Design and evaluation of a learning environment for self-regulation strategies: an intervention study in Higher Education

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Abstract

The literature shows convincingly that metacognitive knowledge and a large variety of cognitive as well as affective and motivational self-regulation skills have a substantial effect on students' learning processes and outcomes (Masui 2002), and, thus, constitute important components of competence in a content domain. Taking this into account we designed a learning environment aiming at improving university freshmen's competence and learning proficiency by acquiring integratively eight self-regulation skills. As a whole the learning environment embodies major components of the CLIA-model (*C*ompetence, *L*earning, *I*ntervention, *A*ssessment), a framework for the design of powerful learning environments (De Corte, Verschaffel, & Masui, 2004). The intervention in this environment focused on teaching to an experimental group (E) of 47 first-year students in business economics four cognitive (orienting, planning, self-testing, reflecting), and four complementary affective (respectively self-judging, valuing, coping, attributing) skills. The study also involved two control groups of 47 students.

In the CLIA-model productive learning is considered as an active/constructive, cumulative, self-regulated, goal-directed, situated, collaborative, and individually different process of meaning construction and knowledge building (De Corte 2007). Taking this view of learning as a starting point, the design of the intervention was based on an integrated set of seven interconnected instructional principles: 1. embed the acquisition of knowledge and skills in the study context of the students; 2. take into account students' learning orientation and their need to experience the usefulness of the learning tasks; 3. sequence teaching methods and learning tasks and relate them to a time perspective; 4. use a variety of forms of organisation and social interaction; 5. take into account prior knowledge and large differences between students; 6. stimulate articulation of and reflection on learning and thinking processes; 7. create opportunities to practice and transfer learned activities to new content domains.

The effects of the learning environment were investigated in a pre-test – post-test quasi experimental design with control groups, thereby using a variety of assessment instruments (tests and questionnaires) and study results (exam scores, pass rates and students' study career). The major positive effects of the intervention on the learning proficiency and academic performance of the students in the experimental group are reported and illustrated mainly for two of the eight self-regulation skills, namely orienting (preparing one's learning process by examining the characteristics of a learning task) and self-judging (evaluating one's competencies in view of an accurate appraisal of the efforts needed to accomplish a learning task).

Keywords: learning environment; self-regulation strategies; intervention research; higher education

1. Introduction

Higher education is facing a number of major problems world-wide. Firstly, universities must adjust to larger and more heterogeneous populations than in the past. Secondly, in tertiary education in many European countries the output of students completing a degree is

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insufficient. Last but not least, there is an urgent need for graduates who are prepared for lifelong learning. In response to these challenges we carried out a research project aiming at the design, implementation, and evaluation of a powerful learning environment for fostering learning competence in beginning university students (for more detailed information see Masui 2002; Masui and De Corte 1999; Masui and De Corte 2005). In designing the study we took into account the growing knowledge base about self-regulated learning (see e.g., Boekaerts, Pintrich, and Zeidner 2000).

This intervention study embodies major components of the CLIA-model, a framework for designing powerful learning environments that has resulted from our theoretical and empirical work over the past years relating to the creation of instructional settings that facilitate in students the acquisition of productive knowledge and learning and thinking skills (De Corte, Verschaffel, and Masui 2004). The next section gives a brief overview of the CLIA-model (see De Corte, Verschaffel & Masui, 2004 for a more detailed discussion) as background for the review of the intervention study in the section 3.

1. CLIA: A framework for designing powerful learning environments

The CLIA-model is structured according to four interconnected components:

1. ***C****ompetence*: components of competence in a domain.
2. ***L****earning*: characteristics of effective learning processes.
3. ***I****ntervention*: principles guiding the design of learning environments.
4. ***A****ssessment*: instrument for monitoring learning and teaching.

2.1. Competence

Acquiring competence in a domain requires the acquisition of five categories of components (De Corte & Verschaffel, 2006): (1) a well-organized, flexibly accessible domain-specific knowledge base; (2) heuristic methods; (3) metaknowledge about one's cognitive functioning and one's motivation and emotions: (4) self-regulatory skills relating to cognitive as well as affective and motivational processes; (5) positive beliefs about the self as learner in a domain, and about the content domain.

2.2 Learning

Although important issues remain for continued inquiry (De Corte, 2007), the following characteristics of productive learning are well documented by research: it is an active/constructive, cumulative, self-regulated, goal-directed, situated, collaborative, and individually different process of meaning construction and knowledge building (De Corte, 2007; National Research Council, 2005). These features of effective learning should guide the design of learning environments.

