Modeling and Supporting Planning Regulatory Processes in a CSCL Environment

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Abstract

Collaborative learning, especially in blended design, stresses learning regulation processes both at individual and collective levels. Learning regulation is an active process involving behavioral, motivational, cognitive and affective regulation. It is exercised through recursive phases of task definition, planning, performance, and adaptation. In this research, we aim to support planning in Computer-Supported Collaborative Learning (CSCL). We articulate models of Self-Regulated Learning (SRL), Co-Regulated Learning (Co-RL) and Socially Shared Regulated Learning (SSRL). We address two contributions. First, to understand the contextual and individual factors that influence planning processes at the personal, interpersonal and collective levels. Secondly, to produce and evaluate principles for the design and integration of information and communication technologies to support collaborative planning. We are designing a plugin for LabNbook, an experimental science learning environment. The evaluation is being carried out as part of field studies at a French university.

Keywords

Regulation of learning activities, CSCL, TEL, design-based research

1. Introduction

Learning behaviors are influenced by the learning design and the characteristics of the learning environment property. Technology Enhanced Learning (TEL) and collaborative learning are trends influencing how teaching is designed in higher education.

Blended Learning [1] is a learning design using information technology to extend teaching beyond class sessions. Due to unsupervised activity, this learning design entrusts part of the management of learning activities to students. Managing learning requires regulation skills that are situative and difficult to acquire.

Collaboration is a mean to promote learning from a socioconstructivist perspective. Collaboration covers a wide range of group organization (from a dyad to a large scale thematic community) and goal (from performing a task to being part of a community of interest). In our research, we focus on learning groups organized to carry out a specific learning task designed by a teacher. "Computer Supported Collaborative Learning" (CSCL) is the research field studying technologies for creating, supporting and orchestrating collective learning [2].

On the one hand, these situations involve a higher cognitive load [3], and on the other, they are useful for developing self-regulation.

Perry [4] identify two task requirements to promote learning regulation: an optimal challenge and authenticity.

Effective regulation of learning is a factor in academic success, especially in Blended Learning [5]. Similarly, Järvelä and Hadwin [6] identify the regulation of collective activity as a necessary condition for successful CSCL. In addition, Greene et al. [7], see it as a mediator of the effectiveness of technology enhanced learning.

The research presented in this communication is part of the LabNbook project [8, 9]. LabNbook is an online learning environment dedicated to experimental sciences widely available since 2017.

LabNbook is designed to scaffold the writing of scientific experiment and reports through a notebook interface. LabNbook is used both around the learning situation (to prepare and assess) and during the learning situation as a planning scaffold and notebook.

Notebooks outlines can be designed by teachers. Teachers choose the tasks to be accomplished, select the available tools and design scaffolds. Each team of students works on a personal report, based on the activity prepared by the teachers. In a report teachers and learners can interact synchronously and asynchronously via different communication channels: messaging, comments (between students) and annotations (teacher feedback).

LabNbook is designed for collaborative learning. Our goal is to improve the platform by designing a

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plugin to support self and group regulation of learning.

In this research we seek to understand how individual and contextual factors influence regulatory behaviors in CSCL activities and provide design principles to support them. We focus on specific subprocesses of the planning phases: achievement criteria identification and planning course of actions.

To meet these objectives, we design and evaluate a plugin to support planning processes. The plugin is implemented and evaluated on the LabNbook platform.

In the second section, we present the conceptual framework used and an overview of the tools developed by the TEL community.

In the third section, we present our research questions.

The fourth section presents the design and evaluation processes based on a design-based research method.

In section five, we describe the initial results of an exploratory study.

In section six, we present our expected contributions to the TEL community.

2. Conceptual framework

2.1. Regulation of learning activities

The concept of regulation appears in the field of cybernetic research [10]. Cybernetic regulation describes how a system can regulate its activity by monitoring and controlling the differences between a desired (or avoided) goal and feedback on the current state.

In the field of teaching and learning, this concept has evolved into "learning regulation". Based on the metacognitive theory the family of models known as "self-regulated learning" broadens the scope of regulation to include motivational, affective and behavioral dimensions [11]. We describe the framework used to understand individual and group regulation in the next paragraphs.

2.2. Self-Regulated Learning

Self-regulated learning models aim to explain and describe the strategies and behaviors implemented by a learner to achieve a specific learning goal. It is defined by Greene as "the active and conscious pursuit of a defined learning goal through planning, achieving, monitoring, controlling and reflecting on internal (cognitive, metacognitive, motivational, emotional, behavioral) and external (environmental) factors before, during and after learning" (cited in [12]).

