

# Assessing self-regulated learning in early childhood education: Difficulties, needs, and prospects

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Self-regulated learning is one of the main processes being investigated today within developmental and educational psychology; however, the research has come up against a number of challenges for which no satisfactory response has been found, and which are impeding progress in the field. These challenges are two-fold: one part is methodological, as the process of self-regulation must be evaluated at the very moment in which it occurs, and the other part is developmental, as these processes have not been fully assessed in children under the age of 6 years. This article gives a broad overview of these challenges, as well as prospects for future solutions which are beginning to take shape.

*Evaluación de aprendizaje autorregulado en educación infantil: dificultades, necesidades y perspectivas para el futuro.* El aprendizaje autorregulado es uno de los principales procesos que están investigando, hoy en día, dentro de la Psicología Educativa y del Desarrollo. Sin embargo, la investigación ha tropezado con una serie de retos, para los cuales aún no hay respuesta satisfactoria, y que están obstaculizando el progreso en el campo. Estos retos son dos: uno es metodológico, ya que el proceso de autorregulación debe ser evaluado en el momento mismo en que ocurre, y el otro es psicoevolutivo, ya que estos procesos no han sido plenamente evaluado en niños menores de 6 años de edad. Este artículo aporta una visión general de estos retos, así como las perspectivas de las futuras soluciones que están empezando a tomar forma.

In recent decades, the topic of “self-regulation processes” has been one of the most researched areas in the field of psychology, seeing substantial growth since the 1990s (Post, Boyer & Brett, 2006). In this decade an avalanche of research studies and articles about self-regulation appeared, taking on such diverse fields as emotion, cognition, behavior and language. This accumulation of knowledge has given rise to different definitions of self-regulation depending on the approach adopted, whether exclusively psychological, or psychological and educational (De la Fuente & Justicia, 2007). From a strictly psychological perspective, self-regulation has been defined as the process by which a person generates thoughts, feelings and actions which are systematically oriented toward achieving one’s goals (Bembenutty & Karabenick, 2004; Zimmerman, 2002). From a psychological and educational perspective, self-regulated learning can be defined as an active process by which the person establishes objectives which direct his or her own learning, and tries to observe, regulate and control cognitions, motivations and behaviors for the purpose of meeting those objectives (De la Fuente & Martínez, 2007). Another result from the numerous studies has been a large quantity of models about self-regulated learning over the last decade; the

most important models (cf. Puustinen & Pulkinen, 2001) agree on the interaction of cognitive, metacognitive and affective-motivational factors in the subject’s self-regulation process.

One important research thrust in the area of self-regulation has been its acquisition during the early years of life. This article will focus on research topics in self-regulation which have been addressed so far for the 3-6 year age range. The most recent contributions can be classified under such constructs as attention (Berger, Kofman, Livneh, & Hesnick, 2007), metacognition (Alexander, Carr, & Shwanenflugel, 1995; Liebermann, Giesbrecht, & Müller, 2007; Muñoz, 2003; Salmerón, Ortiz, & Rodríguez, 2003; Neuman & Roskos, 1997; Schneyder, 1998; Schneyder, Visé, Lockl, & Nelson 2000; Winsler & Naglieri, 2003), emotion (Berger, Kofman, Livneh, & Hesnick, 2007; Liebermann, Giesbrecht, & Müller, 2007; Moreno & Robinson, 2005), memory (Cherney, 2003; Roebbers & Schneider, 2006), self-regulation strategies (Calero, García-Martín, Jiménez, Kazén, & Araque, 2007; Raffaelli, Crockett, & Shen, 2005; Roebbers & Schneider, 2006) and attributional processes (Heyman, Gee, & Giles 2003; Heyman & Compton, 2006).

From this developmental perspective, Sokol and Müller (2007) show concern about the persistence of the emotion-cognition antimony, one of the great difficulties in studies on self-regulation. Some studies consider the interaction of both sides: use of cognitive, metacognitive and affective-motivational strategies while performing an academic activity (Amate, 2003, 2004; De la Fuente, Amate, Gómez, & Martínez, 2000); cognitive, emotional and behavioral regulation (Smith-Donald, Raver, Hayes, & Richardson, 2007); self-control and emotional awareness, learning

new strategies and decision making processes (Lewis & Todd, 2007); working memory, self-control, temperament and brain activity (Wolfe & Bell, 2007); relationships between cognitive control and temperament (Carlson & Wang, 2007).

