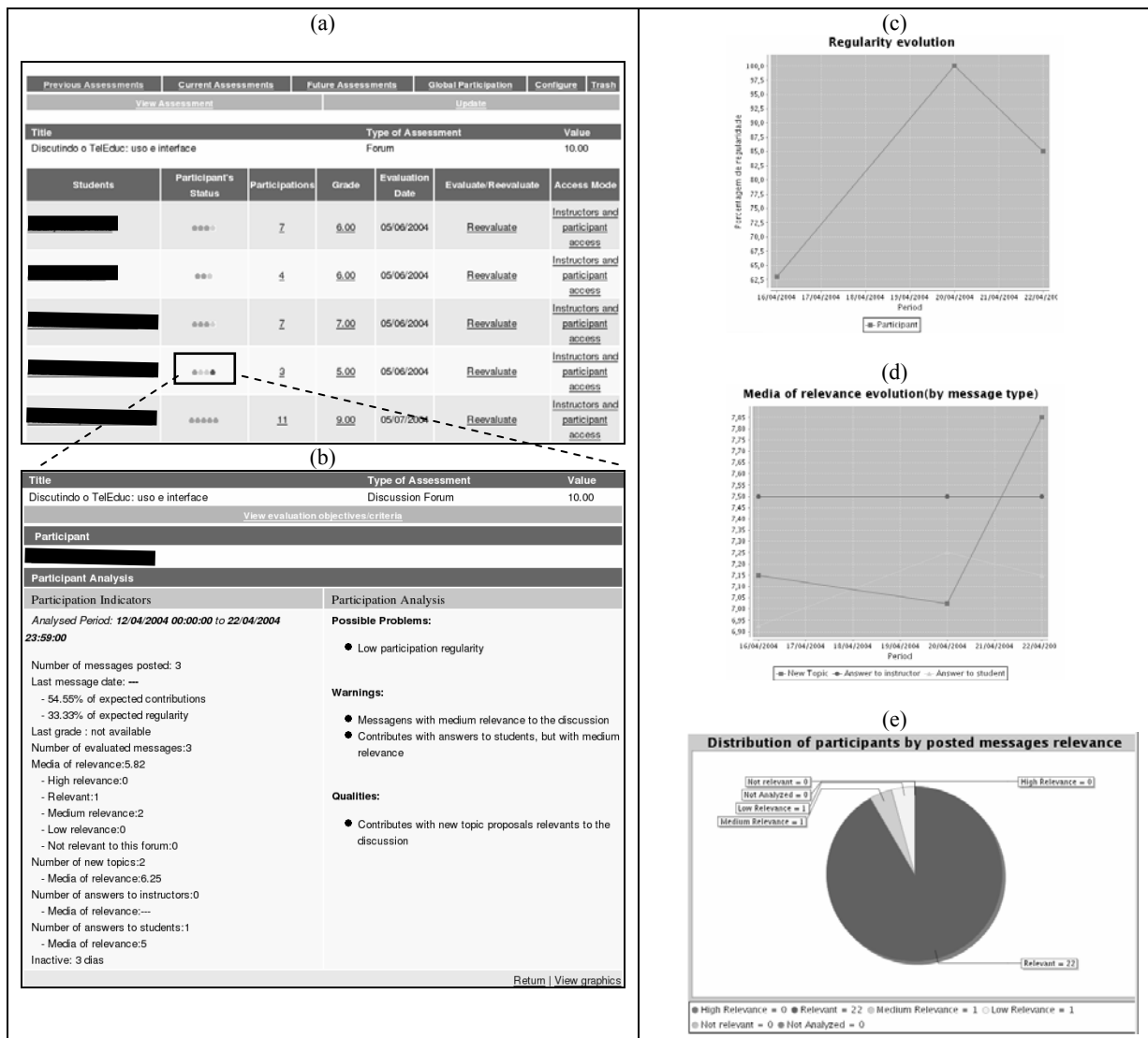


Figure 2. Monitoring functionalities implemented in TelEduc LMS: (a) Learner's participation overview in an activity; (b) Detailed participation analysis of one specific learner; (c) Evolution of learner participation regularity throughout a discussion forum activity development; (d) Evolution of learner participation relevance (by type of contribution) throughout a discussion forum activity development; (e) Distribution of class' participants by the number of messages posted in a discussion forum activity (by relevance).