In this research, we use the COPES model as a reference [13]. COPES defines regulation through four loosely production phases: task definition, goals and plans, performance and adaptation.

In each phase, the learners activate their knowledge and representations of themselves and the tasks (**C**onditions) to choose and implement learning behaviors (**O**perations). These behaviors produce learning artifacts (**P**roducts). Artifacts are assessed (**E**valuations) against personal achievement criteria (**S**tandard). Depending on the evaluation, behavior may be adapted to the goals pursued by the means of metacognitive control and cognitive conditions may be updated.

This model emphasizes the role of context through perceptions of the task and properties of the learner known as "conditions", as the basis for regulatory processes.

This model was chosen for two reasons. First, it accurately describes the components, the phases of regulation and the metacognitive processes [14] involved in self-regulated learning. Secondly, this model was used to create the research field of Socially Shared Regulated Learning (SSRL) [6].

2.3. Regulation of learning activities in CSCL

The learning environment (peers, learning materials, discursive practices, norms) also regulates the learners learning process.

Co-Regulated Learning (Co-RL) and Socially Shared Regulated Learning (SSRL) are two concepts used to describe inter-individual regulations.

Co-regulated learning, from a social-cognitive point of view, describes the temporary process of supporting the regulation of a learner's learning activity [15]. We can consider this to be an asymmetrical process. Sociocultural [16] and situated perspectives [17] add clues to understand how learners internalize these regulations.

When the regulation process is equally distributed and managed by group members, Järvelä and Hadwin [6] describe it as Socially Shared Regulated Learning. The object of regulation is the group as an integrative entity. The SSRL model derives from COPES and is adapted to collective regulation. The phases become: the creation of a shared understanding of the task, the definition of collective goals and the planning, the execution and control of the collective activity, and the evaluation and adaptation of the collective activity.

For Järvelä and Hadwin [6], these research fields describe the regulation process in a collaborative learning situation from three perspectives: "I" (SRL), "you" (Co-RL) and "we" (SSRL).

Some authors advocate an integrative perspective [18] of the regulation of learning. Mottier Lopez [19] highlights the limits of separating self-regulation and other forms of regulation. In the situated point of view, self-regulated and shared-regulated learning are mutually constituted. Learners regulate their activity in a context of possibilities and constraints. In addition, the context is shaped by the behaviors of the stakeholders. Thus, Morales Villabona [20] articulates SRL, Co-RL and SSRL in a continuum varying between the shared regulatory components defined in COPES [13].

We share this point of view and in our research we seek to understand how contextual and individual factors (Conditions) influences the planning regulation processes (Operations and Products) and its adaptation (Control) at personal, interpersonal and collective levels.

2.4. Supporting and measuring SRL in TEL systems

Many tools have been designed to promote and measure Self-Regulated Learning. Panadero [21] describes three waves of measurement types used to assess learning regulation. Self-reported data and online activity traces are the first two waves. The third consists of tools playing both an intervention and a measurement role. TEL systems are part of this type of measure.

We can identify two broad categories of TEL systems designed to support learning regulation:

towards Self-Regulated Learning (MetaTutor [22], gStudy [23], NoteMyProgress [24], etc)

towards Shared Regulated Learning in Computer-Supported Collaborative Learning (CSCL) contexts (Radar / OurPlanner / OurEvaluator [25], SEST and SERT [26], S-REG). Järvelä et al. [27] proposed the following classification of functionalities: “sharing information”, “sociability, social space, and social presence”, “support for self-regulated learning and metacognition” and “being aware of his own and others behaviours”. The tools reviewed [25, 26, 28] use prompts, collaboration scripts and visualization of activities to support shared regulation.

We can also classify these designs using Dignath’s and Buttner [29] direct/indirect and explicit/implicit support framework. Direct support corresponds to teaching strategies whereas indirect support refers to supportive environments.

Certain gaps have been in the literature. The most important thing is the relationship between the designs and the processes supported. Jivet et al. [30] note that few tools explicitly describe the underlying conceptions of learning and assess how they contribute to these theories. This assertion is shared by Alvarez et al. [31] about SRL tools designed for Learning Management Systems (LMS)

In both categories the tools reviewed mainly focus on supporting specific phases. We find that the performance phase receives the most support. The adaptation phase is also supported by individual and group rating and feedback tools such as “OurEvaluator”[25].

The planning phase was supported, but mainly at a general and personal level. We believe there is a need to scaffold closer planning processes, focusing on task completion and achievement criteria.

