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Article

Journal of Educational Technology Systems
2017, Vol. 46(2) 191–214
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DOI: 10.1177/0047239517710769
journals.sagepub.com/home/ets
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Self-Regulated Learning: The Continuous-Change Conceptual Framework and a Vision of New Paradigm, Technology System, and Pedagogical Support

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Abstract

A modified conceptual framework called the Continuous-Change Framework for self-regulated learning (SRL) is presented. Common elements and limitations among the past frameworks are discussed in relation to the modified conceptual framework. The iterative nature of the goal setting process and overarching presence of self-efficacy and motivational beliefs are emphasized as an improvement in the modified framework. Also, the limitations of current SRL frameworks in terms of full SRL are identified. On the basis of these limitations, we discuss the potential of SRL for the information-age paradigm of education as well as implications for pedagogical thinking for teaching students to be more self-regulated.

Keywords

self-regulated learning, conceptual framework, learning management system, pedagogy

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Introduction

In the same class, given the same problem or task, some students are more motivated and willing to try many strategies to solve the problem by themselves, whereas others are less or not at all willing. They usually set goals for learning, plan for strategies, and resources to utilize in order to accomplish the goals, monitor their progress toward meeting the goals, adjust their plan and action, and evaluate how well they meet or fail to meet the goals at the end of their learning activities. In this example, learners' self-regulated learning (SRL) is witnessed, and the importance of SRL is more emphasized with growing interest in learner-centered instruction (McCombs & Whisler, 1997; Reigeluth & Karnopp, 2013), 21st century learners (Wolters, 2010), online or blended learning (Huh & Reigeluth, 2017; iNACOL, 2013), and life-long learning (Bhola, 1989).

Bandura's (1977b, 1986) social cognitive theory has especially had a significant influence on theorizing and understanding SRL. In his social cognitive theory, he views human functioning as a triadic as well as the dynamic interplay of personal, behavioral, and environmental influences (Bandura, 1986). Moreover, people are viewed to have certain capabilities, such as capabilities to symbolize, plan strategies, self-regulate, and self-reflect, which make up major characteristics of SRL. Stemming from pioneering work on self-control (Bandura, 1977b; Kanfer, 1971; Thoresen & Mahoney, 1974) as well as early work on therapeutic self-regulation (as cited in Schunk, 2005, p. 85), a body of applied research examining SRL and its relationship with student academic achievement has emerged (Bandura, 1986; Pintrich & De Groot, 1990; Zimmerman & Schunk, 1989), and since then researchers have been more and more examining self-regulation in academic learning contexts such as K-12 classroom settings (Ablard & Lipschultz, 1998; Dignath, Buettner, & Langfeldt, 2008; Paris & Paris, 2001; Pintrich, Roeser, & De Groot, 1994; Wolters & Pintrich, 1998; Zimmerman & Martinez-Pons, 1990), higher education settings (I. Lee, 2002; Pintrich, 2004; Paulsen & Feldman, 2006; Valle et al., 2007; Wolters, 1998), and technology enhanced learning environments such as web-based instruction or hypermedia environments (Azevedo & Cromley, 2004; Azevedo, Moos, Greene, Winters, & Cromley, 2008; Chang, 2005; Dabbagh & Kitsantas, 2005; Gravill & Compeau, 2008; H. S. Lee, Shen, & Tsai, 2008; Narciss, Proske, & Koerndle, 2007; Shen, Lee, & Tsai, 2007; Steffens, 2006; Young, 1996).

In traditional classrooms, teachers often provide students with goals to achieve, tasks to perform, and even strategies or resources to use, and students basically follow what they are told to do. However, with evidence of different learning outcomes and levels of motivation among students as well as a massive development of web-based learning, a pressing need for investigating SRL has emerged (M. Boekaerts, P. R. Pintrich, & M. Zeidner, 2000b; Zimmerman, 1994, 2001). Zimmerman (2002) also claimed that SRL is important because one of the major functions of education is developing life-long learning skills, and recently

SRL is viewed as one of the major competencies for the 21st century learners (Wolters, 2010).

SRL is defined as thoughts, feelings, actions, and behaviors generated by learners to systematically and intentionally attain their goals (Boekaerts & Niemivirta, 2000; Schunk & Zimmerman, 1994; Zimmerman, 2000; Zimmerman & Schunk, 1989). Pintrich (2000) also defined SRL, emphasizing areas of regulation, "an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behavior, guided and constrained by their goals and the contextual features in the environment" (p. 453).

Researchers have identified various elements or processes to explain and guide SRL, and there are some common elements as well as slightly different views. The purpose of this article is to describe various conceptual frameworks for SRL, propose an improved conceptual framework, and examine a new paradigm and technology to support SRL as well as implications SRL has for pedagogy on how to teach learners to promote their SRL more effectively.

Conceptual Frameworks of SRL

Several researchers have developed conceptual frameworks to explain SRL (Boekaerts, 1996; Pintrich, 1999, 2004; Schunk, 1990, 2001; Zimmerman, 2000, 2001). The frameworks share some common elements but also have some differences and limitations. Therefore, there is a need to create a modified framework that can encompass the important contributions of the past frameworks but overcome their limitations.

