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ERICA– an instrument to measure individual and collective regulation of learning

ERICA – un outil pour mesurer la régulation individuelle et collective de l'apprentissage

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ABSTRACT

Introduction. – This paper presents two studies that aimed at validating the Individual and Collective Regulation of Learning Scale – ERICA.
Objective. – The scale was developed to measure learner perceptions of macro-level co-regulation strategies in conjunction with self-regulation strategies learners use.
Method. – Studies in two separate educational settings are presented. The first with undergraduate psychology students ($n = 547$) tested the factorial structure and reliability that confirmed its psychometric qualities. The second with undergraduate healthcare students ($n = 191$) provided for tests of convergent and discriminant validity.
Results. – The studies confirm a six-dimensional structure that stands up to tests of validity for structure, consistency and convergence.
Conclusion. – The scale is suitable for use in various educational contexts and environments with large cohorts to study perceptions learners have of the strategies learners use related to planning, monitoring, assessment and decision-making regulation phases.

Mots clés :
Corégulation
Apprentissage
Apprentissage autorégulé
Échelle psychométrique

RÉSUMÉ

Introduction. – Cet article présente deux études visant à valider l'Échelle de la régulation individuelle et collective de l'apprentissage (ERICA).
Objectifs. – L'échelle a été développée pour mesurer les perceptions des apprenants des stratégies de macro-niveau de co-régulation en lien avec des stratégies d'autorégulation que les apprenants utilisent.
Méthode. – Des études dans deux contextes éducatifs distincts sont présentées. La première, avec des étudiants préparant une Licence de psychologie ($n = 547$), a servi à tester la structure factorielle et la consistance interne. Elle a permis de confirmer ses qualités psychométriques. La deuxième, avec des étudiants en soins de santé ($n = 191$), a permis de tester la validité concourante.
Résultats. – Les études confirment une structure à six dimensions dont la structure et la consistance interne sont bonnes avec une validité concourante conforme aux attentes.
Conclusion. – L'échelle est appropriée pour une utilisation dans différents contextes et environnements avec de grandes cohortes d'étudiants pour étudier les perceptions des stratégies utilisées par les apprenants en rapport avec les phases de régulation que sont la planification, le suivi, l'évaluation et la prise de décisions.

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Self-regulated learning (SRL) is a field that educational psychologists have conceptualized as learning processes in which learners actively engage in to create, maintain or enhance their personal conditions for effective learning. Several researchers have focused on motivational dimensions, such as attributional phenomena (Kuhl, 1996; Schunk, 2008); others, on cognitive dimensions (Hadwin, Nesbit, Jamieson-Noel, Code, & Winne, 2007; Winne, 1995); still others on both (Boekaerts, 1997; Pintrich & de Groot, 1990; Pintrich, 2004; Winne & Hadwin, 2008; Zimmerman, 2000). For learners to be proactive, self-awareness is needed in order to achieve control over one's learning processes (Greene & Azevedo, 2009; Winne, 1995; Zimmerman, 1989). If one is aware of one's cognitions, feelings and behaviors, as well as the relations between them, one can then act upon these to better carry out one's learning. Researchers concerned with awareness of cognitive processes refer to metacognition (Achtziger, Martiny, Oettingen, & Gollwitzer, 2012; Efklides, 2008; Fox & Riconscente, 2008; Lajoie, 2008), though overlapping as well as possible distinctions between these constructs have been noted (Dinsmore, Alexander, & Loughlin, 2008). In SRL research, reference is usually made to control of the learning process that is made possible through self-monitoring. Research on SRL has generally addressed both reactive and proactive processes without drawing a clear line between them.

SRL research has also maintained its reference to social-cognitivism in which the relation with the environment predominates (Bandura, 1999). In spite of this, SRL research has mainly focused on the individual characteristics of learners and on their relation to their material surroundings; on occasions to their instructors, but rarely to their peers. SRL had developed out of concern for underachieving students in formal education, which might be an explanation for this. Instructors have relied on learners' ability to autonomously navigate their learning in rough waters and being personally responsible for their success or failure in keeping afloat. Attention has therefore been focused on the learner whereas attention to the environmental circumstances has been somewhat overlooked. In environments over which learner control is limited, which is often the case in commonplace primary and secondary education, expecting learners to negotiate their academic success by means of taking their learning into their own hands is paradoxical if environmental conditions are not enabling. If indeed there is commitment to learner achievement, taking into consideration self-determination theory (SDL) could help guide the design of educational environments that sustain learners' autonomous motivation; a prerequisite for autonomous regulation (Reeve, Ryan, Deci, & Jang, 2008; Ryan & Deci, 2000a, b). In this respect, environmental conditions require consideration in any given educational setting.

Characteristic of learners in post-secondary education is their greater freedom to choose or shape conditions that they sense will be more suitable to achieving learning goals. Studying SRL in terms of learner control, i.e. proactive regulation, is particularly relevant to the field of post-secondary education. Regulation of cognitive processes, emotional states, motivation, volition and environmental conditions is essential to sustain learning. Learners in post-secondary education are also more readily provided with support to cooperate when they are learning in technology enhanced learning environments or when using online social networks during studies. Collective processes of regulation of learning have attracted little attention up until recent years. In continuation of research efforts that have addressed co-regulation (Chan, 2012; Efklides, 2008; Kaplan, 2014; Räisänen, Postareff, & Lindblom-Ylänne, 2016; Saab, 2012; Volet, Summers, & Thurman, 2009), an area we believe merits sustained attention in order to improve understanding of regulation, ERICA, the scale presented here, accounts for two collective dimensions of regulation. These dimensions address two separate levels of socially regulated learning. The first being regulation that relies on cues obtained through interaction with peers; the second being indicative of regulation that is socially shared (Hadwin, Järvelä, & Miller, 2011; Järvelä, Malmberg, & Koivuniemi, 2016; Panadero & Järvelä, 2015).