This assumption is based on two points:

proximal goals are easy to achieve and lead to better learning outcomes

specific task centered goals are easier to assess than general goals and lead to less dysfunctional regulatory behaviors.

We also argue that in order to promote regulatory processes, the environment must allow them (indirect supports) and they must be directly and explicitly instructed.

We choose to investigate and support the planning phase through two processes:

strategic planning i.e. how learners identify and structure the action plan and knowledge needed to achieve their objectives.

Achievement criteria definition, i.e. how learners define when a product is good enough to stop acting on it.

By focusing on the planning phase, we aim to contribute to the research on the design of shared regulation as “shared regulation implies strategically adapting shared task perceptions, goals, and engagement to optimize collaboration in the current and future tasks” by Miller & Hadwin [32].

3. General research questions

The aim of our research is to model, design and evaluate a plugin for defining success criteria and planning activities in a CSCL environment. The general research questions are:

1. How do individual and contextual factors (conditions) interact to influence the planning of activities (products) and the definition of success criteria (standards) for learners in a CSCL environment?
2. How do learners use available designs in their environment to engage in individual

and shared planning regulation in CSCL situations?

3. What CSCL design and integration principles can we formulate to promote the planning of activities and the selection of implementation criteria?

4. Research design

4.1. Overview

We use the design-based research method to carry out the design and evaluation processes. Design- based research aims to acquire theoretical knowledge through an iterative process of designing, implementing and evaluating tools in a specific context. [33]

We use Sandoval's conjecture map [34] to explain the relationships between design and research activities. A conjecture map links a high-level conjecture about how learning takes place in a TEL system to the design introduced in the learning environment. Next, the Conjecture Map explains which interactions between the learners, their environment and design properties are considered and what the testable effects of these interactions are. For each step, measurement methods should be explained [35].

Design and evaluation are structured according to the ADDIE model [36] for instructional design. ADDIE is a cyclical model comprising five stages: Analysis, design, development, implementation and evaluation. **Figure 1** shows the general process associated with the related studies, the stakeholders and the expected outcomes.

In the following sections, we present the first iteration of the design and evaluation phases.

A second iteration of the design and evaluation will be carried out during 2025-2026. This second iteration will be based on the results of the case studies in the field.

DBR	Design phase 1			Evaluation phase 1	
ADDIE Stages	Analysis	Design	Development	Implementation	Evaluation
Studies	**Study 1 :** Interview survey	**Study 2 :** Utility Assessment	**Study 3 :** Usability Assessment		**Study 4 :** Case Study
Outcomes	Learners' factors of planification model Conjecture Map	Low-Fidelity Prototypes	High -Fidelity Prototypes	Adapted Learning Situation	Design Principles
Stakeholders	Learners	Learners	Learners	Teachers	Learners
		LabNbook designers	LabNbook designers		
		LabNbook developpers	LabNbook developpers	LabNbook developpers	Teachers
Progress	**Done**		**Planned**		

Figure 1 : Overview of design and assessment processes

4.2. Design phase

4.2.1. Study 1 : Interview survey

To better understand how learners plan their learning activities, we conducted an interview survey in December 2023. This study aims to answer the following specific research questions:

1. What individual and collective planning behaviors do learners demonstrate in CSCL situations?
2. What factors influence individual and collective planning behavior in CSCL situations?
3. What planning design specifications can we identify from the needs expressed by the students?

Interviews were conducted with 14 first and second-year students in French higher education. Semi-structured interviews were conducted using the 'Story Interview' method [37]. The students were asked to recall and describe as accurately as possible their actions in CSCL situations. The researcher's questions focused on the interactions between the planning of activities and the definition of the performance criteria, the difficulties perceived and the workaround solutions.

The 14 interviews, lasting between 35 and 75 minutes, were transcribed in full and analyzed using a thematic analysis method [38]. An initial categorization was based on the regulatory phases of COPES. The thematization was conducted with the COPES model in mind. The analysis was carried out by a single researcher.

The initial results are presented in section 5.

4.2.2. Study 2: Prototype's utility assessment

Following the interviews, design principles were identified and low-fidelity mock-ups were designed. An evaluation was carried out to assess the perceived usefulness of the selected features and indicators. A focus group was chosen.

This study address the following research questions:

1. What indicators do learners find relevant for planning their learning activity individually and collectively?
2. What indicators do learners find relevant for monitoring individual and collective activities?