Assumptions

Although not every researcher clearly stated so in their research studies, most SRL frameworks share four general assumptions (Pintrich, 2004; Wolters, 2010; Wolters, Pintrich, & Karabenick, 2003). One assumption is that learners are active participants in the learning process (Boekaerts, 1996; Pintrich, 2004; Schunk & Ertmer, 2000; Schunk & Zimmerman, 1994; Wolters, 2010; Zimmerman, 2001, 2002). Zimmerman (2001, 2002) also viewed learning as a proactive activity in which learners are actively participating in their own learning process. A second assumption focuses on the "potential for control" by learners (Pintrich, 2004, p. 387). Potentially, learners are assumed to monitor, control, and change or regulate certain aspects of their cognition, motivation, actions, and even environments. A third assumption is that there is a goal, criterion, or standard in SRL (Baumeister & Heatherton, 1996; Boekaerts, 1996; Pintrich, 2004; Schunk, 1990; Wolters, 2010; Zimmerman, 2000, 2002). Learners can compare their current learning to the goal, criterion, or standard to assess whether or not it is acceptable or needs to be changed. Finally, there is an

assumption that "self-regulatory activities are the mediators between the person, context, and achievement" (Pintrich, 2004, p. 388). Learning is influenced directly not just by their individual demographic, cultural, and personal characteristics, nor just by contextual characteristics such as classrooms or resources, but also by the individual's efforts on mediating the relations among the person, context, and learning or goal attainment.

Past Frameworks of SRL

Several conceptual frameworks have been created to better understand SRL. Although not all learning processes in every context can be explained by the frameworks, the frameworks are valuable in that they help develop constructs of SRL and portray the relationships among the constructs in general. Four examples are identified here, and they illustrate some similarities, differences, and limitations. Based on the limitations, the need to create a modified conceptual framework will be discussed.

Framework of Schunk

Schunk (1990) examined SRL as a combination of three subprocesses: goal setting, self-efficacy, and self-regulation. His thinking is aligned with other researchers who have a social cognitive theory (e.g., Bandura, 1986) background (Pintrich, 2004; Zimmerman, 2000, 2002). Schunk viewed the social cognitive process as an interaction among goal setting, self-efficacy, and self-regulation, and he put more emphasis specifically on self-regulation, which includes self-observation, self-judgment, and self-reaction. Table 1 illustrates key concepts of past SRL frameworks by Schunk and other researchers.

1. *Self-observation* (self-monitoring): An activity of being attentive to one's behaviors. The information from the observation can be used to assess progress toward goals and can motivate changes in behavior (Baumeister & Heatherton, 1996; Schunk, 1990). It can be supported by "self-recording, where behavior instances are recorded along with time, place, and duration of occurrence" (Schunk, 1990, p. 73).
2. *Self-judgment*: An activity of comparing current performance with one's goals, criterion, or standard, so eventually it is affected by "the type of standards employed, goal properties, importance of goal attainment, and performance attributions" (Schunk, 1990, p. 73).
3. *Self-reaction*: The belief that one's progress is either acceptable or not, and the satisfaction from achieving goals.

Although Schunk's (1990) first conceptual framework included only goal setting, self-efficacy, and self-regulation, he later elaborated his conceptual

Table 1. Key Concepts of Past SRL Frameworks.

Schunk (1990)	Zimmerman (2000)	Pintrich (2004)
		Phases
Goal setting	Forethought phase	• Forethought, planning, and activation
Self-efficacy	• Task analysis	
Self-regulation	• Self-motivation beliefs	• Monitoring
• Self-observation	Performance phase	• Control
a. Self-monitoring	• Self-control	• Reaction and reflection
b. Self-recording	• Self-observation	Areas of regulation
• Self-judgment	Self-reflection phase	• Cognition
a. Comparing performance with goals	• Self-judgment	• Motivation/Affect
	• Self-reaction	• Behavior
• Self-reaction		• Context
a. Belief/Satisfaction		

framework with the notion of three phases—forethought, performance control, and self-reflection (Schunk, 2001)—which was proposed earlier in Zimmerman (2000)'s three-phase model (see Figure 1).

Framework of Zimmerman

When explaining a self-regulatory process, Zimmerman (2000, 2002) introduced three phases of self-regulation: (a) forethought; (b) performance or volitional control; and (c) self-reflection. Zimmerman (2002) also used this framework for explaining the phases and subprocesses of SRL. The *forethought phase* covers ''the processes and beliefs that come *before* efforts to learn''; the *performance phase* encompasses ''processes that occur *during* behavioral implementation,'' and the *self-reflection phase* refers to ''processes that occur *after* each learning effort'' (Zimmerman, 2002, p. 67). This framework is unique in that it attempted to explain the SRL process by explicitly dividing it into phases. Each phase has its subprocesses; for example, the forethought phase has task analysis and self-motivation belief as its subprocesses, the performance phase has self-control and self-observation subprocesses, and the self-reflection phase has self-judgment and self-reaction as its subprocesses (Zimmerman, 2000, 2002). In addition, under each subprocess, specific methods or strategies are also introduced.

