Psychology, 2016, 7, 1587-1607
http://www.scirp.org/journal/psych
ISSN Online: 2152-7199
ISSN Print: 2152-7180

Theoretical and Conceptual Approaches to Co-Regulation: A Theoretical Review*

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How to cite this paper: Moreno, J., Sanabria, L., & López, O. (2016). Theoretical and Conceptual Approaches to Co-Regulation: A Theoretical Review. *Psychology, 7,* 1587-1607.
http://dx.doi.org/10.4236/psych.2016.713153

Received: October 10, 2016
Accepted: November 11, 2016
Published: November 14, 2016

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Abstract

During the last two decades, interpersonal regulation in natural and digital learning environments has gained importance. Ever since the first conceptual and methodological precisions regarding collaborative learning were made, educational psychology has focused its interest on analyzing collective regulation of motivation, cognition, and behavior. Despite the fact that the body of research on co-regulation has grown, emerging epistemological frameworks evidence a lack of conceptual and theoretical clarity. In response to this situation, the authors propose a conceptual approach in order to address interpersonal regulation in four aspects: first, they describe three learning theories which have been used to study co-regulation. Second, the authors recommend a conceptual delimitation of terms regarding the learning theories on social regulation. Third, they highlight diffuse boundaries between theoretical approaches and terms used in the literature on co-regulation. Finally, the authors suggest some challenges the researchers in this field face.

Keywords

Learning, Cognition, Interpersonal Interaction, Peer Tutoring, Computer Assisted Instruction

1. Introduction

In the 2001 renowned article on teaching and learning in digital environments, Hill and Hannafin indicated how one of the main challenges that educators and technological designers face is the lack of metacognitive knowledge and monitoring abilities of the users of said environments. Quoting their own work, the researchers claimed that students fail in identifying their learning needs, locating relevant resources, evaluating the utility of said resources, and improving their learning strategies (Hill & Hannafin,

*This article represents a contribution to the first author's doctoral thesis.

2001). In this same train of thought, other researchers have discussed cognitive and metacognitive knowledge and abilities that computer-based environments require from students for their learning to be effective: analyze the learning situation, formulate significant goals, determine what strategies to use to reach their objectives, and among others, evaluate their understanding (Azevedo & Cromley, 2004; Azevedo, Cromley, Seibert, & Tron, 2003; Azevedo, Cromley, Winters, Moos, & Greene, 2005; Azevedo & Hadwin, 2005; Azevedo, Moos, Johnson, & Chauncey, 2010; Dillon & Gabbard, 1998).

In this sense, diverse studies on self-regulation, field dependence-independence cognitive style, and computer-based learning environments (CBLE), have hinted that not all students benefit equally from such digital scenarios (Hall, 2000; Handal & Herrington, 2004; López Vargas, Hederich-Martínez, & Camargo-Uribe, 2011; López Vargas & Valencia Vallejo, 2012). López Vargas (2010) states that this situation has been explained according to two approaches: the student's self-regulating capacity and their field dependence-independence cognitive style. In the former case, digital environments require processes through which students activate and systematically maintain their cognitions, emotions, and behaviors oriented towards achieving their personal goals (Zimmerman & Schunk, 2011a, 2011b). In the latter case, with regard to the relationship between field dependence-independence cognitive style and learning environments, multiple studies have indicated that most of the instructional methods (including those implemented in diverse CBLE) (dis-)favor subjects depending on individual differences with respect to perception and information processing (Hall, 2000; Handal & Herrington, 2004; López Vargas, 2010).

Addressing the foregoing, two research trends have emerged in the field of technologies applied to education. Those proposed that implement different types of scaffolding to promote self-regulated learning in students (Azevedo, Cromley, Thomas, Seibert, & Tron, 2003; López Vargas, 2014). Such is the case of digital environments that provide implicit and explicit aids (Hadwin & Winne, 2001), as well as mixed and adaptive scaffolding (Azevedo, Cromley, & Seibert, 2004), or static and dynamic scaffolding (Molenaar, 2011) to favor monitoring and metacognitive control during learning. On the other hand, during recent years a second research trend based on collaborative work and the social regulation of learning has gained importance. Along this line, some studies have approached interpersonal regulation with mobile tools and wireless networks (Järvelä, Näykki, Laru, & Luokkanen, 2007); socially shared regulation of motivation and emotions (Järvenoja, 2010); the development of metacognitive abilities through the scaffolding provided by classmates in a computer-based environment (Pifarre & Cobos, 2010); the difference between social regulation and the regulation of the learning task in online collaborative learning (Janssen, Erkens, Kirschner, & Kanselaar, 2012); and among other research, the study of regulation at an individual, dyadic, and group level, in computer-based collaborative learning (Saab, 2012).

In spite of the progressive emergence of research on social regulation of learning, co-regulation as a way of fostering self-regulated learning, is a relatively new term in educational psychology, which still lacks conceptual and empirical clarity (López

Vargas, 2010), specifically in the area of digital learning scenarios. In fact, the study of interpersonal regulation in collaborative environments is still in its initial stages of development and it is expected to grow exponentially in coming years (Volet & Vauras, 2013). Based on these precisions, this document addresses two questions. In the first place, what epistemological principles support the terminology on social regulation of learning? In the second place, what definitions have emerged in the literature regarding co-regulation and socially shared regulation?