This study was carried out in order to refine the prototypes before designing high-fidelity prototypes. It was scheduled to run from March to April 2024, when the first mock-ups were designed. During this period, French students are preparing for their second semester exams. This has led to recruitment and scheduling difficulties. A single focus group was organised with two students. A new wave of recruitment is planned for December 2024.

The following paragraphs up to section 5 describe the planned studies that have not yet been carried out.

4.2.3. Study 3: Protoype's usability assessment

Study 3 aims to assess the usability of the design and its ability to support collaborative planning.

We plan to use a mixed approach comprising individual and dyadic tasks, a questionnaire and interviews.

The design is presented to participants using a video tutorial designed to be implemented as a resource in the LabNbook platform. The study is divided into two periods.

First of all, participants are invited to carry out a number of scripted tasks using the design. The environment is highly structured. During this phase, we aim to assess the usability of the design. After completing the tasks, the participants fill in the SUS questionnaire [39].

Next, participants are asked to complete a collaborative task in a less structured environment using the design. In this phase, we aim to assess how the design is immediately remembered and how it is used to support collaboration.

The study will be conducted in the laboratory and video recordings will be made to analyze the participants' behavior and reactions. We will also record data traces to carry out behavioral analyses: number of entries required, time spent carrying out an operation.

Finally, qualitative information will be gathered through dyad interviews.

This study addresses the following research questions:

1. How learners perceive the system to plan individual learning behavior?
2. How learners perceive the system to plan collaborative behavior?
3. What difficulties do learners encounter?
4. What workarounds learners have implemented to achieve the tasks?

4.3. Evaluation phase

4.3.1. Study 4 : Case Studies

The model and design will be evaluated in two field case studies. We plan to conduct these studies from January 2025. We are selecting two different courses based on the following criteria:

- Multiple teaching sessions
- Blended learning design
- Team-based learning design

The criterion of blended learning is chosen in response to the LabNbook's objective: to improve learning opportunities during, before and after experimental learning. Team design is necessary to meet the requirements of our research problem: to explore the interaction of individual and group factors in the regulation of learning. The multi-session design allows us to observe the adaptation of learning behaviors of groups and individuals.

This study will follow the entire course to assess how regulatory processes and events unfold over time, what components of the design and learning environment are involved, and to what extent these processes are shared between team members.

Study 4 research questions are:

1. How do the elements of CSCL learn-ing situations (task designs and sce-narios) support the processes of indi-vidual and shared goal setting and ac-tivity planning?
2. Does definition of achievement crite-ria interactions and activity planning interactions appear during group self-evaluation of collaboration as assess-ment criteria?
3. How do learners individually and collectively interact with the design?

The study is structured around three measurement periods: before, during and after the lesson.

Before the lesson, we meet the teachers responsible for the learning situation. By documenting the exchanges and the different versions of the learning situation, we can study the characteristics of the learning context as defined by the teacher. Particular attention is paid to the way in which the introduction of design modifies the conditions of the learning situation: instructions, tasks, assessment.

We also plan to measure learners' attitudes towards group learning strategies and regulation processes before the start of teaching and after the end of the course, using validated questionnaires such as the MSQL [40] and the Group Self-Efficacy Questionnaire [41]. This questionnaire will be submitted to all course participants.

During the teaching period, we plan to carry out several direct observations of the selected teams. The observations will take place during class sessions. Before, during and after these observations, trace data of the learners' activity in LabNbook will be collected. We plan to describe learners' planning behaviors using LabNbook trace sequence recordings in the spirit of Villalobos et al [42].

After the teaching period, we plan to conduct interviews with teachers to observe how they evaluate this teaching period. We plan to involve the teachers in the discussion of the results. Congruences and discrepancies between their interpretation of the data and that of the researcher are used to assess the validity of our model.

Several semi-structured interviews will also be conducted with the students. We will examine how they define their success criteria and plan their activities with the plugin at individual and team level, and how they perceive peer regulation.

The interviews will enable us to assess the validity of the model according to two criteria: can we explain the learners' behaviors using the model and do the learners find the model relevant for describing their behaviors.

Participating learners will take the MSLQ [40] and the Group Self-Efficacy Questionnaire [41] a second time after the teaching period to measure differences since the start of the intervention.

With this mixed-method case study, we aim to obtain sufficient qualitative and quantitative data to conduct a qualitative evaluation of the model and designs. This information will lead to the second iteration of the design phase.

5. First results and discussion

In this section we present the initial results of our study 1. We have used these results to make our initial design choices and draw a conjecture map.