Under the *forethought phase*, *task analysis* involves goal setting and strategic planning, and considerable evidence indicates that learners with proximal, specific goals demonstrate increased academic achievement (Zimmerman, 2002). *Self-motivation beliefs* are often derived from self-efficacy and outcome

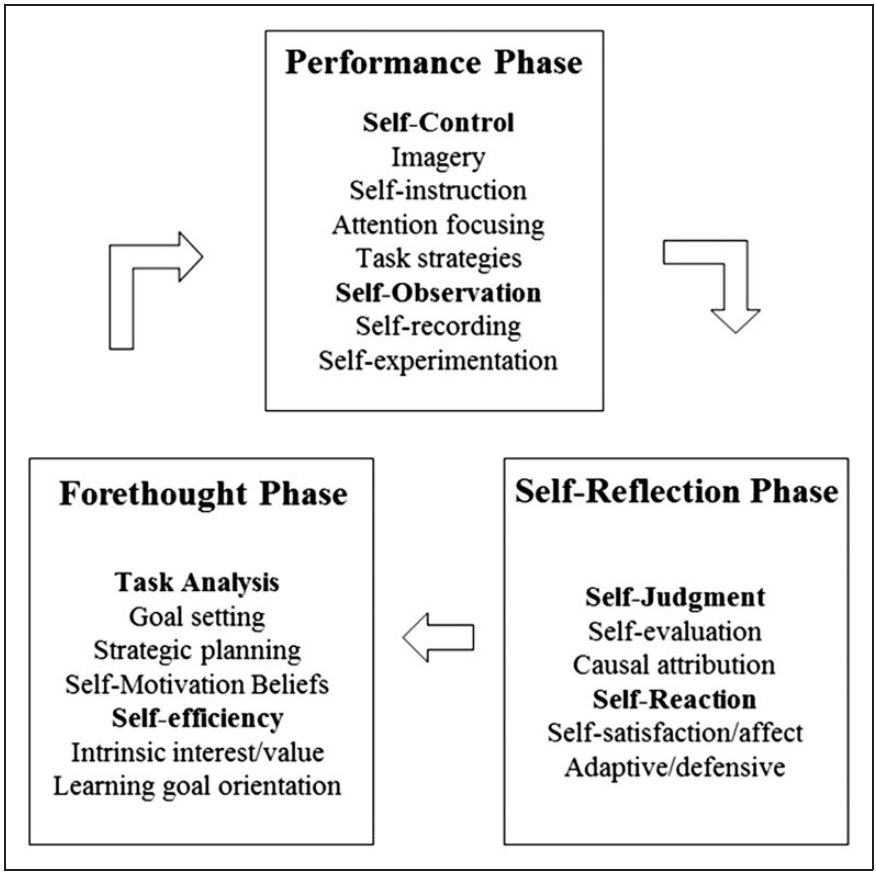

Figure 1. Phases and subprocesses of self-regulation. Reprinted from B. J. Zimmerman (2002), Theory into practice, 41(2), p. 67. Copyright 2002 by College of Education, The Ohio State University.

expectation. Self-efficacy refers to ''people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives'' (Bandura, 1994, p. 71), and outcome expectation means how learners perceive the consequences of learning. In addition, Zimmerman (2002) stated, ''Intrinsic interest refers to the students' valuing of the task skill for its own merits, and learning goal orientation refers to valuing the process of learning for its own merits'' (p. 68).

Under the *performance phase*, *self-control* illustrates application of certain methods or strategies selected from the forethought phase, and examples of self-control strategies are imagery, self-instruction, attention focusing, and task strategies. *Self-observation* refers to ''self-recording personal events or

self-experimentation to find out the cause of these events'' (Zimmerman, 2002, p. 68). Self-recording and self-experimentation are typical strategies of self-observation.

Under the *self-reflection phase*, there are self-judgment and self-reaction as subprocesses. Self-evaluation and causal attribution are forms of *self-judgment*, and self-satisfaction/affect and adaptive/defensive reactions are forms of *self-reactions*. (Interested readers can refer to Zimmerman, 2000, 2002 for detailed information.)

Compared with Zimmerman's framework, Schunk's early framework (1990) lacked the notion of phases. Schunk's three subprocesses of self-regulation (self-observation, self-judgment, and self-reaction) belong under Zimmerman's performance and self-reflection phases, which means Schunk did not conceive of SRL as involving these processes before an effort to learn. Schunk did mention goal setting and self-efficacy as parts of the social cognitive process, which might be considered to fall under Zimmerman's Forethought phase. However, he considered them as separate processes outside of the self-regulation process. Yet, some common constructs are used in the two frameworks, such as self-observation, self-judgment, and self-reaction.

Framework of Pintrich

Pintrich (2000, 2004) developed his conceptual framework of SRL to cover common ground identified by other conceptual frameworks in the past. Pintrich's idea of an SRL framework seems to be more comprehensive, including ideas from Schunk and Zimmerman. It is notable that Pintrich attempted to explain SRL processes by organizing them based on phases and areas of regulation.

Phases of SRL is noted as

> a general time-ordered sequence that individuals would go through as they perform a task, but there is no strong assumption that the phases are hierarchically or linearly structured such that the earlier phases must always occur prior to the later phases (Pintrich, 2004, p. 389)

and they include (a) forethought, planning, and activation, (b) monitoring, (c) control, and (d) reaction and reflection. In addition, areas of SRL refer to where learners attempt to monitor, control, and regulate. They include (a) cognition, (b) motivation/affect, (c) behavior, and (d) context.