To our knowledge, only one scale to study SRL was developed in French. It does not include collective regulation strategies although it was intended for use with learners in technology enhanced learning environments (Brodeur, Mercier, Dussault, Deaudelin, & Richer, 2006). ERICA was thus developed to further the study of regulation strategies that post-secondary learners use both individually and collectively, in French. This paper presents the validation process of the scale and discusses its potential to gain ground in understanding how learners regulate their learning in contemporary learning environments.

1. Background

Self-regulated learning has been approached from different perspectives, each leading to separate though often overlapping theories (Sitzmann & Ely, 2011). Co-regulation among self-directed learners was introduced as a concept by Kaplan (2009, 2010b) following a study of learner self-regulation in small face-to-face groups. In these groups, learning regulation strategy use was described as being predominantly collective (Kaplan, 2010a). Exploring learner regulation in these groups was a first step in a quest to further understanding of regulation in larger communities of learners as well as those that form online. In the latter, interaction takes place over mediating channels. The present scale was developed in order to capture patterns in learners' perceptions of macro-level regulation strategies they use. The scale aims to provide a means for comparison between perceptions that learners have of the strategies they believe they use in different environments, eventually providing insight as to how environmental characteristics and perceptions interplay. Other observation methods would later be needed to study the relations between characteristics of the learning environments, perceptions and actual strategy use. Many contemporary learning environments rely on mediating software on computers and mobile devices that enable interaction between peers, with tutors, instructors and other reference persons to the field of study. The aim sought in developing the scale was to provide a means to measure learner perceived strategies that rely on others, such as peer learners, in pursuing educational achievement. Taking social dimensions into consideration would enable comparing perceived strategies in relation to cultural values and practices or any other of numerous variables that could be studied in conjunction with learning regulation strategies. No known psychometric instrument has been developed to measure macro-level co-regulation perceptions of strategy use. Furthermore, despite the fact that authors have cautioned that self-reports of self-regulation strategy use are contingent on context (Hadwin, Winne, Stockley, Nesbit, & Woszczyna, 2001), no known instrument enables to study patterns including co-regulation in contemporary learning environments. Contemporary learning environments include the use of electronic media that enable vast numbers of learners to access courses and interact at a distance. Strategy choice and use are also very much a personal matter. As a result, generalization is highly improbable from studies of micro-level strategy use. The empirical utility of observing strategies at a macro-level was suggested by Greene and Azevedo (2009) and can serve the study of regulation differences that are contingent on environmental variables. ERICA aims at studying macro-level strategy use. Several reasons were central to choosing to develop a self-report instrument as opposed to observing regulation strategy use through trace data for example. First, collecting

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data about what is being done by learners does not provide a full picture of regulation strategies used, as regulation can also include choosing not to enact a behavior. Regulation of learning can include motivational, volitional, cognitive and metacognitive dimensions that are not easily accessible to measurement. For example, after assessing that the current behavior is appropriate to the successful attainment of a learning goal, one may choose to not change one's learning strategies. Control is the distinctive feature of proactive regulation. It includes making choices to enact or not to. The scale therefore includes a decision-making component that can only be accounted for through self-report. A microanalytic approach that has been used for self-reports involves interrupting learners to question them (Cleary, Callan, Malatesta, & Adams, 2015; Kitsantas & Zimmerman, 2002). These interventions are rather intrusive and ill-suited to the study of strategy patterns with large cohorts as questions are typically open-ended. The second reason for choosing to use a self-report instrument is that it enables to account for anticipation strategies that precede the cognitive activity, such as choosing a suitable environment for one's learning. Environmental control is just one example of strategies used outside of the learning activity at hand; another is, co-regulation strategies that involve discussion with others, such as assessment strategies taking place after or in-between lessons. The developed scale enables to account for these co-regulations.

1.1. A brief overview of SRL research

Research into SRL initially borrowed from social learning theory. Concepts included self-consequences, self-attributions, self-manipulation, which are motivational in essence, and self-evaluation as constituent of regulatory appraisal. From these origins, some SRL models combined motivational elements with cognitive ones in their models without clearly separating between them (e.g. Winne & Hadwin, 1998; Zimmerman, 2000). Others offered to differentiate them. Boekaerts (1997) clearly separated motivational and cognitive self-regulation. Most models that stemmed from Zimmerman and Martinez Pons's (1986) initial work nonetheless blended types of strategies of regulation from both realms.

Researchers vested in depicting the processual character of regulating one's learning have grouped strategies within cyclical phases. Zimmerman (1998) conceptualized them as: forethought, performance (or volitional control), and self-reflection phases. Kaplan (2009, 2010b, 2014) set apart monitoring and added a decisions-making phase.

Monitoring comprises strategies that a learner or a group of learners may use to assist metacognition, cognition of metacognition (meta-metacognition) as well as to help gain awareness of motivation, volition and affective states.

As to decision-making, including a decisions-making phase was based on the premise that regulating learning purposefully involves choosing to enact a learning strategy or not to enact a specific strategy and to perhaps use another. Making decisions therefore is an indication of cognitive adjustment. Making decisions also suggests that metacognitive knowledge as well as knowledge about affective states, which in both cases is provided through monitoring strategies, is being put to use when assessment of the learning strategies that had been used is carried out. According to the Rubicon Model of Action Phases (Achtziger & Gollwitzer, 2008, 2010), decisions take place at the juncture between deliberation and planning phases.

Greene & Azevedo (2009, p. 23) suggested examining macro-level processes of regulation that are associated with learning. At the macro-level, general tendencies can be observed across populations, something inconceivable on the micro-level as micro-level strategy use can vary highly from subject to subject as well as across contexts and situations in which the subject is performing.

