

A Framework of Students' Regulation Processes for Flipped Learning

Estrutura de Processos de Regulação dos Alunos para a Aprendizagem Invertida

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Abstract

In order to achieve success in flipped learning individual and collaborative tasks, students can engage in productive regulatory processes to manage cognitions, behaviours, emotions and context. Self-regulated learning frameworks has come to be cornerstone for examining social forms of regulation. Despite recent advances in the area of co-regulation, more research is still needed on how groups of students regulate their learning in collaborative environments. In this work we apply an exploratory and integrative method to elaborate a framework of regulatory processes and an evaluation by experts to validate it. We re-designed Pintrich's self-

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regulation framework, placing a special emphasis on the crucial role of group work in flipped learning, providing a more holistic view of regulatory processes. Seven experts in collaborative learning answered positively to a questionnaire to evaluate the framework quality regarding clarity, compatibility, productivity, technological role, scope and focus on the student. The extended framework presented here has implications for practice, being especially beneficial in creation of strategies for facilitating students' self-regulation and co-regulation. This study provides valuable information for educators regarding instructional design and selection of an appropriate regulatory processes to shape learning activities to facilitate students' engagement in the flipped learning approach.

Keywords: Flipped learning. Regulatory processes. Student engagement. Self-regulation. Co-regulation.

Resumo

A fim de alcançar o sucesso em tarefas individuais e colaborativas de aprendizagem invertida, os alunos podem se envolver em processos regulatórios produtivos para gerenciar cognições, comportamentos, emoções e contexto. As estruturas de aprendizagem autorreguladas tornaram-se a pedra angular para examinar as formas sociais de regulação. Apesar dos avanços recentes na área de correção, ainda são necessárias mais pesquisas sobre como grupos de alunos regulam sua aprendizagem em ambientes colaborativos. Neste trabalho aplicamos um método exploratório e integrativo para elaborar um quadro de processos regulatórios e uma avaliação por especialistas para validá-lo. Redesenhamos a estrutura de autorregulação de Pintrich, colocando uma ênfase especial no papel crucial do trabalho em grupo na aprendizagem invertida, fornecendo uma visão mais holística dos processos regulatórios. Sete especialistas em aprendizagem colaborativa responderam positivamente a um questionário para avaliar a qualidade do framework quanto à clareza, compatibilidade, produtividade, papel tecnológico, abrangência e foco no aluno. A estrutura estendida aqui apresentada tem implicações para a prática, sendo especialmente benéfica na criação de estratégias para facilitar a autorregulação e correção dos alunos. Este estudo fornece informações valiosas para educadores sobre design instrucional e seleção de processos regulatórios apropriados para moldar atividades de aprendizagem para facilitar o envolvimento dos alunos na abordagem de aprendizagem invertida.

Palavras-chave: *Aprendizagem invertida. Processos regulatórios. Envolvimento do aluno. Autorregulação. Correção.*

Introduction

In an flipped classroom, the tasks that traditionally take place during the classroom take place before or after the classroom and, conversely, the tasks that commonly happen outside the classroom occur inside the classroom. The basic idea is to deliver online content and video lectures to students before attending the classes, when the students participate in interactive activities, that are commonly group activities. This method of conveying content makes possible to students to advance concepts and engage in problem solving during the class (Hoult; Peel; Duffield, 2021); (Doo; Curtis; Chang; Beo-Dle, 2020).

Despite flipped learning brings opportunities it also presents many challenges, particularly relating to student engagement, motivation, and social connectedness mediated by technology. Flipped learning demands greater use of students' self-regulated learning skills when since they need to regulate their online learning engagement (Alten; Phielix; Janssen; Kester, 2021), (Blau; Shamir-Inbal, 2017), (Hyppönen; Hirsto; Sointu, 2019).

In order to achieve success in flipped learning individual and collaborative tasks, students can engage in productive regulatory processes to manage cognitions, behaviors, emotions and context. As flipped learning involves collaborative learning, students in the same group share a collective responsibility for the task (Chen; Chang, 2017), therefore, individuals need to not only self-regulate, but also guide and support the regulation of others in the group and regulate together as a collective system. They need to be cognitively and socially present in order to attain the learning goals. To put it another way, they can be able to communicate openly and contribute to group cohesion and motivation, constructing meaning in a discursive and reflexive way (Garrison; Arbaugh, 2007).

Nevertheless, if students lack the regulatory skills, abilities, and attitudes, they have a great chance to work ineffectively or fail to accomplish what they are demanded to do. It can be challenging for students to regulate learning by themselves, especially when the activities are computer mediated (Durmaz, 2020). Academic consensus has been reached on the significance of sufficient support regarding regulatory skills development (Muijs; Bokhove, 2020). Therefore, while designing flipped learning environments, instructional designers can provide technological support for learners in regulating learning processes, alongside with teacher support. The teacher role is essential for individual group learning in a flipped classroom setting (Zheng; Ward; Stanulis, 2020).