2.3. Intervention

Taking the literature into account the following guiding principles for designing (powerful) learning environments can be derived from our conception of competence (first CLIA-component), and the characteristics of constructive learning (second CLIA-component).

1. Learning environments should support constructive acquisition processes in all students.
2. Learning environments should foster the development of self-regulation in students.
3. Learning environments should embed constructive acquisition activities in real- life situations that have meaning for the learners, and offer ample opportunities for collaboration.
4. Learning environments should create opportunities to acquire general skills embedded in the subject-matter fields.
5. Learning environments should create a classroom culture that induces in students explication of and reflection on their learning and cognitive activities.
6. Learning environments should allow for flexible adaptation of instructional support to individual differences among learners.

2.*4. Assessment*

Assessment should be aligned with the preceding components of the CLIA-framework. Therefore, classroom assessments should satisfy the following criteria.

1. Assessment should monitor students' progress toward the acquisition of all components of competence.
2. Assessment should provide diagnostic feedback about students' deep understanding of content and their mastery and productive use of learning and thinking skills.
3. Assessment should contain assignments that offer opportunities for self-regulated and collaborative - besides individual - approaches to tasks.
4. Assessment should help students develop skills in individual and group self-assessment.

3. A learning environment for self-regulation strategies in university freshmen

Using the CLIA-model as a framework and, thus, starting from a constructivist perspective on learning, several aspects of competence, namely metacognitive, affective, and motivational skills and related metaknowledge, were integrated into the real instructional context of an experimental group (E) of 47 first-year students in business economics. The intervention focused on the acquisition of eight regulatory skills that were taught in a series of ten sessions of 90 minutes each, supplemented by numerous homework assignments aimed at practising and transferring knowledge and skills. The intervention mainly took place in two subject-matter domains of the curriculum, namely macro-economics and management accounting.

The study involved two control groups of 47 students each: in the first control group (C1) a treatment was applied that focused on cognitive activities such as ‘analyzing’ and ‘rehearsing’; the second control group (C2) was a non-treatment group. All students in the three groups were selected from the total group of freshmen (N = 352) taking into account several entrance characteristics (prior academic knowledge, intelligence, cognitive study skills, attribution behaviour, self-judgments about executive regulation activities, and gender). The design was a quasi-experimental design. E and C1 were independent, but equivalent groups in terms of average level of intelligence, and prior knowledge; E and C2 were matched groups. E and C1 each were obtained by combining two existing practice groups, whereas C2 was composed by matching each experimental student to a student from one of the non-participating groups who had the same profile.

3.1. Competence

The available literature shows convincingly that metacognitive knowledge and a large variety of cognitive as well as motivational self-regulation skills have an effect on learning processes and outcomes (Masui, 2002). Because research also reveals intimate relationships between those skills, we opted for a multidimensional approach, i.e. a substantial number of regulatory activities were addressed integratively in the learning environment. Taking the research findings as well as the study context of the students into account, we first selected four cognitive self-regulation skills, namely ‘orienting’, ‘planning’, ‘self-checking’ and ‘reflecting’. They represent different aspects of metacognitive behaviour, which are undoubtedly significant for university freshmen. ‘Orienting’ means preparing one’s learning process by examining the characteristics of a learning task. ‘Planning’ is taking a series of decisions on how to approach the learning process. ‘Self-checking’ means testing whether intermediate outcomes match the requirements of the intended learning goals. ‘Reflecting’ involves looking backwards to the learning process in view of drawing conclusions about factors that influenced it.

Subsequently we chose four matching affective and motivational skills. Since ‘orienting’ also implies estimating the difficulty of a task and the time needed to finish it, we firstly chose ‘self-judging’ which refers to the willingness to evaluate one’s own strengths and weaknesses in relation to a learning task. Next we assumed that ‘planning’ offers a good opportunity to learn to make choices or to ‘value’. When making a plan a student decides about a learning goal; this involves assigning some value to this goal and to the efforts to attain it. Thirdly, we included ‘coping with emotions’ (e.g., frustration because of a failure) as the affective counterpart of ‘self-checking’. When taking an exam the outcome can be satisfying or disappointing. In both situations the student has to cope with these emotions. Finally ‘reflecting’ seemed to provide good opportunities for learning to ‘attribute’ in a constructive way; for example, attributing a failure to factors that are perceived as controllable by the student (e.g., lack of effort) rather than to uncontrollable aspects (e.g., the difficulty of an exam). There is evidence regarding the effect of all these skills on study results in higher education, but an integrated approach using these types of skills is mostly lacking in previous training studies.