2. Epistemological Principles of Co-Regulation

Since its emergence in 1996, the term co-regulation has corresponded to two learning approaches: a sociocultural one framed in the proposals by Vygotsky (1978), the other socio-cognitive, referring to the contributions made by Bandura (1986) and Zimmerman (1990) regarding self-regulation. Even though each researcher alludes to the term, tries to frame it in one of said paradigms, a third epistemological current has sought to contemplate co-regulation far beyond reductionist positions. In this case, the systemic perspective (Volet & Mansfield, 2006) indicates that interpersonal regulation of learning does not reduce to the breakdown of a whole (learning) into the sum of its parts (social, cultural, and cognitive elements), on the contrary, co-regulation must be understood in the light of highly complex self-regulated systems in collaborative contexts (Vauras & Volet, 2013). These three theoretical paradigms are addressed below.

The origin of the concept co-regulation emerges from sociocultural theory. According to Hickey (2003), the roots of said term lie in the construct that Vygotsky (1978) developed on learning, referring to it as the internalization and transformation of knowledge originating in the relationship between the social and material world, knowledge that resides in the use of tools and in socially-defined interaction methods. In due time, Vygostky would revisit the dialectical approach proposed by Engels to refer to the study and interpretation of man's superior psychic functions, indicating that the environment (nature) influences the man, who in turn, affects the environment creating new conditions for his or her existence.

Based on the fact that the internalization of socially and historically rooted activities is the distinctive characteristic of human psychology, and that studying something historical means studying it in the process of change, Vygotsky introduced a concept that would subsequently be fundamental to the theory of co-regulation, which is to say: the Zone of Proximal Development (ZPD). This concept contains two levels: the current development and the proximal development level. The ZPD, hence, guides the identification of what the novice can do "today" with help and what they will do "tomorrow" independently. Accepting as a fact that ZPD implies social interaction with the other, the individual's psychological development translates into a process that goes from the inter-psychological plane (aid from an external agent to complete an activity that is still outside the independent student's reach) to the intra-psychological plane (the internalization of the steps to solve the problem, as well as the identity, values, and language of that external agent) (Vygotsky, 1978).

Approaching learning from the sociocultural theory and ZPD concept, the category of scaffolding (Wood, Bruner, & Ross, 1976) emerged as another component in the construct of co-regulation. McCaslin and Good (1996) initially coined the term co-regulation to refer to a socially-oriented model of participation and motivation (Hickey, 2003). In other words, co-regulated learning encompasses the manner and the moment when teachers must establish specific goals that influence a student's particular process (motivation or self-evaluation). In order to influence students' learning processes, teachers use scaffolding, transitional support structures framed in a systematic communication between teacher and student (McCaslin & Good, 1996). Scaffolding, category related to Vygotsky's work (1978) and developed by Wood, Bruner, and Ross (1976), consisted of an adult controlling (co-regulating) the elements of the task that initially was beyond the novice's capacity, allowing the latter to concentrate on those elements within their competency range.

Until this point, sociocultural learning theory is one of the three positions within which co-regulation is framed, which encompasses the ZPD concept and the scaffolding category. In this epistemological horizon, those proposals that approach co-regulation and socially shared regulation from a collaborative work framework can be found (Butler, Schnellert, & Higginson, 2007; Butler, Schnellert, & Cartier, 2013; Hickey, 2003; McCaslin, 2009; McCaslin & Good, 1996; Schnellert, 2011). The second position that contemplates the social regulation of learning corresponds to the socio-cognitive theory, which is specifically related to self-regulation. According to Bandura (1986), human functioning is explained in terms of a triadic reciprocity model in which behavior, cognitive, and personal factors, and environmental events are determinants of each other. According to this position, individuals' nature is defined in terms of a basic number of capacities: symbolization, forethought, vicarious learning, self-reflection, and self-regulation.

In the first case, the capacity to use symbols is a faculty that allows man to alter and adapt their environment, since it is through symbols that people process and transform experiences into internal models that guide the execution of their future actions. The capacity of forethought, on the other hand, refers to the way in which the individual can anticipate the consequences of events that have not yet come to pass. The capacity of vicarious learning entails modelling and the capacity individuals have to learn through observation. The capacity of self-reflection, following Bandura (1986), is the distinctive human trait through which they analyze their experiences and their own thought processes. Finally, self-regulation refers to those functions guided by internal standards and self-evaluative reactions with regards to the subject's own actions. This faculty, consequently, allows the individual to evaluate their behavior based on the discrepancies between performance and previously constituted standards.

Self-regulation implies that subjects choose and use strategies to reach the desired academic results based on feedback on their abilities and the effectiveness of their learning; in other words, a self-regulated student is a subject that is actively involved in their learning in metacognitive, motivational, and behavioral terms (Zimmerman,

1990). Multiple factors influence the development of self-regulation, some of which, according to Schunk and Zimmerman (1997), can be generated as a product of social influences. Time management and planning, focusing on the instruction, strategically organizing and coding information are self-regulating abilities susceptible to being transmitted by social models. In this sense, self-regulation develops from external sources (models, verbal descriptions, guidelines, and feedback), and gradually manifests itself as an attribute that is inherent to the subject (their own standards, self-regulating processes, and beliefs about their self-efficacy). Thus, as in the self-regulation model proposed Schunk and Zimmerman (1997), two of the three levels that it consists of (observational, imitative, and self-regulated) they encompass the influence of social factors in the subject's learning.