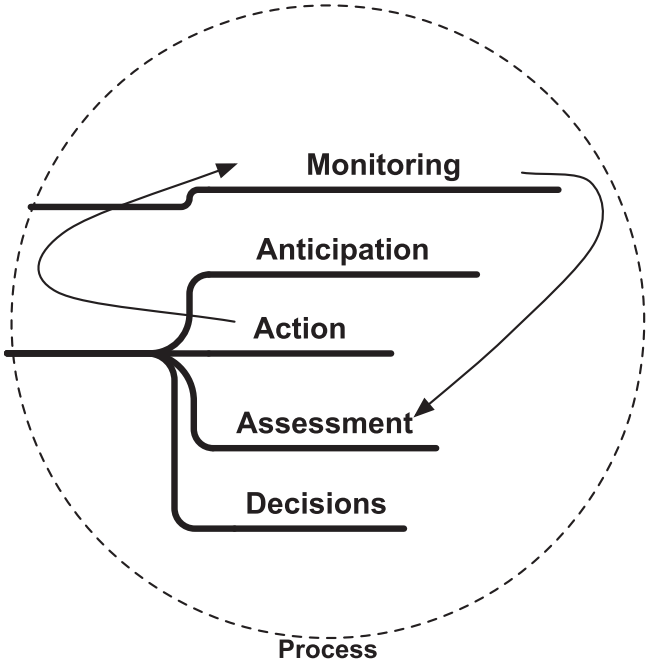

Fig. 1. Regulation of learning phases model (Kaplan, 2009).

Research using the term co-regulation (Efklides, 2008; Salonen, Vauras, & Efklides, 2005; Volet, Vauras, & Salonen, 2009) has mainly been connoted with metacognition, primarily focusing on affective and motivational regulation. Volet et al. (2009a) used the term 'other-regulation' to label regulation that includes interaction with other people, including reciprocal regulatory processes with peer learners. The term 'co-regulation' is used by these authors to label regulations in which a joint task is pursued by two or several learners sharing reference values and norms. This definition suits well to describe co-regulation uncovered in the study circles researched by Kaplan (2009). Based on those findings, and in accordance with recent research in the domain, ERICA was construed to study co-regulation at the macro-level of strategy use as well as related self-regulation. Apart for measuring perceptions of strategy use at the macro-level, the novelty of the scale is in introducing measures of co-regulation. The scale comprises two collective regulation and four individual regulation macro-level strategy components.

2. Methods

2.1. Overview

The instrument was developed with an aim to measure perceived macro-level strategy use in reference to the regulation phases proposed by Kaplan (2009, 2010b, 2014). Strategies that were included in the scale were chosen according to two combined criteria: strategies forming the crux of self-regulated learning (Sitzmann & Ely, 2011); and, strategies that pertain to cognitive control from an action perspective (Achtziger & Gollwitzer, 2010). For example, anticipation strategies are used by learners to plan and set the conditions for their learning. Being a proactive learner requires anticipating materials to be used for one's learning and looking up references to enable later assessment of goal attainment. Fig. 1 represents the regulation phases that guided the construction of the scale.

The method used to develop the scale is consistent with suggestions by DeVellis (2016). After defining the objectives for the scale, as previously explained, an initial set of 60 items were proposed in order to assess the likelihood of learners declaring their use. The

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Table 1
Learning regulation strategies measured with ERICA.

Phase	Code	Regulation strategy	Items
Anticipation	IAR	Individual anticipation of materials and references	1, 3, 14, 20, 25
	IEC	Individual environmental control	5, 9, 15, 21, 26
Monitoring	ITM	Individual tracking and monitoring	6, 10, 16, 22, 27
Assessment	CEC	Collective evaluation of content	2, 4, 11, 17, 28
	IEM	Individual evaluation of method	7, 12, 18, 23, 29
Decisions	CDM	Collective decisions for method change	8, 13, 19, 24, 30

starting point for drafting items was previous research (Kaplan, 2009) that enabled to identify regulation strategies observable at a macro-level across various learner populations, including students following studies in different post-secondary institutions with different curricula and in different environments. Scale items were then assessed on the basis of published research on SRL, cognitive control and metacognition in day-to-day learning circumstances and balanced to equally reflect strategies in each of the regulation of learning phases. As the intent was to reflect action oriented strategies, items pertaining to motivation and the regulation of affective states were eliminated, this included eliminating items related to beliefs, such as perceptions of self-efficacy at learning. As the scale is intended for use in various contexts of adult learners, statements that implied or assumed micro-levels strategies or that required a specialized vocabulary were excluded. After applying these criteria through discussion, a shorter list was evaluated by a group of five practitioners who are experts in the field to eliminate ambiguous items and improve clarity. These steps resulted in a scale comprising 30 items that represent six macro-level regulation strategies.

Following these steps, a first study, which we present here, was intended to put the scale to test for structural soundness. For this, exploratory analyses were performed. The data model was then confirmed with data collected through the second part of our student sample using confirmatory factor analysis. The second study presented here sought convergent and discriminant validity with the only other known self-regulation questionnaire in French (Brodeur et al., 2006).

2.2. Scale learning regulation strategies and definitions

ERICA is composed of six macro-level strategies that learners might use consistently over a period of study within a learning context. These strategies are grouped under one of four phases during which they take place and to which they are related (see Table 1). Phases are generally thought of as occurring successively, each lasting variable lengths of time and forming cycles as they repeat. Some phases may be a fraction of a second long, while others may last weeks. Cycles will hence differ in duration. Several cycles of phases, related to different aspects of one's learning, may occur simultaneously and overlap. A learner may be unaware of a fraction-long phase, part of a short-lived regulation cycle occurring within another longer cycle of which the learner may well be aware of. An illustration of this will follow in the subsection on individual environmental control (IEC).

A change in the way one learns needs to be introduced deliberately by the learner for the learner to be regulating her or his learning in a new situation. Phases thereby need to be considered as occurring cyclically, not simply in terms of repetition but rather as connected between cycles, eventually leading to a change in the way learning in managed. A routine would disqualify the process as a process of regulating one's learning. A change to be made is the outcome of a decision to change the way one leads one's learning process. However, decision-making does not signify something will change. A change may or may not ensue. From our perspective, self- and co-regulation (SCoR) of one's learning is thus a deliberate adjustment that is made to the learning process, which includes intention formation that is reflected in a decision to make a change or to keep things the way they were. A learner may decide not to change anything after having assessed that the process engaged in is appropriate and is expected to lead to the desired outcomes. In this case, a decision is made as to not have anything changed. Thus, SCoR cannot merely be detected on the basis of strategies being enacted. Regulating one's learning relies on awareness of what one is doing in order to make decisions about what needs changing and what does not.