According to MacMahon (Macmahon; Leggett; Annemaree, 2020), the students can learn how to regulate themselves as individuals and as a learning group, the student capacity for regulation can be developed through observing and emulating regulatory processes. The teacher can apply a set of strategies to facilitate student's self and co-regulation. Such teaching strategies, as well as strategies designed by designers of computer environments of flipped learning, are under the light of regulatory processes, that is, designers and teachers need to know the regulatory processes that students must engage in order to develop strategies that promote the engagement of the student.

In order to provide an integrated, cohesive and comprehensive view of regulatory processes in flipped learning, addressing both self-regulation and co-regulation, we developed a framework with processes of self and co-regulation, such as an expansion of the Pintrich's framework (Pintrich, 2000) for undergraduate students. The Pintrich's (Pintrich, 2000) framework is the starting point for our research, as it is the most complete self-regulation framework in the literature.

Background

Recent research in collaborative learning have extended theories and models of self-regulation to collaborative learning situations where shared knowledge construction is underneath. Self-regulated learning frameworks has come to be cornerstone for examining social forms of regulation (Hadwin; Jarvela; Miller, 2018). Despite recent advances in the area of co-regulation, more research is still needed on how groups of students regulate their learning in collaborative environments (Lobczowski, 2020). In this research, Pintrich's (Pintrich, 2000) self-regulation framework is used as a pillar for the generation of a framework that encompasses both self-regulation and co-regulation processes.

Andrade and Brookhart (2020) expanded Pintrich's model (Pintrich, 2000) in its phases and areas of self-regulation of learning to include regulation by others, where the learning regulation is led by an individual group member. In addition, the authors use teacher assessment in the classroom as a parameter for the co-regulation of learning. In the elaboration of the Framework developed in this research, we used the theoretical assumptions of the collaborative learning area supported by the computer. In collaborative learning supported by the computer, all students are responsible for advancing knowledge or to achieve the solution of a problem or task, the group's goals and strategies are negotiated and shared by the group. Thus, although Andrade and Brookhart (2020), address all phases of Pintrich's model (Pintrich, 2000), their approach differs radically from ours with respect to the theoretical perspective.

Lobczowski (2020), proposes a co-regulation model with a focus on the emotional aspect of students. This author uses ideas from traditional, social, developmental and educational psychology, combining key elements of seminal theoretical models to present a new model of formation and regulation of emotions in collaborative learning environments. Again, this model differs from ours, since our proposal includes, in addition to the emotional dimension, the socio-cognitive, behavioral and contextual dimensions.

Chen and Bonner (2019), present a conceptual structure that enhances the synergies between classroom assessment practices and self-regulated learning theory, by articulating the shared processes between classroom assessment and self and co-regulation, and creating a framework with three phases: premeditation, performance and self-reflection. As in the work of Andrade and Brookhart (2020), this research is based on teacher evaluation processes, therefore it differs from the framework proposed in this work that addresses processes that lead to successful student collaboration, that is, where students build knowledge together.

The study by Hwang *et al.*, (2021), adopted an online learning approach based on social regulation to help students self-regulate to achieve mathematical learning goals with the help of their peers. In this study, an online learning structure based on social regulation is proposed to deal with this problem of self-regulation in mathematics. It is expected that, when referring to the self-regulated students' learning strategies, the lower self-regulated students will learn how to make and achieve their own study plans and, therefore, improve their learning outcomes. The authors argue that it is imperative to understand and record student behaviors in student-centered and problem-based learning. Students' learning behavior patterns can be a reference for researchers and teachers to examine factors that affect students' learning outcomes, as well as to develop more effective learning strategies (Hwang; Wang; Lai, 2021). And the approach differs from the approach proposed in this research, as it is limited to social aspects in favor of self-regulation, leaving aside group regulation processes, such as co-regulation processes to determine a common objective and strategies for collaboration.

Jarvela and Hadwin (2013), provided a theoretical background for social modes of regulation conducted in collaborative contexts. They defined socially shared regulation of learning as groups metacognitive control of their co-constructed cognition, behavior, motivation, and emotions through interactions and negotiation on planning, task enactment, reflection, and adaption. Jarvela and Hadwin (2013), defines co-regulated learning as the dynamic metacognitive processes through which self-regulation and socially shared regulation of cognition, behavior, motivation, and emotions can be stimulated or impeded. Despite having explored some co-regulatory processes in a computational tool. Jarvela, Sanna and Jarvenoja (2011), do not provide a comprehensive framework for co-regulatory processes, instead they focused on emotional aspects and awareness processes.