On the other hand, the sociocultural model by Vygotsky (1978) emphasizes the self-verbalization process, the self-regulation model from a socio-cognitive perspective encompasses other processes, for example, the practice of self-control of motor elements, the use of environmental resources, and personal processes related to emotions and cognitive strategies (Schunk & Zimmerman, 1997). Thus, this second position on interpersonal regulation is based on the socio-cognitive perspective, contemplating the triadic model of social learning, given in environmental, personal, and behavioral conditions (Bandura, 1986). Some cases on the influence of external factors (environmental) on subjects' self-regulation correspond to tutoring, collaborative group learning, peer training and evaluation, and reciprocal teaching. This approach (socio-cognitive) contains those theoretical proposals that conceive co-regulation in terms of an exterior regulation, which is to say, learning guided by the interference that external elements and individuals have on the development of their self-regulation (DiDonato, 2013; Hadwin, Järvelä, & Miller, 2011; Harley, Taub, Bouchet, & Azevedo, 2012; Iiskala, Vauras, & Lehtinen, 2004; Janssen, Erkens, Kirschner, & Kanselaar, 2012; Järvelä, Näykki, Laru, & Luokkanen, 2007; Molenaar, 2011; Perry & Winne, 2013; Salonen, Vauras, & Efklides, 2005; Volet, Summers, & Thurman, 2009; Whitebread, Bingham, Grau, Pino-Pasternak, & Sangster, 2007).

Finally, the systemic position, third theoretical perspective, understands that groups (of collaborative work) are emerging social systems, entities qualitatively different to individuals working side-by-side. Consequently, the motivational and relational characteristics, as well as the functioning of groups, are understood as emerging phenomena of situational interaction dynamics in different systemic levels (Vauras & Volet, 2013). This analysis trend on social regulation is based on the assertions made by Corning (2002) on the concept of emergence and the synergy hypothesis, constructs from which he proposes a multilevel paradigm that encompasses reductionist (socio-cognitive perspective) and holistic (sociocultural perspective) positions to explain the functioning and evolution of complex systems. According to the theory proposed by Corning in the area of evolution and natural selection (Darwin, 2009), the synergistic effects (collaborative) produced by the combination of parts have played a greater causal role in the evolution of biological complexity.

Corning defines emergence in relation to dynamic systems whose behavior stands out from the interaction between its parts, behavior that cannot be predicted with knowledge of these in isolation. Emergence, thus, refers to the emergence of novel and coherent structures, patterns and properties, during the self-organization process in complex systems. Corning conceives emergent phenomena as subsets of the vast universe of collaborative interactions that produce various types of synergistic effects, both in the nature and human societies (Corning, 2002). Synergy, another fundamental concept in this perspective, refers to the combined effects that are produced by two or more particles, elements, parts, or organisms. According to Corning, there are several types of synergy: 1) functional complementarities, referring to the effects produced by new combinations of different parts; 2) the symbiosis between two or more systems that involve the division/combination of work; and among others, 3) synergy of scale, and the aggregation of interchangeable parts that produce unique collaborative effects.

In this perspective, co-regulation implies that learning given in individual or collaborative activities encompasses emergent functions and results that cannot be predicted nor be reduced to its parts in isolation (Goldstein, 1999, as cited in Vauras & Volet, 2013). According to this premise, the members of a group contribute their own motives and goals to the learning situation. Then, the motivations and objectives are profiled through the group's joint activity, insofar as the identities and positions in it evolve, together with the characteristics and structure of the group thereof (Horn et al., 2012, as cited in Vauras & Volet, 2013). Hence, here are included the investigations that have approached social regulation from the systemic perspective (Horn, Nolen, & Ward, 2013; Turner & Fulmer, 2013; Vauras & Volet, 2013; Volet & Summers, 2013; Volet, Vauras, Khosa, & Iiskala, 2013).

3. The Social Regulation of Learning: Towards a Conceptual Delimitation

The foregoing section reviewed three theoretical positions that have approached co-regulation. Each position has generated particular concepts and characteristics on the social regulation of learning. Three conceptual trends that have emerged in the literature on the subject will be described below. First, the concept of co-regulation based on the sociocultural paradigm of learning, term used to designate the relationship between teachers and students, as well as the influence that different factors (individuals and objects) have on said relationship (McCaslin & Good, 1996). Second, the construct of socially shared metacognition from a socio-cognitive position, theoretical proposal that has originated a large conceptual corpus on social regulation (Iiskala, Vauras, & Lehtinen, 2004). Lastly, a third terminological trend that conceives social regulation processes as self-regulation and co-regulation systems with constant occurrences in learning situations (Vauras & Volet, 2013).

3.1. Co-Regulation Sociocultural Model

Initially, co-regulation is defined as the process in which teachers support their stu-

dents' learning through the relationships that they establish with them. Said support translates into scaffolding so that students understand themselves as students, social beings, and human beings. Co-regulated learning, thus, encompasses two distinctions: it distinguishes between the scaffolding provided by the teachers and the processes undertaken by the students, highlighting multiple bonds between that which the teacher wants to discuss and the manner that the novices mediate the conversation. On the other hand, co-regulated learning differentiates between motivation, goal formulation, action (resource management), and evaluation, being these processes interdependent and characteristic of both the learning environment and the scaffolding provided by the teacher (McCaslin & Good, 1996).