Nonetheless, as Amate (2003) states, studies related to strategic behavior in a strict sense, or in line with some theoretical self-regulation model, are practically inexistent for children from 0-6 years of age; studies of their self-regulated learning are even less present. Considering this situation, we can observe two underlying realities. On one hand, we find models of self-regulated learning which have significant empirical support (Puustinen & Pulkinen, 2001), allowing us to investigate these processes in subjects. On the other hand, as several research studies confirm, children are perfectly able to regulate their conduct, including in learning. This brings us to a series of questions which we seek to address below: the possibility and/or relevance of using pre-existing self-regulation models with small children, the difficulties of assessing this set of constructs and the added difficulty of trying to do so with preschool children. Finally, we will attempt to offer a number of possible alternatives and solutions.

### *Self-regulated learning*

As mentioned above, the many studies on self-regulation have given rise to different theoretical models. One of the most significant is the self-regulated learning model by Pintrich (2000), an important attempt to synthesize the different processes and activities which help increase self-regulation during learning (Torrano & González, 2004). Based on a socio-cognitive perspective, Pintrich organizes the different regulatory processes in four phases: planning (before beginning the task), self-observation and control (during task execution) and evaluation (after finishing the task). In each of the phases, regulation activities are considered for four separate areas: affective-motivational, behavioral, contextual and cognitive.

Affective and motivational regulation encompasses the subject's beliefs about himself or herself in relationship to the activity, for example judgments about one's own effectiveness, the value assigned to the task, and related personal interests.

The area of behavioral regulation includes the subject's attempts to control his or her behavior: effort in executing the tasks, persistence, help-seeking and choice of strategies.

The area of regulating cognition includes both cognitive and metacognitive strategies. According to González (1997), cognitive strategies involve all those learning strategies which help in the process of understanding, codifying and remembering information. Metacognitive strategies, for their part, refer to those strategies that allow for planning, controlling and directing one's own mental processes in order to achieve the desired goal. Metacognition includes both the subject's knowledge about his or her own mental processes as well as the ability to control these processes through regulation. The duality of metacognition, both *knowledge* and *regulation*, is analyzed by Brown (Georghiades, 2004) in order to establish its particularities. As for knowledge about one's own mental processes, this requires the subject to consider his or her own cognitive process as an object of thought and reflection, and is therefore something which develops later. The subject must be able to consider this process as a relatively stable, verifiable, and possibly fallible act. By contrast, cognitive regulation addresses relatively unstable activities independent of age, it is not easily verifiable since

the fact that the subject knows how to do something does not imply that he or she is aware of the process followed nor is able to explain it. As is shown by several different research studies with children, the awareness of using a strategy is not a prerequisite for its use or effectiveness (Kuhn, García-Mila, Zohar, & Anderson, 1995; Siegler, 2000; Winsler & Naglieri, 2003). It is in the area of identifying or measuring metacognitive aspects, key elements in the self-regulation process, where we find problems (Georghiades, 2004). Despite this, studies such as those by Amate (2003, 2004) and De la Fuente et al. (2000) show the possibility of using a model like Pintrich's in order to evaluate self-regulated learning strategies in 5-year-old children.

### Assessing self-regulated learning

#### *Difficulties*

Cascallar, Boekaerst and Costigan (2006) review the contributions to date and establish several methodological aspects as the main problems in the field of assessing self-regulated learning. One of the problems lies in the level of awareness of the behavior to be assessed. When assessing, it is assumed that the subject is aware of his or her cognitive activity (thoughts, feelings, etc.) and that he or she can establish relationships between these and the final results. However, research shows that our cognitive system only has limited access to the processing and establishing of causal relationships for the behavior being assessed. Another of the problems stems from the inadequate definition of the constructs, or inadequate transfer to assessable behaviors; partial consideration of the theoretical implications and/or their research relevance; use of insufficiently validated models and use of instruments which lack the necessary psychometric properties. The researcher must then be selective with the questionnaire to be used for assessing self-regulated learning (Muis, Winne, & Jamieson-Noel, 2007). Another aspect to take into account is that most instruments were developed under the paradigm of Classic Test Theory, which has not always been managed well, as is demonstrated in excessive confidence in factorial analysis and the use of correlation with ordinal and nominal items (Lambert, Nelson, Brewer, & Burchinal, 2006). Elsewhere, the widely used think-aloud measures for metacognitive assessment only permit us to understand processes which are in working memory, while automatic processes cannot be measured with these methods (Prins, Veenman, & Elshout, 2006).