The Study Method

This study adopted Gibbons and Bunderson's method (GIBBONS; BUNDERSON, 2005) for the elaboration of the regulatory process framework. Gibbons and Bunderson (2005), identify exploratory and integrative models as a means of defining and categorizing groupings and relationships, providing a basis for explaining and understanding the processes that are involved in learning approaches, see table 1.

In this work we approached exploring and explaining phases (table 1) by means of a content analysis of the literature having in mind Pintrich's main categories, performing a theoretical validation of the framework. Exploratory research seeks to define and categorize, identifying what exists and what are the possible groupings and relationships between what exists. Also seeks to explain why and explain how.

Table 1 – Features of Gibbons and Bundersons' method

Explore	<ul style="list-style-type: none"> • Answers "What is there?" • Defines • Categorizes
Explain	<ul style="list-style-type: none"> • Answers "Why does it happen?" • Search for causality and correlation • Works with variables and relationships between them

Source: Gibbons and Bunderson (2005).

The evaluation by experts was also used to validate the framework developed in the research. Seven experts were recruited, and the selection criteria used were whether the specialist is a Ph.D and has recent publications in the CSCL area. The seven experts answered a questionnaire based on the assessment framework proposed by Kimmons *et al.* (2020). Kimmons *et al.* (2020) argued that the criteria for valuing a pedagogical model are not purely arbitrary but based on structured value systems that represent the beliefs, needs, desires and intentions of teachers in a particular context. Six criteria were proposed to determine the quality of an educational framework: clarity, compatibility, productivity, technological role, scope and focus on the student. Table 2 describes the questionnaire, in which the two possible answers were "yes" or "no".

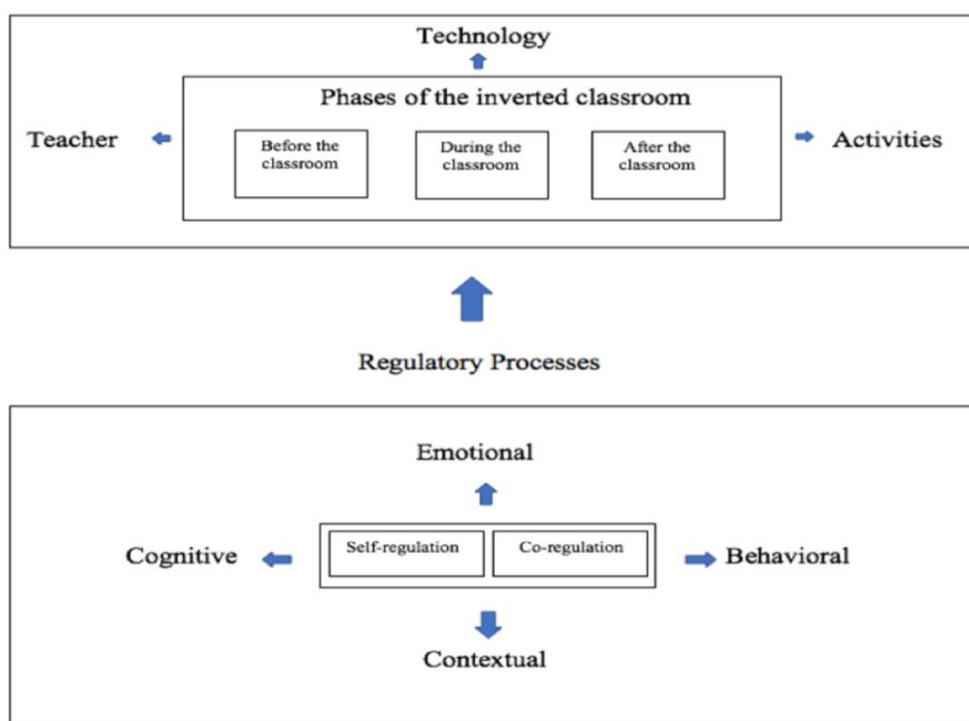
Table 2 – Instrument for evaluating the framework proposed in the research

Criteria	Questions
Clarity	"Is the framework simple enough, clear and easy to understand, with no hidden complexities?"
Compatibility	"Does the framework support existing educational practices considered valuable to teachers in flipped learning?"
Productivity	"Are the co-regulation processes present in the framework linked to the student's engagement on productive collaboration in flipped learning?"
Technological role	"Does the framework complement flipped learning as a means to improve student engagement mediated by technology?"
Scope	"Is the framework parsimonious enough to ignore aspects not useful for teachers, but comprehensive enough to guide teacher's strategies for self and co-regulation?"
Focus in the Student	"Does the framework dialogue with the abilities to be developed by undergraduate students?"