A Formative Assessment Tool based on our model has also been developed and integrated to the TIDIA-Ae LMS, a free, open source and component based system, which provides a more effective solution for extensibility of our assessment system by means of well-defined component interfaces that must be concretized by assessment components that must be developed for each TIDIA-Ae monitored tool. The support model integration with TelEduc and TIDIA-Ae made possible an initial validation of the model concepts and generality.

An initial analysis of this multi-agent support has been conducted in courses developed using TelEduc, focusing on the support effectiveness and efficiency (can it help educators and learners on behavior perception and problems identification in time to provide a useful remediation?). The initial analysis have showed that our model can provide autonomous, periodic and relevant feedbacks for learners and educator throughout the learning activities development according the planned goals and criteria. In addition, the periodic participation analysis ensures an earlier identification of some problems in the learning process and makes possible an earlier remediation of the identified problems, even with late regulations by educators (Otsuka 2006).

4. RELATED WORK

Some studies have investigated assessment criteria and rubrics to assist collaborative learning activities analysis, mainly in asynchronous textual and structured discussion. Some authors have also explored computational techniques to keep track of learners' interactions and to provide continuous assessment support.

Chang (2002) proposes an automatic tool to help the instructor and the student in web interaction analysis using mobile agents that travel to the students' workstation and to keep track of students' navigation behavior in a high granularity approach (each text paragraph and picture visited). The students' navigational behavior and the students' performance in problems proposed in a course are tabulated in a Student-Problem-Course table that aims to identify some caution indices such as the problem outcomes; the quality of the problem; the degree of student navigation and so on.

Dringus and Ellis (2005) propose the application of a data mining process to discover and build alternative representations for the data underlying asynchronous discussion forums, seeking to intersect the information (i.e. participation indicators) an instructor may wish to extract from the forum with viewable and useful information that the system could produce using data and text mining techniques.

Gerosa et al. (2004) investigate the exploration of aspects of discourse structures, such as message chaining, categorization and timestamp to provide participation analysis computational support without having to inspect message content.

We also analyzed some LMSs (like Moodle and Aulanet) assessment functionalities. This analysis showed that most of them implement the basic functionalities to support participation monitoring, but without a deep relation with planned goals/criteria. In most cases the monitored participation indicators are static, not personalized and independent of planned criteria. In addition, the analyzed LMSs do not provide autonomous and periodical analysis (that is the basis of our multi-agent model) and therefore they do not ensure a periodical feedback and a continuous participation evolution analysis (Otsuka, 2006).

5. FINAL CONSIDERATIONS

The innovative contributions of this work are: (i) To define a formative assessment support model founded on Assessment Research Area and practical experiences in distance education that made possible a mapping of general formative assessment recommendations to the context of distance education; (ii) To provide a set of predefined criteria seeking to promote a collaborative learning approach based on the related research and on our previous experiences; (iii) To define a flexible and extensible multi-agent architecture; (iv) To make possible the dynamic construction of a learner's participation profile based on the analysis of the consolidation of participation indicators on a set of learning activities.

Future works involves a more intensive use of this model in real courses to make possible model refinement; to extend TelEduc and TIDIA-Ae with new monitored tools; to refine and extend the predefined criteria set and the agents knowledge base; to study CMC analysis methods to provide more effective support for learner communication analysis (Wever, 2006); to apply data mining techniques to extract participation behavior patterns; to apply Information Visualization techniques to combine and present learner assessment and behavior information in optimized representations.

Formative assessment permeates the entire learning process as it contributes to the improvement of ongoing learning through the analysis and regulation of actions (not only of the learners, but of the instructors), which take place during this process. If properly employed, it can be a powerful tool in support of the learning process. The objective of the current work is to provide methodological and technical support for formative assessment in online learning management systems, aiming to diminish the difficulties intrinsic to this evaluation approach through the exploration of computational technical resources.

Finally, it is important to underscore that the proposed model provides technical support for formative assessment in learning management systems, aiming to promote more formative assessment practices, but that, in fact, the "formative portion" of each evaluation depends fundamentally on the intentions and actions of the instructors and learners in the teaching-learning process.

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