Co-regulation in Technology Enhanced Learning Environments

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Abstract. This paper discusses the importance of strategy use in regulating cognitive processes, with a particular interest in co-regulation of the learning by peers in technology enhanced learning environments. Research on self-regulated learning has focused on cognitive, motivational and emotional regulation in relation to academic achievement. Co-regulation is an important facet of the regulatory processes taking place in communication-intensive learning environments that are geared towards peer interaction and social networking. This paper succinctly presents Self- and Co-Regulation (SCoR) general concepts and research and elaborates on why SCoR is particularly relevant to learning environments such as MOOCs that are designed with reference to connectivist learning theory. The paper discusses difficulties inherent to the field and stresses the need for commitment to designing environments that are effective for learners.

Keywords: Self-regulated learning, Co-regulation of learning, SCoR, e-Learning, Massive open online course, MOOC.

1 Introduction

One of the main issues that regularly plague the introduction of any 'new' technology, is, and should be: How would it make things better, and for whom? In present times educational contexts, this could be put in terms such as: How would Massive Open Online Courses (MOOCs) make *learning* better? Putting the question this way points to the choice of making education better for learners. This is the concern of this paper. Looking into facets of learning that involve the use of Internet-based applications for e-learning is burgeoning when it comes to MOOCs. There is another level, inherent to online learning, which is its social dimension. The social dimension of learning which is drawing growing interest among some researchers requires that attention be paid to interactions between learners in studying the learning process.

Cognition has long been considered from the individual level. This is mainly true within twentieth century epistemology which developed in conjunction with the then massively industrialised economies led by capitalism. This epistemology

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has been one of competitiveness and the individualistic outlook that this has produced. This article focuses on an approach to understanding learning on the level of collective processes. It is somewhat a renewal of an interest dropped soon after the previous century began.

As access to the Internet became public from the beginning of the 1990s onward and ignited new ideas for education, the trend has been to explore Internet-based technologies that could serve educational endeavours. The evolutionary process of human technologies, as Marchal McLuhan [17] describes it, is one in which first a new technology is used to do what was previously done without it. Then, through its use, perceptions of one's environment shift and are reshaped. The next step in this cyclic process comes about when one's changed perceptions inspire new ideas for uses of the technology. It is at this point that new applications develop and are experimented, and so the process goes on. If we focus on a technology at one point in time, we should be able to tell at which stage the technology is evolving in. Perhaps more accurately said: at which stage we are in, in relation to the technology we are using. An example can be given from the way MOOCs are being used now, as the race to adopt them has commenced. Most experimentation is taking place within the stage of using MOOCs to do what we did in the past, hopefully bettering it as one's power to act grows with the use of the new human "extension" [17]. MOOCs follow from the general concept of open education, though what is open may be conceived differently [19]. Apart from the understanding of what is open, MOOCs have been classified according to two major tendencies, each related to a separate paradigm, which inevitably is also related to what is being conceived of as open. The first are c-MOOCs. In these, knowledge is thought of as being constructed through interaction among peers forming communities of learners. c-MOOCs have been referred to as MOOCs congruent with connectivist theory. The second type are x-MOOCs. In these, knowledge is believed to be acquired by integrating knowledge established by authoritative others. x-MOOCs are congruent with a paradigm based on knowledge transmission from instructor to student [7,15,19]. Referring back to the stage in the evolutionary process of usage of MOOC educational technologies, x-MOOCs appear as a form of powered-up lectures. This is a case of using new technology to do what was done in the past without it. c-MOOCs are affixed to student driven learning. Student driven learning relies on learner self-direction; an educational ideal that has been marginal in some realms albeit its longstanding history and fervent proponents. As Bady states "the pro-MOOC argument is always that it's cheaper and almost never that it's better" [3]. This article discusses and suggests directions that can be taken to ensure that wherever technology enhanced education ventures to go its concern with learner affordances and the quality of the learning be prime.

2 Background

For learner self-direction to thrive, motivation needs to be autonomous. Autonomous motivation is linked to autonomous regulation of one's learning [18,20,21]. The autonomous character of interactions in c-MOOCs, on which

learning in these relies on, brings forth the concept of co-regulation of the learning process. Co-regulation was first studied in pioneering research on self-direction in communities of learners [11,12,13]. The research demonstrated that Self- and Co-Regulation (SCoR) take place when adults learn cooperatively. The research also demonstrated that two regulation strategies: Group Processing Anticipation (GPA) and Co-Evaluation, were more salient where no person was designated as a reference person to the field of study (i.e. groups to which no facilitator or instructor were assigned). GPA was also more collective vs. individual in these types of groups. Several other regulation strategies were perceived by learners to be more often the result of collective activity than of individual activity. More self- and co-regulation is assumed to characterise self-direction in learning. It logically follows that more frequent and thorough regulation of learning takes place when there is less a feeling of someone else leading and directing one's learning. One does not feel as autonomous and therefore regulates one's learning less when control is taken over by the instructor. This does not necessarily mean that stronger learning outcomes will correlate positively with enhanced self- and co-regulatory activity. Nonetheless, it has been pointed to the need in studying self-regulation (and co-regulation as it may be) to also link it to academic achievement, lest there would be little point in researching it [28].