In summary, Pintrich's model (PINTRICH, 2000) involves the metacognitive control of individuals over their cognitive, affective, motivational and behavioral states when planning, monitoring, evaluating and adapting learning, however it is limited to the individual context. In other words, it does not include the regulation of students in collaborative groups.

Figure 1 describes the framework of self and co-regulation for student engagement proposed in this research. The inverted classroom comprises three phases: before, during and after class. The phases before and after the class take place remotely, while the class can be in person or remote. The regulatory processes occur in the 3 phases of the inverted classroom and aim at engaging students with tasks that are mediated by the teacher and technology. In each phase of the inverted classroom, any type of regulation can be applied (self or co-regulation), and in each phase learning can occur individually, collaboratively or in both modes simultaneously.

Figure 1 – Framework or regulatory processes for student’s engagement in flipped classroom



The student's social engagement is expressed in this research as his “social presence”. Social presence in online learning has been described as the ability of learners to project themselves socially and emotionally, thus being perceived as “real people” in mediated communication (GUNAWARDENA; ZITTLE, 1997), being related to the group's cohesion and commitment, an open and productive communication, and an affective connection. As valuable as it is to establish affective communication and develop social bonds, for a learning group to sustain itself, it is essential that the students feel secure to communicate openly and coalesces around a common goal or purpose (THOMPSON; MACDONALD, 2005). Social presence must move beyond simply establishing socio-emotional presence and personal relationships. Cohesion requires intellectual focus (i.e., open and purposeful communication) and respect.

After an exhaustive literature search, regulatory processes were selected to integrate the framework. Such processes were selected from empirical studies that demonstrate their relationship with the student's social presence during collaborative learning. Besides, all the seven experts selected answered all the questions in table 2 favorably, all questions were marked "yes", thus providing a validation of the framework.

The framework (table 3) is main contribution of this study, providing an integration and categorization of co-regulation processes, as an expansion of the framework by Pintrich (2000), aiming at a social engagement of undergraduate students during flipped learning. In the extended framework proposed here, we show how the students can negotiate and share cognitive, socio-cognitive and meta-cognitive, emotional, behavioral, and contextual evidence-based processes for effective collaborations. The framework integrates fragmented regulatory processes from different studies in the scientific literature, constituting a more complete and comprehensive educational resource for teachers to develop strategies for student's engagement.

Table 3 – Expansion of the Pintrich's (2000) self-regulation process framework for co-regulation processes

Phases and areas for self-regulated and co-regulated learning					
Phases	Kind of regulation	Areas for regulation			
		Cognitive	Motivation/Affect	Behavior	Context
Phase 1. Forethought , planning and activation	Self-regulation	Target goal setting. Prior context knowledge activation. Metacognitive knowledge activation	Goal oriented adoption. Efficacy judgements. Perception of task difficulty. Task and value activation. Interest activation.	Time and effort planning. Planning for self-observations of behavior.	Perceptions of task. Perceptions of context.
	Co-regulation	Establishing sharing understandings of tasks demands, negotiating the meaning of the problem and setting goals. Communicating with team members about the actions to be performed.	Anticipating good relations in the group. Encouraging future participation in interactions.	Making workflows to achieve goals, including setting timelines. Negotiating the division of labour.	Negotiating and describing roles according to students' profile. Planning team organization (communication protocol/rules of engagement). Choice of groupware technologies (workflows, etc.).
Phase 2. Monitoring	Self-regulation	Metacognitive awareness and monitoring of cognition.	Awareness and monitoring of motivation and affect.	Awareness and monitoring of effort, time use, need for help. Self-observation of behavior.	Monitoring changing task and context conditions.
	Co-regulation	Monitoring the shared understanding. Monitoring overall group processes. Monitoring knowledge advancement. Detecting errors or checking plausibility. Detecting group socio-cognitive conflicts.	Monitoring group motivation for participations and interactions. Detecting group socio-emotional conflicts.	Awareness on the group's goals and progress. Using workflows to monitor activities progress.	Monitoring changing roles and communication protocols. Monitoring rules of engagement.