Hickey (2003) revisits the concept of co-regulation (McCaslin & Good, 1996) in order to approach motivation from a sociocultural perspective, supposing knowledge resides in the contexts of its use and participation is built based on standards and values that emerge in learning contexts. From this premise, Hickey defines co-regulation as a process in which the socio-instructional environment supports the individual through their relationship with the teacher and classmates, as well as with objects, with different environmental configurations and with themselves (Hickey, 2003). In the same sociocultural line, Butler et al. (2007) conduct a study to address the relationship between research processes and teacher professional development. These researchers understand that co-regulation encompasses collaborative work between teachers to establish goals, plan classes, guide the same lessons in different schools, reflect on their teaching practices, and build new notions about teaching (Butler, Schnellert, & Higginson, 2007).

McCaslin (2009) reuses the term co-regulation, proposing an identity model based on the construct of emergent interaction (Vygotsky, 1978). According to the researcher, co-regulation refers to the bond between cultural, social, and personal sources that guide subjects' identity constitution. For McCaslin, co-regulation seeks to capture the process in which the individual internalizes social and cultural influences that occur in learning scenarios. Thus, co-regulation has two objectives: 1) sociocultural enrichment and 2) the development of adaptive learning (McCaslin, 2009). Schnellert (2011) revisits the literature on collaborative work in teacher training (Butler, Schnellert, & Higginson, 2007) referring to professional development as the situated co-construction of learning and teaching practices. The collaborative work in which the teachers participate is a type of co-regulation since the teachers jointly (together with peers and researchers) monitor and adapt strategies specific to the teaching context. Additionally, the lessons and teaching practices are constantly profiled by historical, social, and political forces, in other words, sociocultural factors (Schnellert, 2011).

McCaslin and Burross (2011) address co-regulation and adaptive learning regarding individual differences from a sociocultural perspective. These researchers use co-regulation to analyze how teachers and students adapt to the social requirements inherent to academic achievement. The authors revisit the c-regulation model (McCaslin, 2009) to assert that multiple personal, cultural, and social factors reciprocally co-regulate subjects' emergent identity. Finally, Butler et al. (2013) continue to address co-regulation

in teacher professional development, this time referring to teachers' collaborative work to support teenagers' self-regulated learning through reading. They propose a "layer" model that explains co-regulation as the teaching collaborative work to formulate goals, plan the lesson, execute classroom practices, and monitor results (outer layer), in relation to the students' self-regulated processes (inner layer) (Butler, Schnellert, & Cartier, 2013).

After reviewing co-regulation under the sociocultural approach, it is possible to distinguish two terminological trends: co-regulation as a model that explains the relationship between students and teachers, taking into account the influence of social factors in learning, as well as motivation and identity as emergent co-constructions in educational scenarios. On the other hand, co-regulation to describe collaborative work in the context of teacher education. In this case, the sociocultural factors that influence teachers' professional development are contemplated and, in addition, the extrapolations of self-regulated learning (planning, execution, monitoring, control, and calibration) onto social spheres in which collaborative processes are developed.

3.2. Socio-Cognitive Model of Social Regulation

Although Bandura (1986), Schunk and Zimmerman (1997) were the first to approach learning from a socio-cognitive perspective, Iiskala, Vauras, and Lehtinen (2004) are who initially referred to co-regulation from this epistemological paradigm. They propose the socially shared metacognition category based on three precedents: 1) social metacognition, which encompasses the beliefs about one's own mental states and processes, as well as the beliefs on classmates' processes (Jost, Kruglanski, & Nelson, 1998); 2) collective metacognition, relationship between individual, social, and cultural factors, and their influence on small groups' reflective thinking (Hogan, 2001; as cited in Iiskala, Vauras, & Lehtinen, 2004); and 3) socially mediated metacognition, which refers to social interaction patterns that influence metacognitive activity during problem solving (Goos, Galbraith & Renshaw, 2002; as cited in Iiskala, Vauras, & Lehtinen, 2004).

The tern socially shared metacognition refers to the metacognitive regulation that takes place in a genuine collaboration and that cannot be reduced to individual regulation. The regulating processes, hence, are divided into three levels: self-regulation; other-regulation, which contemplates those situations (unequal) in which the student regulates their classmates, since, unlike them, they dominate a key element for the task's solution; and shared metacognition, which refers to learning balanced situations mediated by peers in which there is a joint monitoring and regulation of a task (Iiskala, Vauras, & Lehtinen, 2004). Thus, the term socially shared metacognition designates a process that takes place in the problem's interpersonal plane, place in which two or more individuals influence its solution much more than would occur with only one subject (Molenaar, 2011). This term also describes the regulation of joint cognitive processes in complex situations of collaborative learning, situations where regulating activities are shared and interdependent and, consequently, collaborating involves

symmetry, common goals, and a minimum division of work in the interaction (Volet, Vauras, Khosa, & Iiskala, 2013).