2.2.1. IAR

Individual anticipation of materials and references (IAR) pertains to seeking standards against which one can decide what to learn and to which extent, as well as to measure one's attainments (Winne & Hadwin, 1998). When one searches and organizes printed or electronic material one is in the process of situating oneself relevant to the outcomes one has set for oneself. Documents may include a syllabus or anything that serves as a reference for the learner to decide what is relevant, which areas or sub-topics to invest effort in, taking into account what might be expected either to satisfy one's own curiosity in a topic or relevant to what may be expected of one from others, such as in a new professional context the learner is preparing for.

Even learners who do not report having anticipated materials to work with or reference documents, do use references, though they might be unaware of this such as when their knowledge of what is needed is implicit. As our interest lies in the ways learners regulate their learning in a proactive attempt at academic success, it is measuring deliberate seeking of references that is aimed at.

2.2.2. IEC

Individual environmental control (IEC) pertains to control a learner exerts on the environmental conditions that provide the comfort one feels one would like or even need in order to study. When a learner chooses to study in a quite place, or perhaps in a place where others are studying too, such as in a library; or still, when a learner turns on certain music, the learner is enacting environmental structuring (Zimmerman & Martinez Pons, 1986) or managing resources of the study environment (Pintrich, Smith, Garcia, & McKeachie, 1991). Individual environmental control can be seen as a strategy taking place in anticipation of learning. It can also be attributed to the performance control phase (Pintrich, 2004). For example, a learner who notices there is too much noise around may decide to move to a quieter room. This regulation takes place during the cognitive activity. However, one may consider the interference (the noise) as prompting the subject to interrupt cognitive activity, launch a brief regulation cycle while the larger cycle is being suspended, then pick it up in a new environment (e.g. another room). The brief regulation cycle resulting from assessment of the current cause for disturbance and the decision to change rooms includes anticipating the move, the action of moving, assessing the new environmental conditions as more suitable and the decision to remain in the new location. After settling down in the new environment, the learner can pick up at the point left off during the encompassing cycle. Conceptualized in this manner, IEC is seen as a regulation cycle taking place during the action phase, but it could also be considered as belonging to an anticipation phase if one were to ignore the encompassing cycle during which it took place. This example illustrates how regulations can take place in cycles that are interwoven and spanning different durations.

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2.2.3. ITM

Individual tracking and monitoring (ITM) can be typified as any strategy enabling deliberate metacognition. By keeping track of one's learning activity (in an automated way such as with software generated logs, or by taking notes in a logbook or weblog), one is providing the means for oneself to reflect on one's processes and assess them. Monitoring has been regarded as essential to SRL (Pintrich, 2000; Winne & Hadwin, 1998; Zimmerman, 2000). In one study, conducted by Greene & Azevedo (2009, p. 23) "only monitoring statistically significantly affected the likelihood of having a more sophisticated mental model at post-test".

2.2.4. CEC

Collective evaluation of content (CEC) is a strategy previously observed (Kaplan, 2009, 2010b) in which learners readily seek to evaluate their progress by comparing attainments with peers and through discussion e.g., with alumni. This form of assessment of one's knowledge relative to others can be seen as self-evaluation benchmarked against peers or others that are acquainted with the topic. Yet, learners discussing study topics are also responding to others' requests. These interactions mutually form a field of reference. It is perhaps attributable in part to such interactions that teachers and instructors perceive 'classes' or groups as comparatively 'better' or 'worse' than ones from previous years. Interactions can influence perception, heightening or lowering effort levels. From this point of view, CEC is rather a collective form of evaluation.

2.2.5. IEM

Individual evaluation of method (IEM) refers to thoughts the learner may have on the process being used to achieve desired learning. Reflecting on the methods one uses to achieve desired learning requires tracking, at minimum accessing one's memory, to monitor progress (ITM strategies) and use this information to assess means used as adequate to the attainment of desired goals. To assess that progress is in line with expectations using current methods, references are needed for benchmarking. Using IAR strategies is a deliberate practice that supports assessment of progress and evaluation of adequacy of cognitive strategies that are being used. As methods are characteristic of personal approaches, their evaluation is expected to be the realm of the individual.

2.2.6. CDM

Decision-making marks the change that the agentic learner intends to make. Regulated learning comprises of processes that support agentic and deliberate adjustment to better the learning. Cyclic processes enable adjustment by providing the means to evaluate and decide on maintaining the current procedure or to modify some aspect or other of it. SRL models represented as cyclic assume the ability of learners to act on elements of the process. Collective decisions for method change (CDM) ventures to discern decisions that are made collectively. It has been previously observed (Kaplan, 2009, 2010a, 2010b) that decisions are more readily made after consulting others. Relying on others' ideas and experiences is reassuring. It provides a sense of shared responsibility and facilitates decision-making when decisions are perceived as crucial. Contrary to collective decision-making, individual decisions occur constantly throughout activity. They are embedded in action, leaving little hope for the micro-level decisions learners make to be systematically remembered. Collective decision-making on the other hand, is expected to be more deliberate, hence more available to self-report.

2.3. Study 1

2.3.1. Participants

Respondents were 547 undergraduate psychology students, 443 women and 104 men, in their first and second years of studies. Their mean age was 20.06 years (SD = 4.43, min = 17, max = 54). The questionnaire was made available to all the students online on the university's Web server. Participation relied on an informed voluntary procedure. Students were informed on the opening page of the questionnaire that strict confidentiality will be observed. No identifying data were collected with questionnaires except for student registration numbers (automatically associated) that could eventually serve the purpose of combining scale scores with grades through software manipulations that would not reveal persons' identities. Students were informed that combining data could only be used for statistical analyses and would ensure that no personal information is ever revealed. Formal research ethics approval was not required in the country where the research was conducted – France.