Phase 3. Control	Self-regulation	Selection and adaptation of cognitive strategies for learning, thinking.	Selection and adaptation of cognitive strategies for managing, motivation and affect.	Increase/decrease effort. Persist, give up. Help seeking behavior.	Change or renegotiate task. Change or leave context.
	Co-regulation	Communicating with team members about the actions being performed. Making collaborative plans to achieve goals, including selecting socio-cognitive strategies. Discovering the type of collaborative interaction to solve the problem, along with goals. Advancing and explaining solutions. Coordinating socio-cognitive conflicts. Controlling overall group solutions.	Controlling group quantity and quality of participations and interactions. Providing feedback on group participations and interactions. Avoiding and controlling group socio-emotional conflicts. Facilitating respect on criticizing other's point of view.	Managing workflows. Seek help from the teacher when a conflict of idea does not reach consensus.	Controlling group roles and communication protocols. Providing feedback on group roles and communication protocols.
Phase 4. Reaction and Reflection	Self-regulation	Cognitive judgments. Attributions, rehearsal elaboration organization, critical thinking and metacognition.	Affective reactions. Attributions, intrinsic and extrinsic goals, task value, control beliefs, self-efficacy, and test anxiety.	Choice behavior. Effort regulation. Help-seeking. Time/study environment.	Evaluation of task. Evaluation of context. Poor learning. Time/study environment.
	Co-regulation	Reflecting and repairing the shared understanding. Evaluating current joint solutions. Monitoring results of actions and evaluating success in solving problems. Reflecting on the group's goals. Progress and achievements. Making adaptations to goals, collaborative plans or strategies.	Evaluation of the emotional aspects of the group members, with respect to mutual respect and engagement in group activities. Group assessment regarding the amount of interactions and how many different people interacted. Preventing lack of participations and interactions.	Reflecting on the group's goals and progress. Reflecting on workflows to check productivity. Adapting workflows.	Adapting group roles and communication protocols.

Forethought, planning and activation (Co-regulation)

In relation to dimension cognition, Newman, Webb and Cochrane (2004), divides the task or problem shared understanding in two parts: elementary clarification and in-depth clarification, linked respectively to problem/task identification and definition. During problem/task identification, learners discuss about a problem, identify its elements, and observe their connections for an initial understanding. For defining the problem/task, students analyze jointly a problem/task to come to a shared understanding which sheds light on the values, beliefs and assumptions underneath the statement of the problem/task.

Jarvela (2013), propose the identification and ranking the three most important things for the group achieve the objectives to address the difference of opinions within the group.

Regarding dimension motivation/affect, In order to anticipate good relationships in the group and stimulate fruitful interactions in the future, students should establish good rules of communication, assess how they feel about other members of the group and encourage self-assessment of their performance and involvement. Also try to understand what the group's objectives are and, with them in hand, try to integrate them so that everyone benefits. Manage various conflicting objectives and objectives, trying to agree on which objective will be accomplished first. Or when a person's goals do not match those of the group, they should try to reconcile these conflicting goals (Ullmann, 2016).

In relation to dimension behavior, in this phase, students must plan collaborative activities, setting up a task flow to be performed. Students should also discuss to reach consensus on the division of labor and time management (Zheng; Ward; Stanulis, 2020).

Regarding dimension context, students can choose or not choose an agile computational tool like Trello for division of labor, definition of communication protocol and rules of engagement, assignment of specific roles within the group according to the profile of each student, such as, to define who will be responsible for the search for information or to detect problems of participation in the group.

Monitoring (Co-regulation)

In relation to dimension cognition, this dimension addresses the awareness and monitoring of collective activities for possible adjustments. Awareness is a precondition for monitoring the group progress, generally subsumed as students' perception and knowledge about a certain situation or as the understanding of the activities of others, which provides a context for our own activity (Gigler; Bjorn-Soren; Bailur, 2014).

Monitoring group progress involves the detection of wrong ideas, paths, and cognitive conflicts, as well as validation behaviors as a reaction to the work progress and shared understanding. On one hand, cognitive conflict occurs when a student reject, deny or give a negative answer to/evaluation of what been said or done before. On the other hand, acceptance takes place when learners agree to what been said or done without further elaboration or when they adopt the perspectives of their peers and build syntheses of various arguments and counterarguments that learning partners have presented before (Noroozi; Omid; Weinberger, 2013).

To increase learners' awareness of their own and others' learning process, Jarvela *et al.* (2011), proposes the investigation and synthesis of students' impressions about the learning situation before the activation of regulatory processes, such as if they think the task is interesting, if they feel capable to perform the task, or if the students think the group is able to perform the task.

Regarding dimension motivation/affect, in the co-regulation of motivation and affect, individuals regulate each other's learning predispositions to participate and interact in collaborations and the detection of emotional conflicts during the group interactions (Zheng; Ward; Stanulis, 2020).

Monitoring the amount of interactions, as well as whether there is cordiality between the group is essential for maintaining a sense of belonging to the group. Students should inspect both the dialogues and the shared ideas, also monitoring the statements and other movements that provide the structure and organization for each situation within the group. The relations between the group members must be monitored, in order to facilitate the promotion of good interpersonal relationships. It is important to monitor connectivity within the group, that is, to try to understand if people are happy with the group's behavior, in order to get around a problem if it exists (Ullmann, 2016). Students should understand what the group's objectives are and, with them in hand, try to integrate them so that everyone benefits. Also manage several conflicting goals and objectives, trying to agree on which goal will be accomplished first. This type of problem can occur when a person's goals do not match those of the group, so this leadership profile must try to unite these conflicting goals (Ullmann, 2016).