3.2. Learning and Intervention

The characteristics of the learning component of the CLIA-framework mentioned above were the starting point for developing a learning environment to elicit and stimulate these learning qualities. Besides, learner variables (esp. prior knowledge) and instruction-related aspects (goals, domain content, support) were considered. Taking into account all these variables, the design of the experimental intervention was based on an integrated set of seven interconnected and partly overlapping instructional principles.

1. Embed the acquisition of knowledge and skills in the real study context, i.e. the selected activities have to be taught in the context in which students must apply them (situated learning).
2. Take into account students' learning orientation and their need to experience the usefulness of the learning and study tasks (personal usefulness).It was explicitly explained to the students how each part of the intervention could be linked to their learning orientation and their personal goals (especially being successful in their first year).
3. Sequence teaching methods and learning tasks and relate them to a time perspective (sequencing and time perspective). This principle fits well with the cumulative, goal-oriented and self-regulated character of productive learning. The intervention was spread over a period of six months using a variety of teaching methods such as modelling, coaching, scaffolding, articulating or verbalising and reflecting. To sequence the learning tasks their complexity and diversity was progressively increased over time.
4. Use a variety of forms of organisation and social interaction (variation in organisation and social settings). By alternating modelling, individual assignments, working in pairs, small-group work, and whole-class discussion a stimulating social environment was created in line with the constructive and collaborative nature of learning.
5. Take into account prior knowledge and large differences between students (adjusting to prior knowledge and differentiating). This principleserves especially the cumulative and the active character of effective learning. By using a variety of teaching methods (third principle) and social settings(fourth principle) it was possible to meet students' informal prior knowledgeand individual differences.
6. Stimulate articulation of and reflection on learning and thinking processes (verbalising and reflecting). Articulating or verbalising problem-solving strategies is necessary as a starting point for reflection; indeed, verbalising is an appropriate method to become aware of metacognitive, affective and motivational aspects of learning. Techniques used for verbalising were thinking aloud, writing while thinking, and oral or written retrospection. Reflecting was one of the four metacognitive regulatory skills on which the intervention focused because it is essential to achieve conscious regulation of learning, thinking and problem solving.

7. Create opportunities to practice and to transfer learned activities to new contentdomains (practice and transfer). Whereas the intervention focused on the courses macro-economics and management accounting (see above), transfer exercises were assigned in different other disciplines of the curriculum, especially history and sociology.

The intervention sessions in the E-group took place in groups of 15 students. A session started with an overview of the intended goals, the planned activities, and the kind of contribution expected from the students. Next, the students made two or more exercises in macro-economics or management accounting individually or in pairs. After each assignment they were invited to draw some conclusions, both with regard to the specific content and with regard to the problem-solving process. At the end of the session students received all necessary information about the homework they had to make individually or in collaboration with a fellow student. All E and C1 sessions were audio taped.

In C1 the focus of the treatment was on cognitive activities. This implied practising such activities as ‘relating’, ‘analyzing’, ‘structuring‘, ‘concretizing’, ‘applying’ and ‘rehearsing’ during the intervention sessions (for macro-economics and management accounting), as well as in homework assignments. C2 was exposed to the usual instructional support and study guidance consisting of lectures, practicals, consulting hours, and individual feedback on assignments and examinations.

3.3. Assessment

A variety of *summative assessment* instruments were used spread over three posttest sessions to assess the effects of the intervention on self-regulation behaviour. In the first posttest session assignments for management accounting and multiple-choice questions for macro-economics were administered; besides solving the questions, students were also asked to write while thinking, a variant of the thinking aloud technique. During the second posttest session an attribution questionnaire was used, and metaknowledge of the regulatory skills on which the intervention focused was assessed with a direct knowledge test. For instance, with regard to ‘orienting’ students were asked: “*What do you have to know at the start of a trimester in order to be able to organize and plan your study for a particular course? Also mention how you can obtain that information”;* and with regard to self-judging: *“Which personal characteristics of a student can be advantageous or disadvantageous when studying or making exams? Explain their effect”*.