2.3.2. Data collection, dates and procedures

The tested scale was composed of six variables representing the macro-level regulation strategies, each composed of five items. Data were first gathered from second year psychology students at a French university ($n = 231$) between October and December 2013 followed by undergraduate psychology students in their first year at the same French university ($n = 316$), between February and March 2014.

2.3.3. Results

The expectation-maximization (EM) algorithm was used to impute missing data (less than 2%) prior to exploratory factor analysis of observed data. This method is considered better than deleting subjects with missing data (Allison, 2002). Two types of analyzes were applied to verify scale structure. Exploratory analyzes were carried out using the data obtained from the second year psychology students ($n = 231$) while confirmatory analyzes were carried out using the data from the first year psychology students. Analyses were conducted using SPSS (v22).

2.3.4. Exploratory analyzes

Data were analyzed to reduce the complexity of the observed data using parallel analysis by which the number of major factors is estimated. The procedure used is the one suggested by O'connor (2000) and is based on a Monte Carlo method of data simulation. The method consists of generating random matrices of identical size in terms of the number of individuals and the number of factors as the ones being tested (we used 1000 matrices). Values for factors in each matrix were extracted and used at random to calculate the mean and standard deviation of the distribution for values that can be extracted randomly from a similar matrix to the one being analyzed. The value that corresponds to the 95th percentile is used as a threshold beyond which factors can be extracted at random (Cota, Longman, Holden, Fekken, & Xinaris, 1993). Parallel analysis indicated six factors, as the value for the seventh (.96) was inferior to the value of the 95th percentile (1.36).

As can be observed in Table 2, for each dimension, the five suggested items are apparent with no loading on other factors. Loadings are higher than .30 for each item and internal consistency of each dimension is good as Cronbach's alpha reliability is .75 for one dimension and considerably above that for the five other dimensions (Nunnally, 1978).

Table 3 provides descriptive statistics and correlations between factors. Not all dimensions correlate. The two co-regulation dimensions CDM and CEC do not correlate with IAR. IEC correlates either weakly or not at all with the co-regulation dimensions. These

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Table 2
Principal component factor analysis with oblique rotation results.

Item	Factors						h2	M	SD	Skew	K
	1	2	3	4	5	6					
CDM1	.75						.62	1.71	0.78	0.84	−0.01
CDM2	.73						.64	2.02	0.96	0.69	−0.19
CDM3	.84						.71	1.76	0.84	0.83	0.02
CDM4	.78						.64	1.49	0.73	1.39	1.32
CDM5	.84						.73	1.75	0.90	1.07	0.47
CEC1		.83					.71	3.50	0.98	−0.44	−0.31
CEC2		.83					.68	3.63	0.94	−0.55	0.03
CEC3		.79					.70	3.14	1.10	−0.31	−0.65
CEC4		.79					.61	3.56	1.01	−0.56	−0.11
CEC5		.81					.69	3.23	1.12	−0.26	−0.66
IAR1			−.76				.57	2.94	1.00	0.18	−0.37
IAR2			−.75				.53	2.95	1.01	0.13	−0.53
IAR3			−.71				.54	3.04	1.08	−0.10	−0.73
IAR4			−.77				.66	3.04	1.10	0.12	−0.83
IAR5			−.76				.67	2.94	1.12	0.01	−0.85
IEC1				.76			.59	3.83	1.02	−0.68	−0.11
IEC2				.75			.57	3.60	1.09	−0.35	−0.76
IEC3				.93			.84	3.80	1.06	−0.60	−0.41
IEC4				.89			.80	3.82	0.96	−0.64	0.00
IEC5				.84			.73	3.83	0.98	−0.70	0.15
IEM1					−.78		.52	3.50	1.00	−0.27	−0.33
IEM2					−.56		.69	3.21	0.90	−0.21	−0.07
IEM3					−.87		.51	3.52	0.88	−0.24	−0.15
IEM4					−.61		.61	2.47	1.04	0.37	−0.40
IEM5					−.39		.71	3.12	0.99	−0.16	−0.46
ITM1						−.72	.65	2.25	1.24	0.75	−0.44
ITM2						−.81	.52	1.93	1.14	1.04	0.04
ITM3						−.71	.71	2.39	1.37	0.59	−0.90
ITM4						−.66	.51	1.63	0.95	1.41	1.12
ITM5						−.85	.40	1.64	0.95	1.48	1.56
Eigenvalue	6.39	2.89	2.44	3.95	1.52	1.87					
% variance	21.31	9.64	8.12	13.18	5.07	6.22					
α	.86	.88	.82	.89	.75	0.81					

Loadings below .32 are not reported.

results are an indication that co-regulation is not related to individual anticipation (IAR) or to the exercise of individual control over the environment (IEC). The strongest correlations are with the dimension IEM, which suggests a link between evaluation and co-regulation.

2.3.5. Confirmatory analysis

For confirmatory factor analysis (CFA) Mplus (version 6.1) software was used (Muthén & Muthén, 2010). CFA results are graphically represented in Fig. 2.

Several fit measures were used to test how well the model explains the data. Except for χ^2, several other measures were suggested (Browne & Cudeck, 1993; Hoyle & Panter, 1995; Hu & Bentler, 1999). We adopted measures including Chi^2 degree of freedom ratio (χ^2/df), Comparative Fit Index (CFI), Tucker Lewis Index (TLI) and root mean squared error of approximation (RMSEA). Some authors (Bentler, 1992; Schumacker & Lomax, 1996) agree that a value greater than .90 for CFI and TLI is sufficient, while others (Hu & Bentler, 1999) maintain that .95 and higher is preferable. An RMSEA index below .08 is generally accepted (Browne & Cudeck, 1993) though Hu & Bentler (1999) suggested an RMSEA equal to or lower than .06. In accordance with the results of our exploratory analyses, we tested a six factor intercorrelated model. Analyses indicate that data properly fit a six factor model [$\chi^2(62) = 701.88$, $p = .000$; RMSEA = .05, 90% .04–.06; CFI = .92; TLI = .91; SRMR = .05].