While Pintrich (2004) attempted to describe SRL processes by identifying phases and areas of regulation, there are some additional activities described in this framework. For example, the notion of metacognition is introduced. Flavell (1976) first noted that metacognition is ''one's knowledge concerning one's own cognitive processes and products or anything related to them'' (p. 232).

Researchers of SRL also refer to metacognition as the awareness of, or knowledge about, one's own thinking (Winne & Perry, 2000; Zimmerman, 2002). Under the cognition area, Pintrich (1999, 2004) included metacognitive knowledge activation as well as metacognitive awareness and monitoring of cognition.

Moreover, the behavioral aspect of regulation in the forethought phase also differentiates Pintrich's framework from others. That is, when explaining behaviors as one of the four areas of regulation, he identified regulating behaviors in the forethought phase of SRL, such as time and effort planning and planning for self-observation of behavior. Although Zimmerman (2000, 2002) presented strategic planning under the forethought phase, it has a narrower focus as it is concerned with only cognitive aspects, such as planning or selecting cognitive strategies. However, Pintrich expanded the SRL behavior to include planning for resource management as well as planning for cognitive strategy use.

Pintrich (2000, 2004) also introduced the notion of social context as one of the four areas for SRL unlike other past conceptual frameworks which implicitly or explicitly covered only three areas: cognition, motivation, and behavior aspects of regulation. Although Pintrich described four phases, it seems that his control and monitoring phases can be considered similar to Zimmerman's performance phase, which consists of self-control and self-observation.

A Modified Conceptual Framework

Although the past conceptual frameworks of SRL have explained SRL by its major components and processes, they have some limitations in explaining the nature of the process in SRL. First, initial perceived self-efficacy and goal setting are known to continuously change through the various phases. Yet, the three frameworks failed to demonstrate continuous change in self-efficacy and goal setting by locating each of them in one phase only. Second, the overarching role of self-motivational beliefs and self-efficacy is also undermined in the frameworks by being depicted in the forethought phase only. Third, metacognition and action together are identified as one of the three major elements of SRL with self-efficacy and motivational beliefs. Thus, the Continuous-Change Framework is developed to address the limitations noted in the previous frameworks. Figure 2 illustrates this framework.

The figure is aligned with Zimmerman's (2000, 2002) idea of three phases in SRL: the forethought, performance, and self-reflection phases. Although Pintrich (1999, 2004) suggested four phases of SRL (having the monitoring phase and the control phase separate), it is hard to separate the two because they often occur simultaneously. Thus, this new framework follows three phases, but uses planning (before effort), performing (during effort), and reflecting (after effort) instead of forethought, performance, and self-reflection.

In general, the Continuous-Change Framework suggests an overarching role for self-efficacy and motivational beliefs, since self-efficacy and motivational

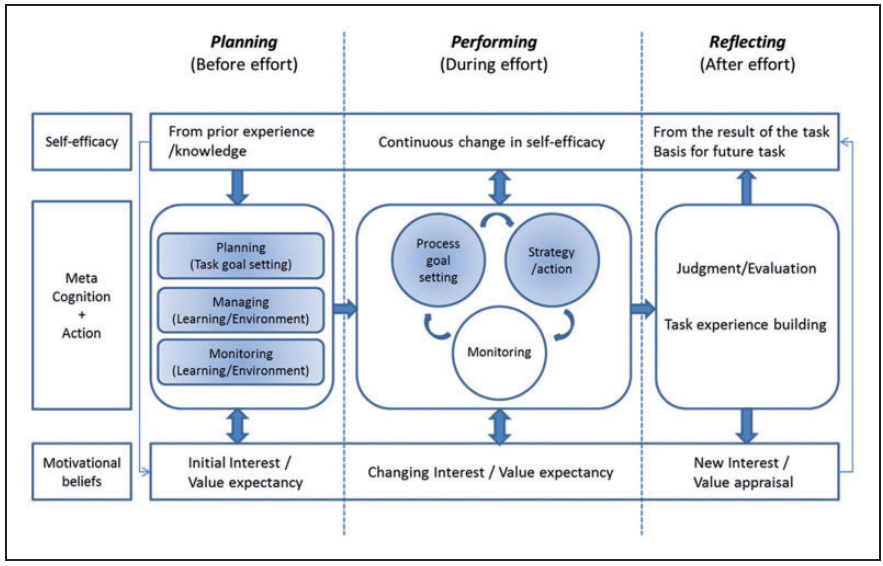

Figure 2. The continuous-change framework for self-regulated learning.

beliefs exist throughout the whole SRL process and influence other subprocess by continuously changing. Other than self-efficacy and motivational beliefs, under the *planning phase*, learners set a task goal with respect to strategies and resources. The task strategy includes cognitive strategies and motivational strategies, and resources needed are identified in accordance with the strategies. Under the *performing phase*, there is at least one iteration of the performing cycle (process goal setting—strategy/action—monitoring). Based on the process goals and resources identified, learners choose the resources upon their availability and select strategies, both cognitive and motivational. They monitor their performance on the project, and the result influences the following performance cycle. Under the *reflecting phase*, learners judge and evaluate their performance on the task, given the task goal they set in the planning phase. Then, their judgment or evaluation constitutes a task experience, which affects and guides related actions in the future.