Another important aspect that must be supervised are disrespectful negative socio-emotional interaction, such as undermining interactions, which would have led to conflicts and shown how certain patterns of interaction may be detrimental for collaborative learning (Isohatala; Naykki; Jarvela, 2013).

In relation to dimension behavior, for awareness on the group's goals and progress, the use of an agile technology, such as Trello can help (Amanpreet, 2018). Trello just like Padlet visually organizes the content and tasks. It enables visual organization of tasks, training materials and setting deadlines for their implementation as well as people responsible for individual parts of the task. Trello helps to organize tasks, plan, organize work, create lists and work on projects. We create our boards in the application, and we divide boards into lists with cards. Boards can be shared publicly or given access to others. In CSCL all students are responsible for knowledge advancement, so all students can act as agile coaches at the same time. Another unique feature of the use of agile technologies is that many students can also perform the same task, differently from the usual division of labor, where a task is assigned to one person.

In relation to dimension context, for contextual co-regulations, the students can monitor rules of engagement, roles and communication protocols. The initial assignment of roles inside the group must be monitored, because the roles must not match the students' profiles. The same applies to communication protocols and rules of engagement, that perhaps should be adapted (Li; Su; Peng; Hu, 2020).

Control (Co-regulation)

In relation to dimension cognition, For the joint construction of knowledge, the group members can contribute with academic knowledge, based on the academic objective of the project, through the collaboration and presentation of new ideas and presenting their meanings through personal reading or scientific research correlated with the task. Students can seek information about the area studied, news about technologies that can be used in the study. Students can also contribute with new ideas and expand knowledge as a whole, giving their group valuable information about the content being studied. Try to relate some ideas or past work in order to reuse solutions, that is, apply the transfer of solutions from previously solved problems to new problems, abstract from similarities and apply productive experiences to new situations (Ullmann, 2016).

Students can search for information, so that to be successful in new discoveries, they must be aware of previous solutions and related solutions. For example, in the context of programming, students can detect relevant data and control structures, choose a suitable function from the programming language library, add or replace a command, condition or function call, etc. similarities, connections and previous instances, considering known problems. Students can also elaborate tasks for each one of the group, qualify, connect, relate and create content, assign degrees of difficulty on the studied theme and evaluate the quality of the works that have been developed and, with this information, try to increase the level of knowledge of group members.

An essential aspect of collaboration is communication within the group. In this way, students can make statements that influence the topic of discussion or the direction of the work, being able to look at another side of a question, return to the original subject or create a new topic of discussion (Ullmann, 2016). To monitor the progress of group activities, students must keep abreast of what is happening in the group and work closely with the group as a whole, that is, they must know the work that is being done and how it is being done. in your working group in order to improve it. For example, be aware of the program execution sequence, where each instruction depends on previous instructions, be aware of the dependencies and independence between program variables, test the programs, among others. Students can also think about the consequences of misusing programming patterns, data structures and variables. But they can also innovate, creating a new code, developing a repertoire of patterns suitable for later adaptation, being aware that the patterns emerge from the fusion of two or more commands. Jarvela *et al.* (2011), suggest students' regulation of differences in perspectives and understanding related to the cognitive aspect of the task.

In order to develop arguments, students can request reasons, evidence, evidence and clarification from others about what is studied, expanding the arguments of other members by refining those arguments or making productive comments about them. It should also instruct the group to justify its considerations so that new discussions and perspectives can emerge (Ullmann, 2016). Students can interact with other group members seeking to make decisions in a participatory manner, that is, they use information and suggestions from other team members in making

decisions that will affect not only them, but everyone. Students can support decision making, qualify interactions (whether they are good, satisfactory, bad, etc.) and engage in negotiations within the group. They should try to promote creativity and critical thinking by instigating the members, requesting reasons, evidence and clarifications from these group members. Then you can try to evolve that thinking with new arguments and comments.

According to Newman, Webb and Cochrane (2004), for collaborative exploration of a task or problem the students need to get insights and understanding based on self and group learning. The skills needed to extend beyond the basis definition include inference: induction and deduction, admitting or proposing an idea on the basis of its link with propositions already admitted as true. But they also include the creative skills needed to widen the field of possible solutions. For problem integration the students need to propose coordinated actions for the application of a solution or following through on a choice or decision. This draws upon existing personal knowledge but is then validated within the group. This is a step where the solutions are grounded back in the real world (Arráiz; Gutiérrez, 2008).

