http://dx.doi.org/10.7468/jksmed.2015.19.1.81
J. Korean Soc. Math. Educ., Ser. D, Res. Math. Educ.
Vol. 19, No. 1, March 2015, 81–88

Students' Self-Regulated Learning Strategies in Traditional and Non-Traditional Classroom: A Comparative Study

DAVAANYAM, Tumenbayar*
Department of Mathematics, School of Arts and Sciences, National Univ. of Mongolia, Ulaanbaatar, Mongolia; Email: tumk_ii@yahoo.com

TSERENDORJ, Navchaa
Department of Mathematics, School of Arts and Sciences, National Univ. of Mongolia, Ulaanbaatar, Mongolia; Email: navchaa@smcs.num.edu.mn

(Received March 10, 2015; Revised March 16, 2015; Accepted March 26, 2015)

This study used a posttest control group design and to find out differences between students' self-regulated learning strategies in traditional and non-traditional classroom. To this end, 131 first year university students within the experimental and control groups took part in the study. While ICT-based approach was used as the main medium of instruction in the experimental group, in the control group the paper-based traditional method was used. A survey adapted from Davaanyam [Davaanyam, T. (2013). *The structural relationships among Mongolian students' attitudes toward mathematics, motivational beliefs, self-regulated learning strategies, and mathematics achievement*. Ph. D. Dissertation. Jeonju, Jeonbuk, Korea: Chonbuk National Unversity.] was used to gather the data. The results of the study indicated a significant difference between the control and experimental groups in regard with their self-regulated learning. That is to say, the experimental group taught through ICT tools acquired higher levels of self-regulation as compared with the control group instructed through the traditional teaching method.

Keywords: self-regulated learning (SRL) strategies, cognitive learning strategies, metacognitive learning strategies, time and resource management, traditional and non-traditional classroom
MESC Classification: C30, D40
MSC2010 Classification: 97C30, 97D40

1. INTRODUCTION

* Corresponding author

There has been considerable interest in self-regulated learning in recent years (Zimmerman & Schunk 2001). Learning to be self-regulating is seen as an essential skill for "life-long learning", which in turn is seen to be an important disposition for living in a post-modern "Knowledge society". Zimmerman (2001) defines self-regulation as the degree to which students are cognitively, metacognitively, and motivationally active participants in their own learning process. Present research concluded that Mongolian students' use of self-regulated learning strategies are the major causes for their success in mathematics (Wang & Davaanyam, 2012; Davaanyam, 2013). Moreover, she suggested that the future research should attend to investigate critical aspects of students' self-regulated learning strategies comparing and contrasting various classroom environments.

Traditional mathematics instruction (TMI) was defined as "teacher-directed instruction using the mathematics textbook, worksheet, hands-on activities, and drill-and-practice activities in large and small groups" and lecture-based classroom teaching (Butzin, 2001; Shults, 2000).

Students in traditional mathematics instruction listen to lecture, use standard tools of mathematics in the classroom such as pencils, and papers, read the textbook, do the corresponding homework, and take exams. Therefore TMI cannot meet the teaching requirements in this information age. In this century, one of the best examples of the integration of mathematics education and technology is the ICT-based mathematics instruction (ICTBMI). It is known as an online environment empowering students to interact with the others and computers individually, to access to an abundance of resources, to eliminate the misconceptions by providing immediate feedback, and to provide self-directed learning to students. Several studies revealed that the ICTBMI could improve student cognitive skills and achievement, change misconceptions. The ICTBMI also makes students develop more adaptive motivational beliefs and to use more complete self-regulated learning strategies (Renkl, Atkinson & Maier, 2000; Underwood, 2009; Balanskat, Blamire & Kefala, 2006).

The overall purpose of this study is to investigate differences between students' self-regulated learning strategies in traditional and non-traditional classroom. Therefore, major research questions to achieve the purpose of this study were as following:

1. Is there a significant difference between the means of cognitive learning strategies (rehearsal, organization, elaboration and critical thinking) of the control group and the experimental group?
2. Is there a significant difference between the means of metacognitive learning strategies of the control group and the experimental group?
3. Is there a significant difference between the means of time-resource management (time-study environment strategies, peer learning strategies, and help seeking strate-

gies) of the control group and the experimental group?

2. THEORETICAL BACKGROUND

Self-Regulated Learning (SRL) has become an increasingly important concept in education studies in recent years. Self-regulated learners have repertoires of strategies to regulate their cognition, motivation, behavior and context. Within mathematics education, it is assumed that self-regulated learners use effective cognitive and metacognitve strategies, motivating themselves to acquire conceptual understanding, making attributions to their strategy use for successes and failures and evaluating their progress toward their learning goals (De Corte, Verschaffel, & Op't Eynde, 2000; Pape, 2005; Pape & Smith, 2002). The model of self-regulated learning strategies described here includes two general categories of strategies: learning strategies (cognitive learning strategies and metacognitive learning strategies) and time, resource management strategies.