The Continuous-Change Framework also includes specific modifications made from the past frameworks. Past frameworks such as Schunk's and Zimmerman's have presented a cyclical nature of the SRL process, but in terms of describing subprocesses, they were short of illustrating their continuous and iterative nature. The new Continuous-Change Framework attempts to address this omission. For example, perceived self-efficacy under the planning phase can be mainly determined by learners' prior knowledge of the task or prior experience on the task or any related tasks. Self-efficacy in the planning phase

continues to be present in, and influenced by, the performing and reflecting phases. Because of the self-monitoring and control process in the performing phase, learners' perceived self-efficacy can change after they examine how they are doing based on their goals. No matter how many processes learners need to undergo before completing the task during the performing phase, learners' self-efficacy will continuously change as they monitor their performance for each process. Subsequently, the self-efficacy during the performing phase also influences one in the reflecting phase. From the self-judgment process in the reflecting phase, the self-efficacy of a learner can either increase or decrease and it becomes the basis of another related planning phase in related future tasks.

In addition, description of the goal setting process is emphasized in the Continuous-Change Framework. The goal setting process is one of the most critical elements in SRL. Researchers such as Schunk (1990) and Boekaerts (1996) claimed that goal-directedness is essential in SRL. Goals can be characterized as two types: task goals and process goals. Task goals are placed in the planning phase, and refer to the goals for the overall task, whereas process goals refer to specific and stepwise goals as learners go through the performing phase. Given the process goals and monitoring in the performing phase, learners can continuously set multiple process goals, come up with new strategies, and change their behaviors for the attainment of their goals. That is, even within the performing phase, multiple iterations of goal setting, monitoring, and change of strategies or actions can occur. Zimmerman (2000) once mentioned a similar idea in goal setting, that there are process goals and outcome goals. Although the concept is very similar, the iteration in the performing phase is not well represented in his conceptual framework of SRL. His framework represents a cyclical relationship of three phases: forethought, performance, and self-reflection. However, it lacks explanation or visualization of the iterative nature of goals-monitoring-action that exists within the phase. This iterative nature within the performing phase is, thus, illustrated in the Continuous-Change Framework.

In addition, the overarching function of self-motivational beliefs is represented in the Continuous-Change Framework, as self-efficacy is emphasized. Because motivational beliefs are highly related to one's perceived self-efficacy, outcome expectation, self-satisfaction, and goal orientation, they influence and are influenced throughout the entire SRL process. Motivational beliefs in the planning phase can be explained by learners' initial interest in the task, their expected value of the task when they are successful, and their affective state at the time of the task. Learners' initial level of self-efficacy about the task can also influence motivation. Throughout the performing phase, learners' interest in the task and their value judgment can also be changed based on the results of each process. After the reflecting phase, learners develop new interest in the task-related topic as well as a value appraisal for the future task related to the topic they have just completed.

Finally, metacognition and action are combined to make one of the three major elements of SRL with self-efficacy and motivational beliefs, which also change throughout the whole SRL process. As Zimmerman (2002) once identified in his framework's performing phase, monitoring and control come hand in hand, often happening simultaneously. Within metacognition and action, there are three subprocesses: planning, monitoring, and managing. This concept of subprocesses is derived from Flavell (1976, 1979) in that he saw metacognition through actions of, and interactions among, four classes of phenomena (i.e., metacognitive knowledge, metacognitive experience, goals, and actions). Planning involves goal setting utilizing metacognitive knowledge and experience; monitoring as well as managing happen in both one's own learning and learning environments.

If taken into consideration for each phase, in the planning (Before effort) phase, learners set task goals based on their metacognitive knowledge of the task. They also monitor their learning and environment, which means they recall prior knowledge and experience and identify environmental conditions around them such as learning materials, people help, and conditions of the place where learning takes place. Then, learners can manage their learning and environment, such as revising task goals or moving to a quieter study area. In the performing phase (during effort), learners set multiple process goals, decide upon the strategy to complete the task successfully, and monitor their strategies (learning) and materials, study areas, or people from whom they can get help (environment). Based on the result of monitoring, they can keep managing to change the strategy or the environmental conditions until they complete the task. Finally, in the reflecting phase (After effort), learners evaluate the results of their monitoring and managing of their learning and environment and develop a new goal or an objective if they want to pursue a related task in the future.

One thing to be noticed in the Continuous-Change Framework is that there are some shaded areas in the processes of the framework, such as task goal setting in the planning phase and strategy/action in the performing phase. The shaded areas stand for the process or subprocesses that are normally influenced or decided by external conditions in traditional classroom contexts. For example, the task goal can be set by teachers and given to students or decisions about resources such as materials and time can already be made by teachers and thereby limit students' choices. This notion of external conditions needs to be considered to further explain SRL.

Discussion

When we carefully examine what typical classrooms look like, we find a critical gap in understanding SRL with the prior frameworks and in conducting research on SRL based on the frameworks.