For Teasley and Roschelle (1993), transactive discussion refers to a type of interaction in which each child uses his or her own conversational turn to operate on the reasoning of the partner or to clarify his or her own ideas. Transactive types of communication are the key to successful collaborations, encompassing 10 types of transactive statements: Feedback Request (Do you understand or agree with my position?) Paraphrase (I can understand and paraphrase your position or reasoning.), Justification Request (Why do you say that?), Juxtaposition (Your position is X, and my position is Y.), Completion (I can complete or continue your unfinished reasoning.), Clarification (No, what I am trying to say is the following.), Refinement (I can elaborate or qualify my position to defend against your critique.), Extension (Here is a further thought or elaboration.), Critique (Your reasoning misses an important distinction, or involves a questionable assumption.), and Integration (We can combine our positions into a common view).

Regarding, dimension motivation/affect, For the co-regulation of friendly relations in the group, students must influence the group positively using language in an affective way and prone to motivate or inspire and encourage other members, thus providing positive interactions within the group. Everyone should show concern for the well-being of the group, check if the group is in harmony. For example, check that everyone is on the same page, asking if everything is okay, if something bothers a group member and then try to solve the problems listed by them in a fair and understandable way.

They can also discuss with group members their concerns about the topic of study. For example, doubts about a specific subject or about the difficulties that the colleague may be facing in relation to the work being done. This will provide a well-being for the group members.

Group members should be treated with respect and try to prevent disrespect among other members of the group. Trying to motivate, inspire and encourage group members, encouraging increasingly positive interactions (for example: Very good! Keep going as soon as we get there! Thank you! You helped us a lot now!). And you should not use language in a negative or critical way, as this can inhibit the success of the group (for example: You never do things right.). If this happens within the group, try to politely address the person who did it by eliminating this type of behavior pattern. In addition, encouraging the colleague to get it right and being supportive when making mistakes is a good practice that should be done by this leader (Ullmann, 2016).

Students can encourage group members to express their ideas and opinions. That is, to instigate the other members of the group to give suggestions and information so that a decision can be made, for example, when there is an interaction or communication problem within the group, a question about how to improve this interaction can be asked and, from the answers, decide which of the suggestions is the best for the group and everyone can try to follow what was proposed.

In relation to dimension behavior, For the regulation of group behavior, relationships of trust, awareness of participation in a group, and collective social identity must be established (Ullmann, 2016). Students can encourage and encourage group members to promote high performance in their studies. To that end, they can recognize the group's efforts and encourage them to solve problems together. This can be done using phrases that demonstrate respect and well-being for the group, recognizing the work of the colleague and encouraging other people in the group to improve it.

You can also encourage the group to set high performance goals. That is, when there is an impasse on some exercise, this leader will try, from the contributions, to show the best way to the solution so that everyone works together and define how far they need to go, what part of the work they need to do until a certain day, for example.

Another student regulation may be to check the general contribution of other group members, seek help and encourage members to help, give and ask for advice for themselves and for other group members, to seek everyone's ideas about work. It also helps to help the teacher when a conflict of ideas does not reach consensus. This can make everyone involved in the work and the discussion flow more naturally (Ullmann, 2016).

Regarding dimension context, in more student-centered classrooms, such as communities of learners, classrooms and project-based instruction, students are asked to do much more actual control and regulation of the academic tasks and classroom climate and structure (AGRICOLA; TARTWIJK, 2020).

They often are asked to design their own projects and experiments, design how their groups will collect data or perform the task, develop classroom norms for discourse and thinking, and even work together with the teacher to determine how they will be evaluated on the tasks. Of course, this does not mean that developmentally all students, especially those in the early elementary years, are able to regulate the academic tasks, classroom context, and themselves, but these types of classrooms do highlight the potential types of contextual regulation that is possible in the classroom context (Pintrich, 2000).

Reaction and Reflection (Co-regulation)

Regarding dimension cognition, the behavioral processes covered in this dimension encompass the triggering, bringing together, evaluating, criticizing ideas. Here, it is evoked Dewey and Bentley's (1949), notion of transactional inquiry to elaborate the creativity concept in a dialogic way. When participants engage in inquiry together, new meanings are created as a co-production. Also, by means of evaluations of ideas students are able to carry out decision making processes based on criteria application and improve ideas considering its bad features.

Newman, Webb and Cochrane (2004) corroborates this assumption. They advocate that the evaluation of alternative solutions and new ideas within a social context is essential for the development of good solutions. This needs judgmental skills of making decisions, statements, appreciations, evaluations and criticisms or "sizing up".

Guilford (1950) reinforces the importance of reflection for creativity. He highlights the importance of the ability to consider and reconsider, to evaluate our ideas as well as the ideas of others; to take time to achieve understanding and insight, to look ahead and plan, and to visualize the complete picture (Erhan, 2016).