In the last posttest students had to fill in again questionnaires on self-efficacy, on self-regulation skills, and on attribution style that were already administered as pretests. At this stage transfer of regulation activities to a course in statistics that was not involved in the intervention was also measured. Therefore, a questionnaire containing eleven questions about study activities in the statistics course was administered. For example, with respect to orienting students were asked: "*How much time do you think you will have to invest in the theoretical and practical parts of the statistics course, including the lessons?*; and with regard to self-judging: *"Do you think that the statistics course will be easy or difficult for you? Explain your answer"*. The overall exam result at the end of the academic year was used as indicator of academic performance.

Multiple opportunities for *formative assessment* resulting in diagnostic feedback and coaching were also integrated during the interventions. This was realised especially through discussion about and reflection on articulated problem approaches and verbalised difficulties experienced by the students, as well as through feedback on individual assignments.

3.4. Results

The results of the intervention were quite positive as is shown by the following major overall outcomes of the learning environment.

The experimental students demonstrated significantly more metaknowledge than the control students about each regulatory skill included in the direct knowledge test. The effect sizes for the difference with C1 varied for the eight regulatory skills between .41 and .93, and with C2 between .26 and .56. For instance, with regard to knowledge about 'orienting', this means that the experimental students referred significantly more to items such as the importance of evaluating the study load of a course, taking into account the way it was organized including the teaching method during classes, considering the usefulness of all types of study material and resources as well as the reliability of all kinds of informants and sources of information. With regard to knowledge about 'self-judging', the experimental students showed more awareness of the impact on learning and taking exams of important affective and motivational student characteristics, such as calmness (avoiding to panic or becoming nervous), concentration, determination (withstanding temptations), assiduity (as opposed to laziness), interest, persistence, self-confidence or fear of failure, and initiative. Another interesting finding is that the experimental students had more extended knowledge about how to cope with negative emotions and stress during learning.

Also a positive relationship was observed between metaknowledge of self-regulatory activities and academic performance. The entering characteristics of the students such as prior knowledge and intelligence, explained 43% of the variance in performance. When entering the metaknowledge variables in the regression equation the amount of criterion variance explained increased to 54%. In other words, differences in performance between students can be partly explained by differences in their entering characteristics, but also partly (up to 11%) by differences in their metaknowledge.

This implies that on average students who showed more metaknowledge got better study results.

An important question was whether, as a result of the intervention, students had become more competent in learning, in the sense that they transferred the trained regulatory skills to a course that was not involved in the intervention, more specifically statistics. Analysis of students' answers to the open-ended questionnaire with eleven questions (see above), showed that the E-students were indeed more self-regulating for the statistics course than their peers in the control groups. For the difference with C1 the effect sizes for the distinct skills varied between .27 and .69, and with C2 between .28 and .58. This means, for example, that the experimental students proved to be better informed about the statistics course, and, therefore, showed evidence of more orienting behaviour. More specifically, we observed differences on the following aspects. In the experimental group more students made an acceptable and well-grounded estimate of the study hours they would need for the statistics course, and more students were capable of recalling orienting information supplied by the statistics teachers at the start of the course. The experimental students were also better informed about several characteristics of the examination, such as the content, the type of questions and the availability of a trial exam. With regard to transfer of self-judging behaviour the experimental students gave a more extensive description of their position with respect to the statistics course and mentioned more personal arguments (such as having to cope with insufficient prior knowledge, or on the contrary, having a good deal of aptitude for mathematics) for their self-judgements (experiencing a lot of difficulties studying statistics or being able to pass smoothly, respectively). The experimental students were also able to formulate more study recommendations (such as the importance to prepare classes in detail and to be active and concentrated during the practicals) with regard to the statistics course, which demonstrated that they were more skilled in reflecting. Moreover, this transfer behaviour explained a substantial part of the variance in the exam scores for statistics: entering variables explained 41% of the criterion variance; this increased to 67% when the transfer scores for all the regulatory activities were included in the regression equation. In other words, differences in exam scores for statistics can be partly explained by differences in their entering characteristics, but also partly (up to 26%) by differences in their self-regulating behaviour in the first weeks of the course. This implies that on average students who showed more self-regulation behaviour got better study results.

Finally, the students of the experimental group obtained better study results as measured by exam scores, pass rates, and study careers. In the first year the experimental students outperformed the control students as well in terms of the overall result (effect size .36 for the difference with C1 and .38 for C2), as for the two intervention courses: macro-economics (effect size .41 for C1, and .26 for C2), and management accounting (effect size .57 for C1 and .26 for C2).

From the 47 students in each of the three groups significantly more experimental students succeeded in the first year, and obtained their master's degree. In E, C1 and C2 respectively 38, 28 and 34 students were successful in the first year, and respectively 37, 26 and 30 got their degree.