Table 3
Descriptive statistics and correlations between scale components.

	M	SD	CDM	CEC	IAR	IEC	IEM
CDM	1.75	0.68	1				
CEC	3.41	0.84	.24***	1			
IAR	2.98	0.81	.09	.12	1		
IEC	3.78	0.86	−.07	.14*	.20**	1	
IEM	3.17	0.68	.35***	.32***	.37***	.19**	1
ITM	1.97	0.86	.28***	.16*	.25***	.24***	.33***

* $p < .05$.
** $p < .01$.
*** $p < .001$

2.3.6. Short discussion

Results of exploratory and confirmatory analyses indicate that the six factors structure of the suggested model is present both in exploratory and confirmatory analyses. Parallel analysis, which was used for the exploratory analyses, establishes that it is possible to extract six factors with an error margin lower than 5%. Adjustment indicators provided through confirmatory analysis point to a fit of the theoretical model of six factors to the observed data. Also to be noted is that internal consistency can be considered to be good in all dimensions.

The second study described hereafter aimed at reinforcing the validity of the scale by testing convergent validity and divergence from another self-regulation scale that is composed of dimensions that can either be considered as close or diverging from dimensions in ERICA. Correlations were expected to be different depending on the theoretic proximity between dimensions in each scale.

2.4. Study 2

2.4.1. Participants

Respondents were 191 undergraduate healthcare students, 169 women and 22 men. Their mean age was 25.78 years (SD = 8.12, min = 18, max = 52).

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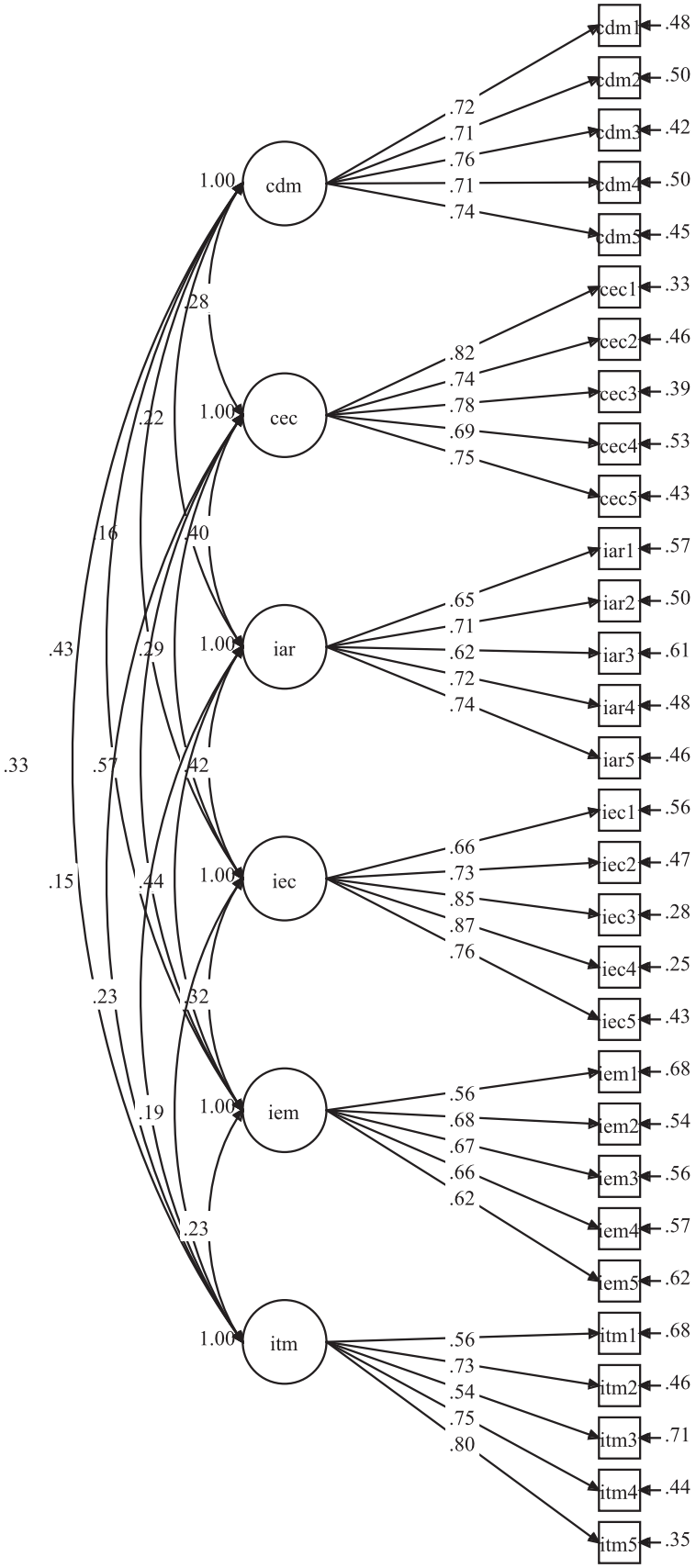

Fig. 2. Confirmatory factor analysis (CFA) results.

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Table 4
Correlations between ERICA and SRLS-ICT (AREGA in French) components.