That said, other-regulation and co-regulation are similar categories in the socio-cognitive approach, researchers that use both terms tend to refer to the same type of social regulation. For example, Whitebread et al. (2007) understand that other-regulation encompasses processes that influence the cognition, motivation, and behavior of one specific member of the group. The interaction that occurs, hence, reveals certain asymmetry in the subjects' relationship since the student dominates to a greater degree a key element of the task in comparison to his classmates (Whitebread, Bingham, Grau, Pino-Pasternak, & Sangster, 2007). Similarly, other researchers define other-regulation in terms of a momentarily unequal situation in which one student with more confidence in their understanding than the rest of the group, takes on an instructional role to guide the others' understanding (Volet, Summers, & Thurman, 2009). Likewise, in other-regulation, an individual seeks to influence the other so that they adopt more favorable conditions for collaboration; therefore, it implies that the most capable subjects guide their classmates in regulating their own learning (DiDonato, 2013; Järvenoja, 2010).

Analogously, diverse researchers suppose that co-regulation emphasizes on the gradual appropriation of tasks through personal interaction (Järvelä, Näykki, Laru, & Luokkanen, 2007). This type of regulation allows examining the manner in which groups of individuals (multiple self-regulated agents) socially regulate the other's learning (Volet, Summers, & Thurman, 2009), which is to say, the most capable subject is seen as the one who supports their classmates' learning processes. Therefore, even though the responsibility gradually shifts from the co-regulator to the novice through scaffolding processes, the emphasis is placed on the unequal interaction between more or less capable individuals (Järvenoja, 2010). In the same manner, other researchers assert that the regulating expertise is distributed among the group's members during co-regulation. Thus, it consists in emergent interactions that temporarily mediate the regulating work (strategies, monitoring, evaluation, goal formulation, and motivation) (Hadwin, Järvelä, & Miller, 2011).

Hence, co-regulation refers to the transitional process in acquiring self-regulated learning; in other words, the novice gradually appropriates it through the interactions with their classmates. This type of social regulation involves the novice and another (usually more capable) sharing the responsibility in the regulation of their learning (situation in which the control shifts from the regulation that the teacher exercises on the student's learning towards the student's own self-regulation) (Hadwin & Järvelä, 2011). Located in this same horizon there are the assertions made by other researchers for whom co-regulation implies that each group member performs a role regulating all the members' learning in the collaborative workspace (Harley, Taub, Bouchet, & Azevedo, 2012). Thus, co-regulation involves giving and receiving support in collaboration with peers, where at least one of the actors possess the knowledge or abilities that the others need to reach personal or group goals. The co-regulator's role can change be-

tween participants and through time and tasks depending on who possesses and who needs the information or expertise as the situation evolves (Perry & Winne, 2013).

Finally, co-regulation has been identified as an essential part of collaborative work in digital environments, scenarios in which students act as their classmates' other-regulators (Kramarski & Michalsky, 2013). There, a student with a greater level of self-regulation undertakes the responsibility of regulating a classmate that evidences a lower level (DiDonato, 2013). Co-regulation also occurs during the use of interactive learning environments, scenarios in which intelligent tutors take on a role of co-regulator. Learning processes, thus, emerge from negotiations and interactions between the novice and the environment (e.g., the term "mixed initiative" has been used to describe negotiations between the system and the user) (Roll, Stampfer, Long, Aleven, & Koedinger, 2014).

Socially shared regulation is the third category proposed from the socio-cognitive approach. This term involves the group's planning, monitoring, and equitable and complementary regulation (Whitebread, Bingham, Grau, Pino-Pasternak, & Sangster, 2007). Hence, shared regulation is the most effective mode of co-regulation since it refers to the constant monitoring of a joint activity, regulation that cannot be reduced to the individual activity of multiple members (Volet, Summers, & Thurman, 2009). In addition, this category describes the functioning of a social entity that regulates its learning consensually, there the regulating processes are co-constructed in reciprocal interfaces and, therefore, regulation can be shared (the group operates as a social entity towards a common goal) or co-regulated (the group cooperates to reach personal goals) (Järvenoja, 2010). In this sense, social regulation encompasses interdependent processes, orchestrated at the service of a common outcome; in other words, its objective is the adaptation and collective regulation of collaborative processes (Hadwin, Järvelä, & Miller, 2011).

Socially shared regulation involves joint monitoring of cognitive processes during problem solving in collaborative situations. It corresponds to the deepest mode of social regulation since it refers to metacognitive processes of individuals that operate as a social entity with a common goal (Iiskala, Vauras, Lehtinen, & Salonen, 2011). This regulation addresses collective activities (Janssen, Erkens, Kirschner, & Kanselaar, 2012) and processes related to group interactions and negotiations of meanings (Hadwin & Järvelä, 2011). Additionally, said social regulation occurs when collaborators co-construct their comprehension about the tasks they face, rendering metacognitive, motivational, and strategic resources, negotiating and choosing what the group considers will be the optimal path to reach common objectives. In this sense, shared regulation implies cooperated knowledge of goals and the articulation of progress monitoring towards a common outcome (Perry & Winne, 2013).

In sum, it is understood that when two or more group members jointly undertake regulation activities, it is shared (DiDonato, 2013). The term "socially shared", hence, denotes joint regulation and encompasses all group regulation (not individual) instances that take care of content processing for the completion of the task (Volet, Vau-

ras, Khosa, & Iiskala, 2013). Therefore, this type of regulation arises when students participate in collaborative work groups with the objective of regulating their learning (Järvelä, Järvenoja, & Näykki, 2013).