Perry and Winne (2006) especially criticize the indiscriminate use of self-report measures. It is assumed that the subject evaluates his or her behavior in relation to a determined context; if this context (for example the type of task and its characteristics) is not clarified in the questionnaire, it is difficult to know in relation to what context the mental activity is being reported on. On the other hand, the student does not usually have a correct appreciation of his or her own thoughts and actions, underestimating the less frequent and exaggerating the more frequent. The self-report, moreover, implies that the subject must draw from memory, more a process of reconstruction than recovery (Perry & Winne, 2006). Samuels-tuen and Braten (2007) consider that overall assessment of strategic processing through self-reports has limited validity and usefulness.

The difficulties commented on above are even further aggravated when one deals with self-regulated learning assessment in small children. Several authors (Alexander, Carr, & Schwanenflugel, 1995; Boekaerst & Corno, 2005; Georghiades, 2004; Monereo, 2001; Pappas, Ginsburg & Jiang, 2003; Turner, 1995; Winsler & Naglieri, 2003) point to such difficulties as the following:

- The indirect nature of the referents, such as language and behavior, used for accessing strategic behavior
- With think-aloud measures, the fact of having to report on one's own feelings and actions during the tasks involves an extra cognitive burden and bias that can interfere with task execution
  - Children tend to be very optimistic in answering, they also present memory and language problems for describing their own cognitive processes when carrying out an activity
  - When interviews are used, children's answers are usually quite vague and irrelevant
  - The number of ambiguous or confused situations and behaviors to be evaluated are greater than at other ages
  - Children tend to describe only recently experienced, concrete aspects. They have difficulty establishing their usual behavior in situations.
  - They often confuse their desires or intentions with their real actions
  - Children are not always aware of the strategies they use, so they may not report them even when they have made use of them.

### Needs

Assessing self-regulated learning is a fundamental element of research in this field (Cascallar, Boekaerst & Costigan, 2006). Understood as such, different authors suggest several key requirements for research progress. Boekaerst and Corno (2005) highlight aspects such as these:

- Research on self-regulated learning should be guided by a clear conceptual model whose basic principles are specified in terms of propositions, such as: direct and indirect relationships, mediating and moderating factors, and limits.
  - It is necessary to assess the subject's concrete strategies and how these interact and are conditioned by developmental, environmental, individual and biological factors.
- Other authors (Butler, 2002; Torrano & González, 2004; Winne & Perry, 2000) indicate a series of topics to be addressed in the area of assessing self-regulated learning:
- A greater number of methods and qualitative measuring instruments should be created and validated (complementary to the use of self-reports), allowing self-regulated learning to be assessed as a dynamic, continuous process which unfolds over time and in a specific context.
  - Greater data triangulation is needed in order to coordinate different measures and make possible a characterization of the complete spectrum of self-regulated learning.
  - There has been little research on self-regulated learning strategies in small children (up to the age of 6), so that practically no measurement protocol appropriate to this developmental stage has been developed.

### Future prospects

Self-regulated learning, in the early research, was considered to be a stable trait of the subject when facing a learning situation, to be assessed therefore as if it were an aptitude. Later, from a situated cognition perspective, one saw the need to assess the regulation process as it is produced (Boekaerst & Cascallar, 2006). Thus, researchers reached the conclusion that in order to obtain a suitable, all-embracing model of self-regulated learning, it was essential to investigate *the process of self-regulation while it is under way*

(Boekaerst & Corno, 2005), with self-regulated learning as a response behavior by definition (Hadwin & Winne, 2001). Various authors stress that self-regulation is a process more than a product, a process that develops and becomes more sophisticated over time and with practice. According to Pintrich (2004), assessment using self-reports only allows us to ascertain a pupil's predisposition to use self-regulated learning strategies. All things considered, their use should be captured as they are put into play during an activity, with online records being one type of process measurement defended by this author. Examining self-regulated learning from this perspective requires collecting information during the space and time that a task is under way (Azevedo, 2005; Chung & Baker, 2003; Hadwin & Winne, 2001; Hadwin, Winne, Stockley, Nesbit, & Wosczyzna, 2001; Howard-Rose & Winne, 1993; Winne & Perry, 2000).