There are various degrees to which SRL can be implemented. In typical classroom instruction, students listen to teachers' lectures, and those lectures

are conveyed with the teachers' control (Zimmerman, 2002). Moreover, the resources are also selected by the teachers and are restricted in terms of variety or availability in the classroom. That is, in a typical classroom context, students have little opportunity to regulate the learning activities. This explains partial SRL where some degree of self-regulation is allowed but much of the learning is controlled by the teacher and other external conditions. The Continuous Change conceptual framework of SRL presented in this study takes into account those external conditions over which learners do not have control, such as teacher-set goals or strategies and limited classroom resources, in any given context.

Then, is full SRL, where learners have complete self-regulation, ever possible in an educational context? A growing movement of online learning combined with traditional classrooms (i.e., hybrid learning) has been identified in K-12 settings (Cavanaugh, Barbour, & Clark, 2009; Zimmerman, 2002). However, although some controls of learning activity have moved over to students in online learning environments (e.g., learning pace, Web resource use), there still remain limitations in order to achieve a full degree of SRL in processes such as goal setting, self-evaluation, and choice of curriculum. To answer the question of whether full SRL is possible in an educational context, a closer look at the paradigm of education is necessary.

Above all, it seems that full SRL is incompatible with the industrial-age paradigm of education. This paradigm is dominant in most current educational systems and focuses on "sorting" students instead of maximizing students' learning (Reigeluth et al., 2008). It also provides teacher-centered instruction, time-based student progress, and norm-based assessment. For example, student progress is based on preset time such as a semester or a week-long lesson on a basic algebra topic. That means students have to advance to the next topic or grade level even though they may not have attained mastery of what was studied and thereby accumulate learning deficits that condemn them to flunk out later. In sum, the industrial-age paradigm seeks to sort out students who score low in the assessments, which made sense in the Industrial Age when manual labor was the predominant form of work. However, now that many of those jobs have been shipped overseas and knowledge work has become predominant, we need an educational system that is focused on maximizing learning for all students—that is no longer designed to leave large numbers of children behind. It is, therefore, clear that full SRL is not possible in the industrial-age paradigm of education.

However, there is a potential that full SRL can be achieved in the information-age paradigm of education. Full SRL can be understood with this Continuous Change conceptual framework as taking place in a context whose external factors do not limit learners' self-regulation: attainment-based rather than time-based student progress, criterion-referenced rather than norm-referenced student assessment, customized rather than standardized learning experiences, and learner-centered rather than teacher-centered instruction, so the

center of the paradigm is learners themselves not teachers, parents, administrators, or anyone else.

Reigeluth, Watson, and Watson (2012) introduced a new conceptual framework for an educational technology system that is aligned with the information-age paradigm—called the Personalized Integrated Educational System (PIES), which is a new generation of learning management system (Reigeluth et al., 2008). The major functions of PIES are *record keeping* for student learning (an inventory of each student's attainments), *planning* for student learning (personal learning plans), *instruction* for student learning, and *evaluation* for (and of) student learning. Numerous subfunctions were identified for each of these functions to best support self-regulated learning to maximize every student's learning.

For example, students in PIES are required to set their own learning goals and plan their own learning activities (e.g., what they want to study, what to study first, how to study, and their short-term and long-term goals). Teachers and parents are involved in students' planning phase, but they play roles of mentors and guides, not decision makers. Students' own wills and interests drive their decisions on planning in PIES. The sense of locus of control is expected to help students continuously stay motivated and interested in their learning activities. Thus, the areas that the prior SRL frameworks could not fully cover can be achieved in the Continuous Change framework under this information-age paradigm of education.

In PIES' instruction function, students are involved in two types of learning "spaces"; one is a project space and the other an instructional space that is seamlessly integrated with the project space. Students are expected to be involved in several different projects at a time based on the plans they set in the planning process. In the project space, students are required to work on a team with peers to solve a problem or do a project. However, while they are in the project space, whenever they find that they need more knowledge on a certain topic or area, they can freeze time in the project space and each can receive instruction from a personal mentor in the form of a virtual pedagogical agent. Basically, the instructional space is an individualized learning space where students can acquire pertinent knowledge by themselves to successfully complete the project. The project and the instruction are both designed for "learning by doing" based on performance criteria, and each student's learning is assessed based on attainment of those criteria. Therefore, numerous occasions for project-goal and process-goal setting can happen in PIES within the duration of each project.

In addition, the assessment function of PIES is fully integrated into the instruction, such that reaching criterion on the practice constitutes the mastery assessment. Students are not evaluated by norm-referenced tests, but by attainment of each criterion. That means they have much more opportunities for mastery experiences, which is the major element for building self-efficacy

(Bandura, 1977a, 1997; Goddard, Hoy, & Hoy, 2004). Their successful performance on projects and on criteria for individual competencies is expected to increase self-efficacy as well as motivation for subsequent projects and instruction. Furthermore, both self and peer assessments occur often while students are in the project space. Finally, each student's mastery on performance criteria is recorded and stored, which confirms to students what their strengths and weakness are and informs how they should plan for their next round of projects. All four major functions of PIES are closely interrelated, and they support learner control and continuous improvements in self-efficacy and motivation, which is noted in the Continuous-Change Framework.