The terms socially shared regulation and collaborative regulation have a similar meaning in the socio-cognitive approach. In fact, both categories come from collaborative learning, there where regulation is associated to the co-construction of a shared understanding of the problem (Roschelle & Teasley, 1995). In other words, the collective jointly constructs and regulates the group's goals, progress, and outcomes (Järvelä, Näykki, Laru, & Luokkanen, 2007). Here, the metacognitive activities are shared between the collective's members, subjects conceptualized as multiple regulating agents who co-regulate the other's learning and act as social systems in two levels: one individual, another social (Molenaar, 2011). In conclusion, groups develop shared knowledge of goals, processes, and tasks (Järvelä & Järvenoja, 2011; Järvelä, Järvenoja, & Näykki, 2013) and, therefore, both socially shared regulation and collective regulation designate processes and products common to the entire group (Hadwin & Järvelä, 2011).

Before concluding this section, three additional characteristics of social regulation will be addressed from the socio-cognitive approach. In the first place, co-regulation presupposes knowledge of one's own and classmate's metacognitive experiences with respect to the task. This regulation involves a continuous effort to coordinate language and attitude with respect to shared knowledge. Hence, co-regulation involves the coordination of cognitive, metacognitive, emotional, motivational, and interpersonal processes during collaboration, processes relative to two types of regulation: 1) one guided by theories and interpersonal beliefs (what level of knowledge do I believe my classmate has on the studied subject?), 2) another based on evidence (signals from transactions that are present in the communication). In addition, two modes of co-regulation exist: semantic mode (negotiation between each one's cognitive and metacognitive processes, linked to the communicative content), and pragmatic mode (negotiation of each subject's relational positions and emotional responses) (Salonen, Vauras, & Efklides, 2005).

In the second place, some researchers have studied two dimensions of social regulation: one centered on the task, another on the group's social and communicative activities. The first case addresses those activities in which students work on common objectives, activities that generally take on the form of a group product. These tend to focus in the exchange of ideas, opinions, and questions to jointly solve a problem. This is how regulation influences group performance, seeking to coordinate activities related to the task (objective formulation, progress monitoring, goal and strategy evaluation, etc.). In the second case, regulation encompasses social and communicative activities to maintain a positive group climate (social and emotional elements of collaboration), favoring mutual understanding and guaranteeing that subjects focus their attention on the task's solution (Janssen, Erkens, Kirschner, & Kanselaar, 2012).

A third characteristic of social regulation relates to its occurrence in digital learning environments; specifically, it addresses the influence of computer-assisted collaborative

learning on the use of student's regulating activities. Researchers in this field also resort to the study of two types of regulation. Task regulation, in other words, monitoring the collaborative process to jointly solve a problem. In this case, subjects approach the task from their own perspective (which is a self-regulating activity), but additionally share information and, as a result, contribute to the collaborative learning process. On the other hand, individuals get involved in team regulation coordinating the collaboration between them. With respect to that, scaffolding tend to be used for group regulation, which is to say, aids that favor effective communication: respect, intelligent collaboration, joint decision-making, and emotional support (Saab, van Joolingen, & van Hout-Wolters, 2012).

3.3. Systemic Model of Social Regulation

Supposing learning group activities involve multiple self-regulated agents that in turn socially regulate the learning of the others, the study of interpersonal regulation is located in the articulation between individual and social processes (Järvelä et al., 2010; as cited in Vauras & Volet, 2013). In this sense, individual, entities (groups), and social contexts (educational communities) are simultaneously conceptualized as self-regulated and co-regulated systems. This approach, hence, seeks to integrate interpersonal processes and individual cognition, facilitating the research on individual in the social activity through time (Horn et al., 2012; as cited in Vauras & Volet, 2013). Consequently, ecological psychology involves a change in perspective: from analyzing individuals' behavior (and their cognition) to studying the behavior of systems in which said individuals participate. This analysis includes individual agents and interactions through time, represented as trajectories between systemic states. Thus, a complex dynamic system is characterized in terms of the components that integrate it, whose interaction is viewed through the intersection points of its trajectories (Greeno, 1998).

The systemic (or situated) model of social regulation emphasizes the coordination principles between a system's components. These include the individual that interact and the resources that they use in their activity: materials and information systems (Greeno, 1998). Here, the activity's most significant aspects evolve in co-construction and negotiation processes between the participants and other systems (Greeno, 1997). It is, thus, how students do not only comprehend what they are explicitly taught, but also develop participation and identity patterns that take shape through the different situations in which they are involved (e.g., the negotiation in the informal curriculum—being a good friend or being an honest student—affects academic performance, as well as the interpersonal dynamics occurring in the learning scenarios). This systemic perspective emphasizes the problem's aspects that arise in the activity, the interactive comprehension building and individuals' participation in said activities, including their contributions to the group's functioning and in the development of their identity (Greeno, 1998).