One important aspect of this phase and dimension is that when students evaluate and critique different perspectives and ideas they must be confronted with uncertainty and conceptual conflict. Both are states of disequilibrium that activate a process of conflict resolution and a quest for certainty (Dewey; Bentley, 1949). Here, the students are supposed to come up with, deepens and widens new ideas. They jointly build new knowledge by evaluating, comparing, selecting concepts and ideas, considering different alternatives, pointing positive and negative outcomes based in criteria application, starting a search for a more adequate cognitive perspective and reasoning process aiming to resolve conflict and uncertainty (Ferreira; Wegerif, 2011). Jarvela *et al.* (2011), propose a reflection on group discussions based on the reasons for the results obtained by the group. Group members should examine the explanations from the given options for decision making about the knowledge building.

In relation to dimension motivation/affect, for the co-regulation of motivation and affect, the assessment of the emotional aspects of the group members, with respect to mutual respect and engagement in group activities is an important step (Webster, 2020). Previous performance measures past performances with the current performance. Normative criteria, contrary to mastery or previous performance, makes comparisons within a social group, i.e., about other's performances. Finally, the criteria for collaborative evaluations involve making a team evaluation, which changes depending on different team endeavors (Erhan, 2016). Jarvela *et al.* (2011), propose rating the motivations, searching for explanations, and evaluating their consequences for learning aiming further planning.

In relation to dimension behavior, this dimension involves the evaluation of the group with respect to the amount of interactions and with how many different people interacted. Reflection on student participation is important for collective decisions about changing group strategies (Kaplan; Montalembert; Laurent; Fenouillet, 2017).

Regarding dimension context, during collaborative learning, the students often are asked to design their own projects and experiments, work together in groups, design how their groups will collect data or perform the task, develop classroom norms for discourse and thinking, and even work together with the teacher to determine how they will be evaluated on the tasks. These types of classrooms obviously offer a great deal more autonomy and responsibility to the students and they provide multiple opportunities for reflections aiming contextual control and regulation (Black; Wiliam, 2005), such as adapting group roles and communication protocols (Webster, 2020). Jarvela *et al.* (2011), propose rating the behaviors, searching for explanations, and evaluating their consequences for learning aiming further planning.

Conclusion

One of the alternatives for course design related to technology integration is a pedagogical model referred in the literature as flipped learning. The integration of digital technologies in teaching demands changing the nature of education. But, in the flipped learning teachers are not replaced by technology. On the contrary, the role of teachers becomes even more crucial in the flipped learning method than in the traditional teaching method.

In the traditional flipped learning model, there is insufficient support for the development of students' regulatory skills. To make flipped lessons successful, it was important to define the quality of the online and face-to-face learning materials and the motivations to self-learn and collaborative learning of the students. Thus, the teacher can play a role as a facilitator for the application of regulatory processes by the students and further development of regulatory skills. For example, during in-class activities, instructors can provide immediate feedback, increase communication with and among the students, monitor and facilitate individual and group progress. However, the teachers cannot be prepared for the shift to the flipped learning approach.

This study presents a re-designed framework of regulatory processes, which combines individual students' regulation with group regulation, in order to be employed by teachers and researchers to develop regulatory strategies in both individual learning (self-regulation) and teamwork (co-regulation). We re-designed the Pinytrich's framework, placing a special emphasis on the crucial role of group work in flipped learning and unveiling elements for students' engagement in the flipped learning. Therefore, this study addresses a more integrated view of the regulatory processes.

Overall, the present study provides support for activities design for flipped classrooms, adding value of digital environments on flipped learning and pedagogy. Taking as a starting point a regulation of learning framework, this research unfolded over literature studies drawing from a variety of data sources and building upon one another to explore the socio-emotional, socio-cognitive, behavioral and contextual aspects of online and face-to-face group learning. Teachers have the opportunity to arrange educational environments in order to facilitate students to gain experiences with and learn different types of learning skills. We report the framework to highlight the best regulatory practices used to remediate engagement problems, with the aim to improve self and co-regulation with the flipped classroom. In this way, flipped leaning design has been put forward which enables the processes necessary for the teacher support.

The extended framework presented here has implications for practice, being especially beneficial in creation of strategies for facilitating students' self-regulation and co-regulation. This study presented significant information for educators with regards to developing teaching strategies and choosing appropriate regulatory methods to direct learning activities, thus making student engagement more effective in implementing the flipped learning approach. For further research, tools and strategies can be integrated within the framework to support students to productively regulate individually and in collaborative groups. Through strategies to facilitate student regulation in flipped learning, teachers can encourage students to sharpen their technology skills alongside with regulatory.

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