The core of PIES is that the focus lies in learners, and learners have control over their decisions for most of their learning activities. The learner is the center of learning, and teachers play a role of guidance only when necessary. This information-age paradigm of education makes full SRL possible. There are a few schools that have already initiated this paradigm change, including the Chugach School District in Alaska, the Minnesota New Country School, and Montessori Schools (Reigeluth & Karnopp, 2013). These schools demonstrate SRL close to its complete form.

As we discussed in the previous section, the prior conceptual frameworks of SRL fell short of conveying the idea of the overarching roles of self-efficacy and motivational beliefs and the continuous change within the major elements of SRL such as self-efficacy, motivational beliefs, and metacognition and action. The lack of the notion of continuous change and the interactive nature of each element has negatively impacted the past research on SRL. Because they had not put much emphasis on continuous changes in the major elements of SRL throughout the whole SRL process, past research endeavors have focused on limited aspects of SRL and often they have investigated just one point in time, for example, at the end of a course. Examples of the limited aspects of SRL in past research are mainly goal setting (Ablard & Lipschultz, 1998; Boekaerts & Niemivirta, 2000; Pintrich, 2000; Schunk, 1990; Wolters, Yu, & Pintrich, 1996), motivation (Boekaerts, 1996; Garcia, 1995; Pintrich, 1999, 2004; Pintrich & De Groot, 1990; Pintrich et al., 1994; Rheinberg, Vollmeyer, & Rollett, 2000; Valle et al., 2007; Vollmeyer & Rheinberg, 2006; Wolters & Pintrich, 1998; Wolters et al., 1996), and SRL strategy use (Chang, 2005; Chen, 2002; Gravill & Compeau, 2008; Lindner & Harris, 1993; Purdie, Hattie, & Douglas, 1996; Young, 1996; Zimmerman & Martinez-Pons, 1986, 1990). However, in order to better recognize the continuous changes as well as overarching roles of the elements in the SRL process, a holistic assessment of each element should be conducted multiple times during the SRL process, for example, at least once in each of the three phases of SRL (i.e., planning, performing, and reflecting). The Continuous Change conceptual framework informs us of the relationships among each major element and the need for multiple assessments throughout the whole process of SRL.

Implications

Along with the concept of the PIES where a personalized integrated technology system can accommodate and facilitate full degree of students' SRL, another emphasis needs to be placed on pedagogical perspective of how to teach students to be more self-regulated, which can create a synergy with the technology system.

There have been abundance of SRL empirical research studies that attempted to apply self-regulatory strategies to the learners and see if they showed any differences in terms of their level of SRL or learning outcomes (Chang, 2005; Gravill & Compeau, 2008; Narciss et al., 2007). However, among the research studies trying to apply or teach SRL strategies to learners, it is rare to identify how they implemented the instruction to teach SRL. For example, they typically just indicated that they made students set goals before the learners started the course or they had a workshop on SRL strategies before the course started without specifically describing how they designed the instruction for teaching the strategies or how they implemented it. Zimmerman (2002) identified early on that SRL strategies are teachable, and what is important and more meaningful to the instructional design field is how to teach those strategies effectively, efficiently, and appealingly (M. D. Merrill, 2007). Also, because one of the main purposes of instructional design is to improve learning outcomes, it would be beneficial for the instructional technology field to examine how instructional design can facilitate students' SRL.

Pedagogical perspectives on how to better teach students to be more self-regulated can be viewed from two levels: the micro and macro levels. The micro level entails designing instruction on each process in each SRL phase of the framework using the standard three-part skill-development model (M. D. Merrill, 2006): generality, demonstration, and practice with feedback. For example, for goal setting (one of the major processes in the planning phase of SRL), you should give students a *general description* of what goal setting is and how to do it. You should show them *examples* of doing the goal-setting process. And you should have them *practice* the goal setting process on their own and give them immediate feedback on their performance. Often, the generality and demonstration are done simultaneously, and the practice typically comes last. Instruction of this kind can be applied to each of the processes of SRL in the conceptual framework, such as using cognitive strategies, self-monitoring, and judgment. M. D. Merrill (2006, 2007) has offered an elaboration on his three-part model: presentation, demonstration, recall, and application. This typically entails adding a recall step between demonstration and practice in cases where it is hard for a student to remember the parts of the skill.

On the macro level, the instruction can be designed for each process separately in a part-task approach to reducing learners' cognitive load. This typically entails sequencing the part tasks in the order they are performed—a procedural sequence (P. F. Merrill, 1980). For example, the goal-setting process can consist

of several part-tasks such as identifying standards, recalling prior knowledge or experience, and so on, and the three-part instruction can be designed for each part-task within the process. Alternatively, the instruction can be designed for an entire phase or even the entire SRL process at once in a whole-task approach. In the part-task approach, students move to the next part of the process after they master one part. In the whole-task approach, it would be wise to use the Elaboration Theory's Simplifying Conditions Method (Reigeluth, 1999) to avoid cognitive overload. This entails first teaching the simplest real-world version of the performance of SRL, before teaching progressively more complex versions. Even artificial simplifying conditions can be created to make sure the first version is simple enough to avoid cognitive overload for teaching a complete SRL process. For instance, in the planning phase, a task goal can be given to the students so that they can move to the next process with minimal learning and soon get experience in the whole SRL process quickly and easily. Once they get experience from a case that meets the simplifying conditions, they can move on to more complex versions of SRL.