Regulating one's learning, in particular co-regulating the process with peers, should be of particular interest when learners form communities when studying online. Learners who are low on self-regulation and have control in computer-based instruction need Self-Regulated Learning (SRL) strategies to achieve success [29]. Having control refers to learning environments that afford sufficient latitude for making choices that enable to structure one's learning. Environments that are restrictive in the sense that they direct learners to use resources chosen by the course designers and that impose learning paths or enforce methods, are examples of environments that do not afford high levels of control. In hypermedia environments students have difficulties "because they fail to engage in key mechanisms related to regulating their learning" [2]. According to Winters, Greene and Costich [28] "individuals that can effectively plan, monitor, and control their learning are best positioned to take advantage of multiple representations and learner control afforded" in computer-based learning environments. MOOCs that are designed around connectivist epistemology are environments that, in principle, should afford such control.

3 Overview of Research

SRL research has been conceptualised in various ways by authors, though a consensual definition can perhaps be the one encapsulated by Greene and Azevedo when they state that "in general self-regulated learning research focuses upon how students actively monitor and control their cognition, motivation, and context to effectively learn" [9].

In SRL research, links are often sought between strategies that learners' use to regulate their learning and academic achievement. SRL strategies that were initially studied borrowed from categories in social learning theory that include goal setting, structuring the environment, self-consequences and self-attributions, as well as self-evaluation. Several researches developed models that coalesce cognitive, motivational or emotional strategy use, while others offering to differentiate between them, e.g. Boekaerts [6] separates cognitive and motivational self-regulation. Nevertheless, most models that stemmed from Zimmerman and Martinez-Pons's seminal work [30], somewhat mingle strategies of quite different nature.

Sitzmann and Ely [24] offer a meta-analysis of SRL research with correlations to learning. Moderate to strong predictors of learning are goal level and self-efficacy beliefs. Although goal level is not a strategy per se, setting goals is. It has been demonstrated that setting goals can play a role, in particular when goals are proximal. As to self-efficacy beliefs, they are not strategies; rather, they are dispositions that subjects have that are in fact linked to goal setting. Learners with high self-efficacy beliefs tend to set goals that are more demanding, persist, exert more effort and achieve higher on standards [4,5]. Accordingly, perceived self-efficacy contributes to volition but cannot be considered a strategy one can deploy when learning.

SRL can be qualified as a nebulous field of study encompassing vast subdomains of interest. Put in practical terms, concern should be with what can be done to enable learners to deploy strategies that will contribute to performance (the learning process) and to achievement (the learning outcome). Interest in the processual aspect of SRL has led to grouping strategies within phases, considered as repeating cyclically. Schunk and Zimmerman [23] conceptualised them as: forethought, performance (or volitional control), and self-reflection phases. Inspired by a somewhat similar cybernetic conception, Kaplan [11,13] separates monitoring, which encompasses strategies that a learner may use to promote metacognition and consciousness of emotions, volition, metacognition (meta-metacognition), plus adds a decisions-making phase (see Fig. 1). Making decisions substantiates adjustments that are made to the cognitive system, or the need to maintain things as they are (a decision to make no adjustments), without which there would be no evidence of learning from metacognitive input (as well as cognition of emotions, volition, etc.) that was used to assess learning by the subject during the last phase of a cycle. Decisions denote the intention formation, the moment of "crossing the Rubicon" [1] that precedes planning for action to come. Regarding monitoring, there is consensus that it is a salient characteristic of successful self-regulation [25]. Greene and Azevedo [9] in a study with middle-school and high-school students found that "only monitoring statistically significantly affected the likelihood of having a more sophisticated mental model at posttest [...], supporting the importance it has been given in SRL models (Winne, 2001; Winne & Hadwin, 1998)".