The systemic model of social regulation integrates sociocultural and socio-cognitive perspectives on co-regulated learning. For example, the study of interpersonal regula-

tion in instructional contexts addresses the interaction in dynamic systems that unfold in real time, addressing the relationship between scaffolding provided by teachers and the changes in cognitive and metacognitive activities in small groups. In this case, the scaffolding processes as the instructional modality imply a gradual change from other-regulation to self-regulation, assisting the student in reaching a greater level of functional autonomy (Vygotsky, 1978, as cited in Vauras, Kinnunen, Kajamies, & Lehtinen, 2013). Thus understood, social regulation is a continuous process of reciprocal transactions, where students contribute to their peers' learning based on different trajectories of metacognitive development (Vauras, Kinnunen, Kajamies, & Lehtinen, 2013).

On the other hand, the systemic approach seeks to track the participation trajectories of the subjects that make up the groups through their positioning, construct based on emergent patters or macrostructures of social interaction, described as participants' frameworks (O'Connor & Michaels, 1996; as cited in Vauras et al., 2013) or normal forms of interaction (Cicourel, 1973; as cited in Vauras et al., 2013). Said frameworks describe the manner in which students interact with others, as well as the way they use particular forms of knowledge. Positioning is indicated through two categories: distribution of authority and distribution of agency. The former regulates who is in charge within a group, who initiates and executes the activities related to the task, and who evaluates the processes. Authority can be distributed unilaterally (the teacher or a dominant member in the group) or multilaterally (two or more participants). On the other hand, distribution of agency refers to the type of mediation assigned to a student. He or she can be position according to a disciplinary agency (following procedures to find the correct answer) or according to a conceptual agency (taking the initiative in the construction of meanings, methods, and concepts).

In the systemic approach of social regulation, joint participation offers opportunities for teachers and students to adapt to the other's needs, sharing decision-making and developing intersubjectivity and trust. However, in all dynamic systems (in)stability exists in the interpersonal regulation patterns during learning: even though at a given moment a system can only remain in one state, a great variety of states are available and the changes from one to the other reflect the system's dynamics. Certain categories allow describing the properties and processes of these systemic phenomena. The range of all the possible states is called state space, within which recurring and stable states are identified as attractors, points the system returns to frequently. Said attractors could account for, for example, a successful interpersonal regulation that involves a joint participation during learning activities. In contrast, repellors refer to another type of states that rarely or never occur. The transition between attractors and repellors can be in turn tracked as trajectories that move around the space state (Turner & Fulmer, 2013).

On the other hand, social regulation from the situated approach emphasizes the evolution of individual novices within specific systems, regarding the learning and motivation of teachers in training. Hence, it is sought to relate individual cognition to extensive interaction patterns (Hickey & Granade, 2004; cited by Horn, Nolen, & Ward, 2013). Focusing on the development of subjects' identity, the unit of analysis in this

perspective corresponds to persons-in-context over time. Said identity can be tracked through the trajectory of individuals' practices throughout time and space, trajectories that allow to identify the way in which subjects establish and maintain relationships with other individuals, as well as the manner in which contexts facilitate or limit the negotiation of meanings (Horn, Nolen, & Ward, 2013).

This approach encompasses two dimensions of social life: negotiated experience and learning trajectories (Wenger, 1998; as cited in Horn, Nolen, & Ward, 2013). The first case contemplates the interactional aspects of identity, given in the manner in which individuals reach their goals, as well as the negotiation and meaning that they jointly (with peers, colleagues, and supervisors) attribute to such objectives. In the second case, the learning trajectories emphasize the importance that the past and the future have on the way individuals act, speak, and give meaning to their activities in the present. It is, thus, how the concept of trajectory allows to capture changes in the way in which teachers in training identify themselves with other individuals and objects, relating such changes to their teaching practices and linking their identity to the subjects' learning. Hence, the analysis of particular interactions embedded in individuals' extensive histories and contexts, during the interpersonal regulation of learning, is addressed (Horn, Nolen, & Ward, 2013).

4. Discussion and Conclusion

In this document, co-regulation was approached according to three learning perspectives. First, reference was made to the sociocultural perspective developed based on the assertions made by Vygotsky (1978). Therefore, learning was understood in terms of the internalization of activities socially and historically rooted, emphasizing the role of the relationships between subjects, objects, and learning contexts. Second, the socio-cognitive position approached learning from a triadic reciprocity model between personal, behavioral, and environmental factors (Bandura, 1986). Here, social regulation was analyzed in terms of self-regulation, one of the basic capacities that define the nature of individuals. Third, the systemic approach (Corning, 2002) addressed the motivational and relational characteristics, as well as the functioning of groups as emergent phenomena of a situational interaction dynamic (Greeno, 1998) in different systemic levels. Hence, co-regulation was analyzed through categories such as emergence, synergy, attractors, and trajectories between the system's components and states (Volet & Vauras, 2013).

As a result of this analysis, it is evident that the terminological borders on co-regulation are very diffuse since it describes complex social and individual phenomena. For example, in spite of cataloguing the original concept of co-regulation in the sociocultural approach (Hadwin, Järvelä, & Miller, 2011; Hickey, 2003; Salonen, Vauras, & Efklides, 2005), some authors assert that one of its objectives is self-regulated learning (socio-cognitive category), and even describe their model based on three processes inherent to self-regulation: planning, strategy selection, and learning evaluation, given in the fulfillment of initial goals (McCaslin & Good, 1996). Similarly, the primal construct

of co-regulation is supported in the concept of scaffolding, another category that (although it comes from vygotskian premises related to ZPD) performs a fundamental role in studies on self-regulation in computer-based learning environments (Azevedo & Hadwin, 2005).