The advances and possibilities for assessing self-regulated learning in hypermedia contexts are defended as being powerful tools for promoting, recording and interpreting actions indicative of self-regulated learning (Baker & Mayer, 1999; Bennet et al., 1999; Chung & Baker, 2003; Hadwin & Winne, 2001; Schacter et al., 1999; Winne & Sotckley, 1998). The record of how the subject handles hypermedia allows us to obtain much more precise information about his or her learning strategies than what can be drawn from any kind of self-report (Hadwin, Winne, & Nesbit, 2005). It should be specified that the program itself must produce this record; it is not a question of observing and recording the behavior from outside (Rogers & Swan, 2005). Despite the potential seen in computer technology, it is still necessary to appropriately justify its purposes within a theoretical framework that can then serve as a reference for establishing evidence acquired in its application (Bennett et al., 1999; Shavinina, 2001).

In addition to being able to collect evidence of the pupil's self-regulated learning, using the computer eliminates some of the drawbacks of classical instruments, while retaining many of their benefits. The pupil's cognitive activity becomes observable without having to interrupt him or her (Chung & Baker, 2003; Shaw et al., 1997; Van Biljon, Tolmie, & Du Plessis, 1999; Winne & Sotckley, 1998, Young, Kulikowich, & Barab, 1997); possible language deficits, such as occur with small children, are not an issue (O'Neill, 1999; Yeh & Lo, 2005); the pupil's activity can be followed reliably and in minute detail, and a large quantity of information is collected and processed at the moment it is produced (Schacter et al., 1999; Winne & Perry, 2000; Winne & Sotckley, 1998); there is total impartiality and objectivity (Powers et al. 2002); statistical aspects are improved, and both the costs and errors in data recording can be reduced (Gosling et al., 2004). Computer use allows us to improve our understanding of the pupil's cognitive processes as well as to make inferences in the area being dealt with (Baker & Mayer, 1999). Hadwin, Winne and Nesbit (2005), summarize the advantages of using the computer in psychology research: the computer makes it possible to collect information that cannot be collected through other means, software can be programmed to interact with the learner's behavior and to do so reliably, information can be collected reliably, in minute detail, and without any added bias other than that inherent in the program.

### *Computers in the assessment of self-regulated learning*

Shih, Feng and Tsai (2008), when reviewing research related to cognitive aspects and e-learning in high impact journals, find that the topics most studied are instructional approaches, learning

environments, prior knowledge, metacognition and cognitive characteristics. Moreover, they identify a growing trend to make use of a pupil's browsing history as data for analyzing his or her cognitive process. Though still limited, an increasing number of studies present research and projects which incorporate some kind of computer-based measure of self-regulated learning during execution of a given academic activity (Moos & Azevedo, 2008). Others, as in the case of models based on neural networks, are in an experimentation phase and evaluate certain cognitive processes in order to validate the methodological model more than the psychological model. Some examples from this research are discussed below, presented in four sections according to how the pupil's activity was monitored: graphic analysis, analysis through conceptual maps, analysis using neural networks, and analysis of browsing strategies.

*Graphic analysis.* Here we include the pupil's activity analyzed through different types of graphics. Graphics can take on many forms, from aspects similar in content to the activity itself (for example, an interactive face in the case of orthodontics-related activities) to arbitrary graphics (for example, geometric figures in a space); they record the subject's different actions and their suitability. In "The Adventures of Jasper Woodbury" (cf. Shaw et al., 1997), all the subject's interactions with the program are recorded in a file, this reveals the pupil's choices, but not the actions and information used in order to make these choices. A computer program, Efken (cf. Shaw et al., 1997), monitors the process of solving hemodynamics problems with nursing students, this process is converted into an explanatory graphic of the subject's activity.