SRLS-ICT	ERICA						
	CDM	CEC	IAR	IEC	IEM	ITM	α
ADA	.12	.22**	.52***	.34***	.42***	.26***	.72
AEV	.15*	.30***	.43***	.31***	.38***	.34***	.74
AII	.09	.30***	.35***	.18*	.31***	.24**	.75
ASB	.05	.21**	.41***	.41***	.27***	.38***	.73
MON	.11	.26***	.35***	.22**	.38***	.21**	.71
PLA	.09	.21**	.54***	.41***	.35***	.43***	.75
SEP	.02	.03	.21**	.09	−.06	.08	.80
α	.84	.77	.78	.86	.79	.76	

* $p < .05$.
** $p < .01$.
*** $p < .001$

2.4.2. Method, dates and procedures

To test for convergent and discriminant validity, the SRLS-ICT scale questionnaire (Brodeur et al., 2006) was used in conjunction with ERICA. SRLS-ICT is intended for use in information and communication technology (ICT) enhanced learning environments, yet it does not use specific terms or makes reference to e-learning in its items. The authors used Zimmerman's model (1998) of SRL to build the scale. As it is hoped that ERICA may serve to study regulation in contemporary environments which are often technologically enhanced, using SRLS-ICT for convergent and discriminant validity was suitable. The scale was used to observe the following seven self-regulation dimensions: goal setting (coded ASB – 4 items), strategic planning (PLA – 5 items), self-efficacy beliefs (SEP – 4 items), self-instruction–mental imaging (AII – 5 items), self-monitoring (MON – 3 items), self-evaluation (AEV – 5 items), and adaptability (ADA – 4 items).

Data were collected from February to mid-May 2014.

The same procedure as in study 1 was used. Similarly, participation relied on an informed voluntary procedure.

2.4.3. Results

As in the previous study, missing data (less than 5%) were imputed using the EM algorithm. Cohen's (1988, 1992) indices for weak, moderate and strong correlation were used for the analysis of intercorrelations between dimensions. A correlation is considered weak if it is inferior to .30, moderate between .30 and .50, and strong above .50 (in absolute value).

Two collective regulation strategies were introduced in ERICA. Collective regulation strategies do not exist in SRLS-ICT dimensions. Collective decisions for method change (CDM) correlated (weakly) with only one dimension in SRLS-ICT–AEV ($r = .15$, $p = .042$). The other collective regulation strategy present in ERICA is co-evaluation of content (CEC). This collective strategy consists of evaluating one's attainments by benchmarking them against others. CEC correlated weakly or moderately ($r \leq .30$) with all SRLS-ICT dimensions but one, SEP. The exception applies not only to CEC but to the five other dimensions of ERICA too. Self-efficacy beliefs are regulatory appraisals that moderate learning outcomes (Sitzmann & Ely, 2011). The mediating role of beliefs should not be confounded with action. ERICA targets strategies that are performed, as opposed to confidence in ability, which SEP represents.

All other correlations of ERICA dimensions with SRLS-ICT dimensions are moderate or at times strong (see Table 4). As expected, we observe a strong correlation between IAR and PLA ($r = .54$, $p = .000$) as both pertain to anticipating action to follow. We also observe a strong correlation between IAR and ADA ($r = .52$, $p = .000$), a dimension named adaptability in SRLS-ICT that represents self-evaluation of strategy use.

3. Concluding discussion

The studies conducted using ERICA have enabled through the analysis of results from two studies in separate educational settings, to confirm a six-dimensional structure. The scale also stands up to tests of validity for structure, consistency and convergence that were conducted, providing a basis for its deployment in future research on self- and co-regulation of learning.

Studying characteristic traits of regulation strategies is of interest in relation to environmental conditions. The environmental conditions for learning are changing. Access to information, learning resources, guidance and even accreditation are developing over the Internet. Environmental contingencies form the organizing circumstances of learning (Spear & Mocker, 1981; Spear & Mocker, 1984). In order to refine instructional design, environments need to be studied in relation to regulation strategies learners use. The environment is made up of artefacts carried over mediating technologies and by others who form the social environment of learning. ERICA is hence intended as an instrument to provide insight into macro-level regulation strategies learners believe they use in different environments with an aim at studying relationships between SCoR strategies and environmental conditions, both non-human and human, including peers, facilitators, tutors and other reference persons to the field of study.

Environmental conditions include predominant cultural traits. These cultural traits may include differences in learning culture and regulation strategies that may differ accordingly (McInerney, 2008). Studying regulation strategies in French speaking countries may provide insight and a basis for future comparisons.

Perceptions of macro-level strategy use are only part of what would be needed to engage students in developing their self- and co-regulation of learning. Comparing side-by-side strategies that learners believe they deploy with actual strategies used would enable this. Hadwin et al. (2007) have used such an approach using 10 items from MSLQ (Pintrich et al., 1991). Similar approaches comparing trace data left on online learning management systems with learner perceptions, using ERICA, will enable examining differences between French speaking learners' perceptions and actual strategy use in online learning environments.

Considerable research on SRL (Goetz, Nett, & Hall, 2013) has provided insight into strategies that are favorable to achievement in learning. Learning that is effectively regulated should enable building more sophisticated mental models of the topics being studied. The vast amount of research on SRL provides valuable directions to engage in order to develop enabling environments in which learners are able to more easily deploy suitable learning strategies. This is a complementary approach and arguably more effective than to teach self-regulation to students struggling in environments, which are not supportive. Advances in education using knowledge from SRL research can be made if learning processes and outcomes are studied in relation to environments. Deploying e-learning, for instance, needs to be based not on learning theory alone. It required studying the relation between ergonomic design and the ability for learners to regulate their learning successfully. Strategies to be studied are those that contribute to performance (the learning process) and to achievement (the learning outcome).

ERICA is an instrument that hopefully will contribute to designs of learning environments that are enabling. Rapport with peers and others involved in the learning (instructors, facilitators, tutors, etc.) needs to be taken into account too. ERICA integrates two collective learning strategies that are used by learners; one to evaluate progress in relation to content; the other, to decide on changes in learning methods.

The scale was developed using samples of learners that were studying primarily in class-based environments. An important future step will be to study regulation strategy use that online

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learners report in environments that are technologically enhanced. Other areas of interest include studying conjointly other variables, such as affiliation, well-being and other affective constructs. Learning cultures, fields of study, levels of formal education, age, past learning experiences in different environments, are some variables that could be studied in conjunction with SCoR strategies through the use of ERICA in future research. ERICA is expected to enable further insight into the interplay between environmental factors and learning processes in a quest to improve the learning experience.