4. Conclusions, discussion, and implications for educational policy and practice

4.1. Conclusions and discussion

The implementation of our CLIA-inspired learning environment resulted thus in significant positive effects in an experimental group of university freshmen in comparison to two control groups. Indeed, after the intervention the students in the experimental group had more metaknowledge about regulation skills, they produced more self-regulation activities in the courses involved in the intervention, and were more in control of their academic performance. They also achieved better academic performance as measured by examination scores, pass rates, and study careers.

Furthermore, the E-students showed significant transfer of the acquired self-regulation skills to a non-intervention course, namely statistics. This finding shows that these students' learning proficiency was enhanced, and it fits well with the new and educationally relevant perspective on transfer introduced by Bransford and Schwartz (1999) that emphasizes *preparation for future learning* as the major aspect of transfer, and puts the focus in assessing transfer on students' abilities to learn in novel, resource-rich contexts (see also De Corte, 2003).

Although the results of the intervention are favourable, we have nevertheless to admit that the observed effect sizes of the learning gains are mostly rather small. But, in this respect one should take into account that several features of the intervention may have had an oppressive impact on the learning outcomes. First of all, the scope and the duration of the intervention were rather limited, and focused on only a restricted part of the students' curriculum; in other components of the curriculum they were still immersed in a more traditional approach to teaching and learning. Moreover, during their preceding school career in primary and secondary school the students had been taught for years mostly according to a more traditional approach. This approach had not only a lesser focus – if any – on higher-order skills and interactive learning, but it may even have resulted in habits and beliefs about learning that are at right angles with the CLIA-framework, and have – so to say - to be "deconstructed" before the novel learning environment can be really productively implemented. Besides, as argued by Gage (1996), the behavioural sciences - just as medical science - should take small effects seriously, especially when they are supported by relevant theory and consistent with other research findings. And, our findings are consistent with results reported by others such as Brown and Campione (1996), the Cognition and Technology Group at Vanderbilt (1997), and Summerlee (2008).

4.2. Implications for educational policy and practice

Taking into account the available research evidence supporting the overall approach to learning and teaching underlying the learning environment presented above, and showing the power and the trainability of self-regulation skills (see also Bransford et al. 2006; National Research Council 2005), it is important to reflect on the implications of these work for educational policy and practice.

The most obvious implication is that this new overall approach to learning and instruction of self-regulation activities and skills should be widely adopted, integrated, and appropriately implemented in everyday educational practices. But this represents a major challenge. Indeed, research on educational innovation has for long documented that the school system is very resistant to change, and this holds certainly for higher education. A first condition for the large-scale dissemination of novel learning environments is undoubtedly that educational policy-makers and school leaders should stimulate and promote the intended innovation. Furthermore, curricula, educational materials such as textbooks, and assessment instruments need to be revised and designed in accordance with the new perspective on learning and teaching as embedded in a framework like the CLIA-model. But whereas all this is necessary it is certainly not sufficient. Indeed, there is ample research evidence showing that introducing reform-based textbooks and materials does not easily and certainly not automatically result in a high-fidelity implementation of the underlying innovative ideas. It is obvious that teachers play an active role in the implementation of curricular materials and textbooks: they interpret – often unconsciously – the new ideas through their existing prior knowledge, beliefs and experiences (Depaepe, De Corte, & Verschaffel 2007; Remillard 2005; Spillane, Reiser, & Reimer 2002). Therefore, the most important and indispensable condition for success lies in the training of teachers. Besides the fundamental reform of initial teacher education based on the innovative ideas and practices, an *intensive* system for sustained staff development of teachers who are in-service is required. As argued by the Cognition and Technology Group at Vanderbilt (1997) the changes that we are asking the teachers to make are “much too complex to be communicated succinctly in a workshop and then enacted in isolation once the teachers returned to their school” (p. 116). Indeed, we should realise that implementing powerful learning environments such as the one designed in our study, requires drastic changes in the role of the teacher. Instead of being the main, if not the only source of information - as is often still the case in average educational practice - the teacher becomes a "privileged" member of the knowledge building community, who creates an intellectually stimulating climate, models learning and problem-solving activities, asks provoking questions, provides support to learners through coaching and guidance, and fosters students' agency and responsibility for their own learning. Putting this new perspective on learning and teaching into practice will take time, substantial investments, and much effort in partnership between researchers and practitioners. Indeed, it is not just a matter of acquiring a set of new instructional techniques, but it calls for a fundamental and profound change in teachers' beliefs about learning and instruction, and in the current school and classroom cultures. In addition, policy makers and university leadership should reward teaching competence, and promote actions and regulations aimed at reducing the currently detrimental conflict between research and teaching at universities.