van Merriënboer's design model, the 4C/ID-Model for complex learning, can be also utilized in designing instruction to promote learners' SRL (van Merriënboer, Clark, & de Croock, 2002; van Merriënboer, Kirschner, & Kester, 2003). He emphasizes well-designed learning environments for complex learning with four components: learning tasks, supportive information, procedural information, and part-task practice. This model is aligned with the Simplifying Conditions Method in that it recommends simple-to-complex versions of the whole task, starting from simple tasks with a high level of embedded support to complex tasks with a lower level of support. Also, if there are recurrent aspects of performance, such as iterative goal setting and strategy selection in the performing phase, additional part-task practice can be applied and examined in the context of whole learning tasks (van Merriënboer et al., 2002; van Merriënboer et al., 2003). Moreover, the Simplifying Conditions Method and van Merriënboer's simple-to-complex versions of the whole task both promote students' mastery experience, which leads to an increase in students' self-efficacy and motivational belief in their SRL. The potential advantage of this simple-to-complex approach can be witnessed in the context where learning processes or environments are relatively simpler than general K-12 settings, such as a Montessori school. It is inspiring to observe the extent to which 3- and 4-year-olds in a Montessori school engage in a level of self-regulated learning that is totally foreign to a typical high school classroom. The Continuous-Change Framework offers guidance that can help instructional designers and teachers to teach students to be more self-regulated.

In addition to the implication for instructional design noted earlier, another implication can be drawn for SRL research based on the Continuous-Change Framework. Although there has been conceptual frameworks of SRL in the past such as Zimmerman's and Pintrich's that had guided numerous empirical

research studies on SRL, little research has been conducted to reflect entirety or heuristics of the entire SRL process. That means, a plethora of studies have examined the relationships of different elements of SRL in a given time as a snapshot picture of the entire process, but failed to capture the systemic nature of SRL process albeit researchers claimed SRL was a complex and cyclical process (M. Boekaerts, P. R. Pintrich, & M. Zeidner, 2000; Pintrich, 2004; Schunk, 2001; Zimmerman, 1986, 2001). The proposed Continuous-Change Framework can not only emphasize the continuous and systemic nature of SRL process in a visual framework but also provide implications for future research to examine the holistic nature of SRL.

Based on the Continuous-Change Framework, self-efficacy and motivational belief are considered to be continuously changing and interacting with other subprocesses. However, research studies on SRL have not captured these continuously changing characteristics of self-efficacy and motivational belief because they were assessed either once or at most twice, once before the instruction or course and once after it ended. To capture dynamic interactions among self-efficacy and motivational belief and other subprocesses, the assessment of SRL components should be implemented at several milestones throughout the instruction or course. In addition to the survey questionnaire, which is the most popular method of SRL data collection, other qualitative methods such as interviews and observations can also be effective in examining the relationships among SRL components and examining how each of them affects the others. In sum, in order to capture the characteristics of SRL more accurately, we recommend *continuous assessment* of SRL components using both surveys and other qualitative methods.

Limitations and Recommendations for Future Research

This article reviewed a limited amount of literature, which might bring bias to the study or limit interpretation of the SRL area. That is, the literature reviewed mainly focuses on the social cognitive aspect of SRL and mainly on its use in education, even though there are few different lines of study dealing with self-regulation in areas such as developmental psychology and medicine.

In this article, past conceptual frameworks of SRL are identified and discussed. The conceptual frameworks identified share some commonalities and differences with each other. However, a few points are found to be missing or underrepresented, such as the overarching influence of motivational beliefs and self-efficacy as well as the iterative nature of SRL subprocesses in the performing phase. Thus, a modified conceptual framework for SRL was offered to capture the relationships among the major elements of SRL in a simpler but clearer manner. In addition, the need for fundamental paradigm change from the industrial age to the information age was suggested, and the conceptual framework called PIES was introduced and examined as a new learning environment where

full SRL can be realized. Finally, given the current deficiency on pedagogical perspective of teaching SRL to learners, instructional design principles and theories were revisited in order to address how to design instruction to better promote learners' SRL.

For future research, we recommend creating a pedagogical guideline that integrates sound instructional principles with the Continuous-Change SRL Framework and applies it in various real-world learning contexts, especially those that involve the information-age paradigm of education. A strategy examined in the Implications section can be a good example of using instructional principles to design instruction for teaching SRL to students. Given the nature of designing instruction to better promote learners' SRL in real-world contexts and capture continuous changes in SRL elements, research studies using design-based research (Wang & Hannafin, 2005) and formative research (Reigeluth & Frick, 1999) are recommended in collaboration with instructors. For future research, design guidelines or a design theory for SRL developed based on the Continuous Change Framework could be tested in real-world learning contexts using the design-based research or formative research methodology. In addition, a conceptual framework for technology system called PIES could be one of the contexts where full SRL could be realized based on the information-age paradigm of education.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

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