Disclosure of interest

The authors declare that they have no competing interest.

Appendix A. ERICA Questionnaire

Responses are coded on a Likert-type scale spanning 0–4 in which Never is coded 0 and Always is coded 4.

Jamais = Je n'y ai jamais pensé [Never = I never thought of this]

Rarement = Je le fais rarement [Rarely = I do this rarely]

De temps en temps = Je le fais de temps en temps [From time to time = I do this from time to time]

Souvent = Je le fais souvent [Often = I do this often]

Toujours = Je le fais toujours [Always = I do this always]

Dans ma formation actuelle :
[In my present course/learning:]

1	Je sélectionne des documents qui serviront à mon apprentissage (p. ex.: livres, pages Web, logiciels). [I select documents that will be of use for my learning (e.g. books, web pages, software)]
2	Il m'arrive de discuter avec d'autres apprenants de l'état d'avancement dans mes études. [I sometimes discuss the state of progress in my studies with other learners]
3	Je consulte les livres, programmes ou documents susceptibles de m'informer sur ce qui est attendu en terme de contenu et niveau. [I refer to books, syllabuses or documents that may help to inform me about what is expected in terms of content and level]
4	Il m'arrive d'échanger avec d'autres apprenants pour situer mes connaissances par rapport à ce que je dois encore acquérir. [I sometimes confer with other learners in order to situate my knowledge relative to what I still need to acquire]
5	Je choisis les lieux les plus propices à mon apprentissage. [I choose the most appropriate locations for my learning]
6	Je note dans un carnet ou dans mon agenda l'état de mon avancement au regard de la formation. [I take down notes on a notepad or in my diary about the state of my progress regarding my education]
7	Il arrive que je me questionne sur ma méthode d'apprentissage. [I sometimes question my learning method]
8	Changer de méthode utilisée pour apprendre se fait à la suite d'une décision prise collectivement. [Changing methods used for learning is done following a decision made collectively]
9	J'évite les tentations qui risquent de me distraire lorsque j'apprends. [I avoid temptations that risk distracting me when I am learning]
10	Je conserve une trace de mes activités d'apprentissage dans un carnet de bord ou un journal. [I keep track of my learning activities in a logbook or a journal]
11	Je discute de l'état de mon avancement de mes études avec d'autres personnes. [I discuss the state of progress of my studies with other people]
12	Il m'arrive de décider d'ajuster les méthodes que j'utilise pour apprendre. [I sometimes decide to adjust the methods I use for learning]
13	Je peux décider avec une ou plusieurs autres personnes de changer de méthode pour apprendre. [I can decide with one or several other persons to switch methods for learning]
14	Je recherche des documents, podcasts, sites ou pages web, etc. qui pourraient me servir pour mieux maîtriser les contenus de mon apprentissage. [I search for documents, podcasts, websites or web pages, etc. that could be useful for me to better master the contents of my learning]
15	Je m'installe dans un lieu où je serai à l'abri des distractions pendant que j'apprends. [I set myself up in a place where I will not be distracted when I am learning]
16	Quand j'arrive au bout d'un apprentissage, je le note sur un support que je conserve. [When I reach the end of studying something, I jot it down on something that I keep]
17	Je m'adresse aux autres pour que je puisse me situer par rapport à ce qui me reste à acquérir pour réussir mes études. [I turn to others so that I can situate myself in relation to what is left to be learned in order to succeed in my studies]
18	Parfois je m'interroge sur ce que je pourrais faire pour améliorer ma manière d'apprendre. [I sometimes ask myself what it is I could do to improve my way of learning]
19	Organiser autrement le déroulement de ma formation est le résultat d'une décision prise avec d'autres. [Organizing differently the course of my learning is the result of a decision made with others]
20	Quand je commence une formation, je rassemble des documents et ressources qui pourraient me servir. [When I start studying, I gather documents and materials that might be useful]
21	Pour être dans de bonnes conditions pour apprendre, je prévois un lieu et des objets propices. [In order to provide myself with good conditions for learning, I arrange for a place and objects that are favorable]
22	Je consigne dans un journal de bord les temps que je passe sur mes activités d'apprentissage (un journal « électronique » dans une application Web, un journal que je tiens moi-même. . .). [I record in a logbook the time that I spend on my learning activities (an 'electronic' logbook in a web application, a journal that I myself maintain. . .)]
23	Je m'arrête pour réfléchir à la méthode que j'utilise pour apprendre. [I stop to think about the method I use for learning]
24	Les méthodes de formation que j'utilise sont le résultat d'un choix collectif auquel j'ai participé. [The learning methods I use are the result of a choice made with others in which I took part]
25	Au début d'une formation je consulte divers documents pour savoir ce qu'il faudra apprendre pour réussir ma formation. [At the beginning of a course I look into various documents to know what it is that needs to be learned in order to succeed in the course]
26	Je me place dans un endroit qui m'offre le confort et les ressources nécessaires pour bien apprendre. [I set myself up in a place that offers me the comfort and the necessary resources to study well]
27	Je me sers d'un journal que je tiens ou qui est enregistré automatiquement (p. ex. dans une application) pour voir où j'en suis dans mes études. [I use a logbook that I maintain or that is automatically recorded (e.g. in an application) so that I can see where I am in my studies]
28	Je me réfère aux autres pour savoir où j'en suis dans la progression de mes apprentissages. [I turn to others to situate myself relative to progress in my studies]
29	Je change parfois la méthode que j'utilise pour apprendre quand je juge que cela sera plus efficace. [I sometimes change the method I use to learn when I reckon it will be more effective]
30	S'il m'arrive d'organiser autrement ma formation c'est à la suite d'une décision que je prends avec une autre ou plusieurs autres personnes. [If it happens that I organize my learning differently, it follows from a decision that I make with another or several other persons]

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