Co-regulation among self-directed learners was introduced as a concept and studied by Kaplan [11,12,13] in small groups with learners meeting in a room on

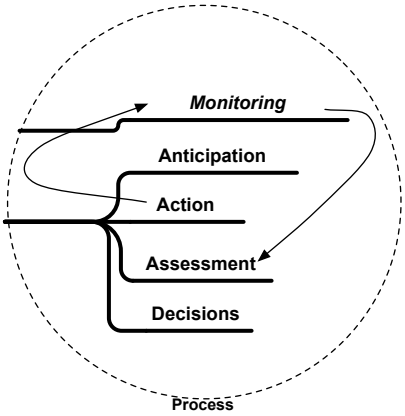

Fig. 1. Regulation of Learning Phases Model (Kaplan, 2009)

a regular basis. In order to study SCoR in large groups with particular interest in those learning together at a distance, such as is the case in MOOCs, Kaplan, Fenouillet and de Montalembert [14] developed ERICA (*Échelle de la Régulation Individuelle et Collective de l'Apprentissage*)–an inventory to measure individual and collective regulation of learning. Following from Kaplan's model (see Fig. 1), the research programme that led to refining the inventory involved large cohorts of students in undergraduate and postgraduate programs. In these, instruction was predominantly organised around lectures, various class-based activities and apprenticeships to gain practical skills.

The ways learners regulate their learning, individually and collectively, depend on the instructional environments, instructional designs, topics being learned, goals being pursued, learning activity types, as well as a myriad of other variables that affect the ways learners tackle a learning task at any one time. Because of the specific contexts in which the study was conducted, certain learning regulation strategies had to be dropped, leading to a smaller set that proved robust through statistical analyses. Testing the inventory in technology enhanced environments will enable determining the validity of the tool to measure SCoR in these contexts too.

There has been some budding of ideas around the concept of co-regulation related to metacognition [8,22,27], primarily focused on affective and motivational regulation. Reference is made by some authors to co-regulation in terms of how individuals regulate each other's learning [26]. These authors use the term 'other-regulation' to designate the effects of interaction with others on self-regulation, therefore pleading for a socio-cognitive perspective in which reciprocal regulatory processes are taken into account. Volet, Vauras and Salonen [27] nevertheless propose distinguishing the term 'coregulation' by considering regulations at the dyadic or group level in which a joint task and goal are pursued and in which participants share reference values and norms.

Conceptualising co-regulation in terms of a joint task such as studying a particular topic in which reference values and norms are shared applies well to the groups that Kaplan [11,12,13] studied. In these groups, metacognitive awareness was identified by learners to be more often than not on the 'we' level, but both self- and co-regulation coexisted.

On the basis of these findings, and in accordance with the emerging literature in the domain, The SCoR inventory ERICA comprises four individual regulation and two collective regulation macro-level strategies [14]. Using the inventory will enable investigating variations in tendencies and features of regulation of learning in e-learning implementations such as those used in MOOCs.

4 Challenges and Practical Suggestions

The challenges facing online education in respect to learners' capabilities to manage their learning is particularly critical in MOOC implementations that do not follow from a peer-managed autonomous learner approach. This is the case in x-MOOC designs that follow from a knowledge transmission paradigm. Persistence in MOOCs has been pointed to as a weakness [10]. This may be the result of lesser ability for learners to regulate their learning in such massive courses in which tutors cannot be present to help each learner. Furthermore, trying to reproduce the way universities dispense courses on campus on an even more massive scale by delivering MOOCs omits taking into account chat that takes place everywhere on campus outside of classrooms and lecture halls. A great deal of co-regulation takes place among peers through informal discussion [14]. Virtual spaces for these are not adequately accounted for in some MOOC designs.

What can be done to overcome the challenges that educational environments pose in relation to potential deficiencies in affording learners control requires paying attention to successive layers in the design of such environments. I will highlight these before offering some principles that would be helpful when choosing a platform and designing online courses.

In order to overcome limitations imposed by these environments, what might first be studied is the front-end software interface and its ergonomics, including the services available to users through modules that are or can be added to the Learning Management System (LMS). For example, does the LMS in use enable adding a module to provide learners with the ability to interact and form small communities in which co-regulation can take place? If so, does the module materialise on the screen on various devices in a way that makes it accessible at all times? Is it easy to locate on the screen and use? etc. If a course is already set up on an LMS, the next step would be to study that specific setup. Obviously, options will need consideration if designing a new course were underway. Choices involve not only modules that can be integrated into an LMS, but also the way services, areas for activities and the placement of contents are laid out by the instructor or others involved in the course design. For example, are there personal tracking tools of learning activities? Are learners able to add notes related

to these activities? Does the LMS enable prompting learners to remind them to keep notes or a journal of their learning activities and this only if they are not already doing so? Scaffolding regulation in this way can be helpful for learners who do not tend to use self-regulation strategies to monitor their learning. Content placement, the ability to access content non-linearly but still contiguously, specific cues and directions that are related to the instructional design that was chosen need to be considered as well, as all these elements conjointly form a learning environment that affords learners with varying levels of choice that in turn affect learning strategy use. Not all considerations can be covered by the examples given here. However, these examples illustrate there is no simple answer as to what works best. This is particularly true when considering the diversity of learning habits, cultural influences, prior learning experiences and so on, that shape each and everyone's ways of managing one's learning. Furthermore, as the learning environment is also shaped to an extent by the learners themselves as they interact, this requires taking the learner into account as well. All these facets of the learning make for unique situations that require being studied on a case-by-case basis. Principles though can be followed when designing learning environments such as MOOCs. These principles follow from research in educational psychology. Although related research spans many branches of knowledge that have seldom been studied in conjunction, taking into account what we do know should enable better affordances of technologically enhanced learning environments. I offer 10 principles to support learners' regulation of their learning:

1. Support phases of anticipation, monitoring, assessment and decision making by learners. This can be done by implementing modules (services) on LMSs and recommendations to cyclically use them or other means to Anticipate, Monitor, Assess and Decide (AMAD). For example, announce the aims of a learning sequence, enable learners to state their goals and how they practically intend to carry out the learning in respect to these goals.
2. Scaffold systematic use of the various services available for learners to AMAD; however, without constraining learners to use them. For example, advise learners to keep track of their activities (monitor) or make sure the LMS does and that the learner can access records.
3. Facilitate metacognition by providing tools and services that can be used by learners to stop and reflect on their learning. One such tool is an individual or a collectively edited journal that learners maintain, in which they recount what they are doing to progress towards their goals. A blog-like page for each learner to use or for a group of learners that can be made public or kept private is a good example.
4. Prompt learners or have the LMS prompt them to enact regulation phases e.g. to periodically go through their automated tracking records or read their group diary. Make sure prompts go away if the learner does enact monitoring strategies or if she or he deactivates the prompt.
5. Inform about norms including those that will be used for accreditation in relation to course objectives so that learners can measure their progress against these standards when self- and co-assessing.

6. Provide learners with tools to self-assess and co-assess the process they are carrying out to attain their learning goals, not only their attainments, and invite them to do so.
7. Enable communication channels for peers so as to enhance co-regulation. Include feedback mechanisms and enable keeping track of discussions. A peer borne frequently asked questions and answers area, online forums and areas where learners can share documents are some examples of such channels.
8. Design courses by breaking them down to well paced sequences that are neither too long nor too short. Proximal goals enhance feeling in control and help perceiving oneself as efficacious.
9. Bolster learner autonomy by pointing learners to tasks and activities to be carried out in a manner that is non constraining. This does not mean not providing guidelines and instructions. Rather, it entails offering flexibility so that learners can choose means and feel in control when striving to attain expected outcomes.
10. Study individual and collective regulation strategies used by learners within each of the phases that are being supported on the LMS to learn about what works and how best to implement courses to cater to learners' needs.

5 Discussion

There are a number of difficulties inherent to studying self-regulation. Co-regulation adds a layer to these difficulties. Firstly, regulation strategies are highly contextual, making inferences and generalisations difficult; secondly, they are hard to observe as they are most often internal processes taking place in the mind; thirdly, not enacting a strategy is a valid regulatory decision, making direct observation impossible; fourthly, requesting subjects to tell about their regulatory processes invokes metacognition, an important dimension of regulation. How then does the researcher know that the subject is able to remember often subconscious or automated cognitive, metacognitive and emotional meandering and not mistake for these metacognition invoked at present by the researcher's question? In other words, how well the subject can distinguish between the actual past experience and present thought on it (as memory is a reconstruction), remains open (cf. Kitsantas and Zimmerman [16] for an attempt to circumvent this problem). Furthermore, co-regulation involves perceptions and strategies that are the result of interaction among co-learners. Trying to capture such ethereal collective moments is a daunting task. Nevertheless, following the track of exploration of the relationship between interfaces used as mediators in education and the quality of the learning, as well as outcomes, is necessary, as education has been endlessly experimenting with technology in a quest for efficiency and hopefully, quality too.

6 Conclusions

Learning environments that include contemporary technological interfaces, enable access to resources, provide for interaction among peers, contain a myriad

of means to form communities through which building up knowledge can be facilitated. These learning environments need to support autonomy, contribute to feeling in control of one's learning and enable cooperative interaction with others to enable learners to engage, persist and perform effectively. For example, users of a MOOC are subjected to environmental constraints and affordances. They also participate in shaping the environment. When a c-MOOC approach is being strived for this is of particular concern. The learning management system and the MOOC design need to support through online services and end-user ergonomics co-regulation of the learning in reference to the regulation phases.

Self-regulation and co-regulation in particular, are relevant to learning situations in which learners are expected to cooperate in the process of knowledge acquisition and are essential to knowledge generation. The domain merits attention in order for learners to benefit fully from technology mediated forms of learning, in particular those that rely on participants directing their learning process.

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