5. References

Boekaerts, M., Pintrich, P.R., & Zeidner, M. (Eds.). (2000). *Handbook of self-regulation.* San Diego, CA: Academic Press.

Bransford, J.D., & Schwartz, D.L. (1999). Rethinking transfer: A simple proposal with multiple implications. In A. Iran-Nejad & P.D. Pearson (Eds.) ,*Review of research in education* (Vol. 24, pp. 61-100). Washington, DC: American Educational Research Association.

Bransford, J.D., Stevens, R., Schwartz, D., Meltzoff, A., Pea, R., Roschelle, J., Vye, N., Kuhl, P., Bell, P., Barron, B., Reeves, B., & Sabelli, N. (2006). Learning theories and education: Toward a decade of synergy. In P.A. Alexander & P.H. Winne (Eds.), *Handbook of educational psychology. Second edition* (pp. 209-244). Mahwah, NJ: Lawrence Erlbaum Associates.

Brown, A.L., & Campione, J.C. (1996). Psychological theory and the design of innovative learning environments: On procedures, principles, and systems. In L. Schauble & R. Glaser (Eds.), *Innovations in learning: New environments for education* (pp. 289-325). Mahwah, NJ: Lawrence Erlbaum Associates.

Cognition and Technology Group at Vanderbilt. (1997). *The Jasper Project: Lessons in curriculum, instruction, assessment, and professional development*. Mahwah, NJ: Lawrence Erlbaum Associates.

De Corte, E. (2003). Transfer as the productive use of acquired knowledge, skills, and motivations. *Current Directions in Psychological Science, 12,* 142-146.

De Corte, E. (2007). Learning from instruction: The case of mathematics. *Learning Inquiry, 1,* 19-30.

De Corte, E., & Verschaffel, L. (2006). Mathematical thinking and learning. In K.A. Renninger, I.E. Sigel (Series Eds), W. Damon, & RM. Lerner (Eds-in-Chief), *Handbook of child psychology: Vol. 4. Child psychology and practice* (6^{th} ed., pp. 103-152). Hoboken, NJ: John Wiley & Sons.

De Corte, E., Verschaffel, L., & Masui, C. (2004). The CLIA-model: A framework for designing powerful learning environments for thinking and problem solving. *European Journal of Psychology of Education, 19,* 365-384.

Depaepe, F., De Corte, E., & Verschaffel, L. (2007). Unraveling the culture of the mathematics classroom: A videobased study in sixth grade. *International Journal of Educational Research, 46,* 266-279.

Gage, N.L. (1996). Confronting counsels of despair for the behavioural sciences. *Educational Researcher,25*(3), 5-15, 22.

Masui, C. (2002). *Leervaardigheid bevorderen in het hoger onderwijs: Een ontwerponderzoek bij eerstejaarsstudenten. [Enhancing learning competence in higher education: A design experiment* *with university freshmen – with a summary in English].* Leuven: Universitaire Pers Leuven.

Masui, C., & De Corte, E. (1999). Enhancing learning and problem-solving skills: Orienting and self-judging, two powerful and trainable tools. *Learning and Instruction, 9,* 517-542.

Masui, C. , & De Corte, E. (2005). Learning to reflect and to attribute constructively as basic components of self-regulated learning. *British Journal of Educational Psychology, 75,* 351-372.

National Research Council. (2005). *How students learn: History, mathematics, and science in the classroom.* Committee on *How People Learn*, A Targeted Report for Teachers, M.S. Donovan & J.D. Bransford, Eds. Division of Behavioural and Social Sciences and Education. Washington, DC: National Academy Press.

Remillard, J. T. (2005). Examining key concepts in research on teachers' use of mathematics curricula. *Review of Educational Research, 75,* 211-246.

Spillane, J.P., Reiser, & B.J., Reimer, T. (2002). Policy implementation and cognition: Reframing and refocusing implementation research. *Review of Educational Research, 72,* 387-431.

Summerlee, A.J.S. (July 2008). *Can universities survive in the 21st century?* Paper presented at the Oxford Round Table on "Educational Leadership and Policy Development", St. Anne's College, Oxford, England, July 6–11, 2008.