Likewise, certain researchers support their studies on co-regulation in the sociocultural perspective, even though they simultaneously refer to the self-regulation socio-cognitive approach (Butler, Schnellert, & Cartier, 2013). Additionally, an indiscriminate use of concepts related to social regulation exists that accounts for the same phenomena in the literature. For example, the terms, co-regulation and other-regulation are categories that equally describe monitoring and evaluation processes conducted by a subject with greater domain or expertise in the group (DiDonato, 2013; Hadwin, Järvelä, & Miller, 2011; Iiskala, Vauras, & Lehtinen, 2004; Järvenoja, 2010). However, co-regulation tends to be used as a synonym of social regulation (Järvelä & Järvenija, 2011; Volet, Summers, & Thurman, 2009); meanwhile it is also employed to refer to socially shared regulation (Volet, Summers, & Thurman, 2009), to collective regulation (Järvelä, Järvenoja, & Näykki, 2013; Molenaar, 2011), and to socially shared metacognition (Iiskala, Vauras, & Lehtinen, 2004; Molenaar, 2011; Volet et al., 2013).

4.1. Arguments in Favor of the Systemic Approach to Study Social Regulation

With the purpose of generating more precise conceptual and methodological frameworks that explain and allow to study group regulation processes (Chan, 2012), it is proposed that social regulation be addressed as an encompassing category from the systemic approach to link the main theoretical perspectives (cognitive, metacognitive, socio-cognitive, and sociocultural) related to interpersonal regulation of learning (Volet & Vauras, 2013). This position supposes that social regulation occurs during collaborative work and includes the different regulating facets described in this document (self-regulation, other-regulation, and socially shared regulation). Similarly, the systemic approach and the literature allow distinguishing two dimensions of social regulation: one referring to the task regulation and another corresponding to collaboration regulation (Carver & Scheier, 2002; Janssen, Erkens, Kirschner, & Kanselaar, 2012; Jermann, 2004; Saab, 2012; Saab, van Joolingen, & van Hout-Wolters, 2012).

We propose two additional arguments in favor of the systemic approach as an adequate paradigm to analyze social regulation. First, this approach uses both cognitive science and interactional studies to approach "learning in action" (Greeno, 2006). Second, the system approach supposes that during collaborative work it is possible for different regulating modalities (self-regulation, other-regulation, and socially shared regulation) to emerge when solving the same task. On this point, it is worth asking two questions: what explanations can be provided with regards to the emergence of one or another type of social regulation? and how to validly and feasibly identify the type of regulation that emerges during collaborative work? With respect to the first question, the literature has addressed different variables that could possibly suggest some an-

swers. For example, the influence of the group's composition (dyads and small groups), the context (in-person or online), the task (math problems, weakly structured science problems, etc.), and the level of education (high school or university) in social regulation (Volet, Vauras, Khosa, & Iiskala, 2013).

Regarding the second question, researchers have supposed methodological positions that coincide in the use of online (less intrusive) information tracking techniques when approaching interpersonal regulation in real time. For example, some studies track the interpersonal regulation given in subjects' interaction when solving complex tasks in computer-based learning environments (Perry & Winne, 2013). This information (coming from chats, direct observations, and among other techniques, videotapes) allows triangulating interpretations about the type of co-regulation that emerges during collaborative work (Whitebread & Pino-Pasternak, 2013). In this case, detailed schemes are usually used to codify the metacognitive regulation given in verbal and non-verbal interactions, determination metacognition and social regulation indicators, as well as classifying the communication inside the collaborative work groups according to categories as speaking turn, episodes, and interactional dynamics (Volet, Vauras, Khosa, & Iiskala, 2013).

4.2. Exploring Future Lines of Action Regarding the Study of Social Regulation

Finally, we see some challenges that researchers face with respect to the interpersonal regulation of learning. First, this type of regulation is a complex process that influences in the success of collaborative work since working together means building and shared representations of the task, undertaking common goals, and co-regulating learning through metacognitive monitoring and control (Hadwin, Järvelä, & Miller, 2011). Second, the research requires adopting a clear and consistent use of the terminology associated to social regulation, in such a way that the researcher is capable of precisely expressing the processes (monitoring, evaluation, control, calibration), constructs (motivation, cognition, behavior), and regulation modalities (self-regulation, other-regulation, socially shared regulation) that they propose to study. Third, the empirical research must be based on the fact that co-regulation is a dynamic process that develops in real situations and, therefore, studies must address how individuals and groups build their regulating processes, strategies, and knowledge throughout time and through different tasks (Volet & Summers, 2013).

Fourth, researchers must examine how to optimize the different modalities of social regulation in order to encourage a more successful collaborative work, studying the effectiveness of learning environments deigned to promote such regulation processes. Lastly, the methodological research spectrum must expand to other fields and disciplines, for instance, social psychology and organizational research, modeling (Sanabria, 2013), verbal (Sanabria, Macías, Rodríguez, & Lizcano, 2013) or algebraic representation (Ibáñez, Pachón, & Muñoz, 2013), and diagramming (Maldonado, Franco, Valencia, & Jaime, 2013), contributing to the development of analytical methods based on interac-

tions codification (Sanabria, 2014). This will allow a better understanding of factors that influence the regulating activity and its effects on interaction and learning achievement.

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