*Analysis using conceptual maps.* Here we include research that makes use of conceptual maps as a tool either for evaluating the pupils' cognitive process, or for seeing the final result. Herl et al. (1999) have the pupil draw conceptual maps in order to assess strategies of collaboration, communication, content comprehension, self-regulation (motivational and metacognitive aspects) and problem solving. Schacter et al. (1999) record strategies in browsing, searching, precision browsing (accessing relevant pages), and feedback or review of one's own work while preparing conceptual maps in environmental sciences.

*Analysis through neural networks.* A neural network is a reticulated computer system taking its inspiration from biological neurons, where one learns from experience through modifying one's own connections (Pitarque, Roy, & Ruiz, 1998). Using CALL, Computer-Assisted Language Learning, Yeh and Lo (2005) present a neural network model which automatically assesses the level of a subject's metacognitive knowledge through his or her browsing behavior. Stevens et al. (1999) carry out research in order to find pupils' information processing strategies in activities from the IMMEX package. Chung et al. (2002) use the same type of activity to record participants' cognitive processes such as paraphrasing, use of inferences, information assessment, discrimination, recognition of knowledge gaps, awareness of one's own errors in comprehension, and self-observation of the problem-solving process.

*Analysis of browsing strategies.* Analysis of browsing strategies actually encompasses the three prior categories since it consists of

monitoring and recording the subject's interaction with the computerized activity. The separation is made in order to distinguish between information collection techniques and information treatment which is produced from the subject-computer interaction. In this category we include research which cannot be classified in the groups above. Some research has focused on the metacognitive activity of subjects (Hulshof et al., 2005; Veenman & Spaans, 2005; Veenman, Wilhelm, & Beishuizen, 2004), other research tries to find reasoning and thought strategies (Bennett et al., 1999; Kumpulainen, Salovaara, & Mutanen, 2001), strategic behavior (Chung & Baker, 2003; Van Biljon, Tolmie, & Du Plessis, 1999) and learning style (García et al., 2007). Winne and Jamieson-Noel (2002, 2003) compare self-regulated learning strategies which students claim to use on a self-report with what they actually use in computerized work. Perry and Winne (2006) and Hadwin et al. (2008) illustrate how to analyze several aspects of self-regulated learning with gStudy. De la Fuente et al. (2007) propose self-assessment and improving the process of self-regulated learning and teaching.

All the research mentioned above has focused on children above the age of 6 years, and most deals with Secondary or University education. As far as we are aware, no online assessment of self-regulated learning has been applied with children younger than 6 years of age. In this article we propose an instrument for this age group, *Software para Evaluar la Autorregulación Infantil* [Software for Assessing Self-Regulation in Early Childhood] (Lozano & De la Fuente, 2008). The program is designed according to Pintrich's model (2000), and comprises three activities similar to those used by Amate (2003, 2004), De la Fuente et al. (2000), Muñoz (2003) and Sarama and Clements (2004) for the same purpose. The child's activity is recorded at three major moments of strategic performance: before executing the task, during task execution, and after finishing the task (De la Fuente & Martínez, 2007). As suggested by the theoretical model in use, both cognitive-metacognitive strategies and affective-motivational strategies are recorded at each of these moments.

As with the IMMEX program (Chung et al., 2002), the structure of each of the activities and the user interface have important characteristics that facilitate making use the information collected:

- The structure of each activity provides the subject with opportunities both to "demonstrate knowledge" and to "demonstrate lack of knowledge".

- Capturing intentional acts takes place without ambiguity, the child knows at all times what he or she can do. Mouse actions reflect his or her reasoning and judgment.

- The quantity of information presented in each scene is concrete and unambiguous, one knows at all times what the child is seeing. The program is linear and offers one single thing at each point (the activity, help, a question, etc).

The program is still being refined and validated, although it is outlined here as a new contribution which seeks to address the needs described in this article. Thus, in addition to furthering knowledge in the field of educational psychology, a specific instrument can be used to perform research with children under the age of six, to better understand the development of regulating cognitive, metacognitive and affective-motivational processes.

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