We identify three families of conditions which influence two distinct processes: the definition of success criteria and the selection of operations to produce plans.

Firstly, the learning environment as defined by the teacher. We have chosen to group together all the factors linked to the teacher's design of the learning situation. These include both discursive practices (instructions) and the characteristics of the learning situation (completion time and pre-structuring).

The **characteristics of the task** as perceived by the learner. The 'task characteristics' category is made up of criteria for perceiving the task and is similar to the 'task structure' category used by Sandoval. It includes the perceived length of the task, its difficulty and the dependencies between subtasks.

Finally, what we call **'team characteristics'** is similar to Sandoval's 'participant structure'. It includes the size of the team, the level of performance of the members, the motivations of the members and the individual constraints.

These three categories form a slightly different proposition from Sandoval's embodiment but correspond well to Winne and Hadwin's conditions.

These results, combined with a review of the literature, led us to our initial design choices. We chose to develop a plugin based on three components. Firstly, a task list interface is instantiated in each LabNbook report. This interface allows a group of students to describe and schedule tasks as two-level elements with several characteristics: priority, due date, expected duration and assignment. **Figure 2** shows a capture of the low-fidelity prototype designed for the task list interface.

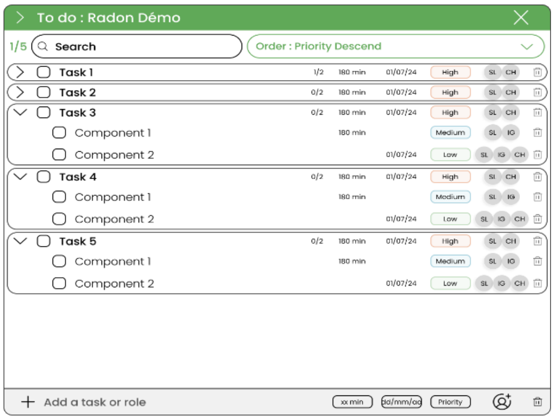

Figure 2 : To-Do List low fidelity prototype

This information is aggregated and displayed in the other two components on the LabNbook home page. They are designed to help users choose which reports to work on. A calendar interface allows students to quickly identify deadlines for completing tasks and manage follow-up with automatic reminders. A personal list displays only those items that have been assigned. It helps learners prioritise the reports they need to work on.

An initial map of conjectures is shown in **Figure 3.** It links the properties and functionalities of the plugin to our research questions through observable interactions in the classroom.

The sub-elements of the conjecture map are presented below:

High-level conjecture:

“Sharing task conditions occur during planning phase of regulation through negotiation and adaptation of individual and collective plans and achievement criteria”

We formulate two design hypotheses concerning the observable interactions and artefacts produced by participants in a learning activity.

Design conjecture 1: "If students engage in a team activity with goal setting and planning tools, we will observe a time of debate and clarification of personal conditions".

Design conjecture 2: "If students engage in a team activity with goal setting and planning tools, they will create intermediate steps in the calendar and make the planned activity explicit with task lists."

Measurement conjecture: " In order to measure these conjectures, we will carry out direct classroom observations, interviews, and the collection and analysis of traces: creation of dates in the calendar, creation and completion of lists."

We will also formulate a theoretical conjecture describing the effects produced if the mediating processes are observed.

Theoretical conjecture: "If learners make explicit and discuss the products of collective planning of the tasks to be carried out, they will reveal the shared conditions of the task and the shared criteria for carrying it out used during the subsequent performance and adaptation phase."

Measurement conjecture: "In order to study the self-evaluation of collective planning, direct observations and the collection of LabNbook traces will be carried out."

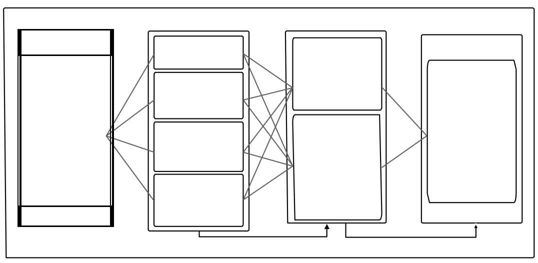

Figure 3 : First Conjecture Map

6. Contribution to the TEL community

The expected contributions of this research to the field of CSCL are as follows:

- A model of factors influencing activity planning and definition of achievement criteria in the context of TEL and experimental science teaching teams.
- Formulation of CSCL design principles and recommendations to support individual and group activity planning and goal setting and achievement criteria definition.
- Formulation of guidelines for using these results and design principles in similar teaching situations.

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