A variety of different taxonomies for learning strategies exist in the literature (Pintrich & Garcia 1991; Weinstein & Mayer 1986). However, there are three general levels of learning strategies that are important in understanding self-regulated learning. First, learning strategies includes strategies, referred to as metacognitive strategies, that are used for controlling and executing students' own learning process. A metacognitive strategy refer to one's self-awareness about one's cognitions and includes planning, monitoring, and regulating cognitions and factors in the learning process (Pintrich & De Groot, 1990). Flavell (1999) describes the regulation of cognition as the learner's goal setting, planning, monitoring of understanding, and evaluating of progress towards the completion of the task.

Second, cognitive learning strategies are used to retrieve, encode, and organize new information and can be subdivided into two levels. Deep cognitive strategies facilitate long-term retention through elaboration, organization, and critical thinking, resulting in a higher level of cognitive engagement. Third, superficial cognitive strategies refer to rehearsal strategies that help encode new information into short-term memory by repetition, highlighting, and memorization (Pintrich, 1988). Rehearsal strategies are associated with repetition, which aim to reproduce the material in some form. Rehearsal strategies involve rereading class notes, underlying information or copying material. These strategies appear to affect the attention and encoding processes, but they do not seem to help learners link the recently acquired information with prior knowledge. Elaboration strategies include processes by which the individuals relate the new information with what they know or learned. Elaboration strategies involve summarizing, paraphrasing information and reorganizing ideas through making connections among them. Organizational strate-

gies enable individuals to organize information into comprehensible categories such as, grouping information and making outlines (Pintrich, et al., 1993; Weinstein & Mayer, 1986). Resource management strategies concerns strategies that students use to manage and control their study environment and time (Pintrich, et al., 1993).

3. METHODOLOGY

3.1. Sample

The research sample consisted of 131 first year students of the National University of Mongolia. The characteristics of the valid samples are distributed in the following manner: 29.8% (N = 39) male and 70.32% (N = 92) female. The students were enrolled in a compulsory "Mathematics-1" course. The students were randomly assigned to the two different research groups that received instruction as follows: 79 students received instruction via a sophisticated ICT-based classroom and 52 students were assigned to a traditional classroom.

3.2. Instruments

In this study, an instrument was used in order to gather data on students' self-regulated learning strategies. 44 items were chosen from adapted version of Mathematics Motivated Strategies for Learning Questionnaire (Davaanyam, 2013). Learning strategies scale consists of 26 items with five subscales. Reliability analysis results suggested that Cronbach's alpha values for each subscale had high, rehearsal strategies (α = .738), elaboration strategies (α = .872), organization strategies (α = .760), critical thinking (α = .775), and metacognitive strategies (α = .861). These results indicated high internal consistency for each subscale of learning strategies scale.

Time-resource management strategies scale consists of 18 items with four subscales. Cronbach's alpha values for each subscale were high, time and study environment (α = .811), peer learning (α = .802), and help seeking (α = .725). These results indicated high internal consistency for each scale of time, resource management strategies scale.

3.3. Procedure and data analyses

The ICT-based "Mathematics-1" course consisted of three key pedagogical elements which were integrated into the learning and instructional process. The first element was a multimedia presentation of the material to the students who logged in to the course. In each lesson the lecturer taught content of the course using aids, simulations and demonstrations. The second element consisted of a presentation of the content of each lesson in

full text specially compiled for the course. Students were able to access the full text asynchronously at their convenience. The third element consisted of pre-prepared exercises that the students answered and checked with feedback by lecturer. Throughout the duration of the ICT-based course students were able to maintain contact with the lecturer via email messages and consult the lecturer in a course chat-room.

The traditional paper-based course consisted of two hours lecture and two hours seminar in a week. During the two-hour meetings the lecturer presented the students with content matter, explained the material and answered any questions arising from difficulties students' may have had understanding the material. During the two-hours weekly meetings the students participated in supervised exercise sessions in which they solved a series of problems directly related to the material taught in the weekly two-hour lecture. The students in both ICT-based and traditional courses studied identical content matter and handed in similar exercises.

For the analyses we used the SPSS19 statistics program. T-test analysis was conducted to assess differences in students' attitudes cognitive learning strategies, metacognitive learning strategies and time-resource management strategies.

4. RESULTS

The mean scores and standard deviations on the research variables and T-test results are presented in Table 1.

T-tests were used in order to compare students' cognitive, metacognitive learning strategies, and time-resource management strategies. There was no significant difference on the rehearsal strategies, $t = -.391$; $p > 0.05$, but significant differences were found for organizational strategies using, $t = -2.38$; $p < .05$, elaboration strategies using, $t = -3.87$; $p < .001$, and critical thinking strategies using, $t = -2.96$; $p < .001$. Also there was found significant differences on metacognitive learning strategies using, $t = -8.5$; $p < .001$. Students who participated in the ICT-based "Mathematics-1" course attained higher mean scores on the four learning strategies than students who participated in the traditional classroom (see Table 1). T-test results also showed that mean of the time-study environment regulation ($t = -3.51$, $p = .001$) and help seeking strategies ($t = -2.16$, $p = .032$) in ICT-based classroom students' was significantly higher than traditional classroom. There was no significant difference for peer learning strategies, $t = -1.19$; $p = .233$.

Table 1. Mean scores and standard deviations for students' cognitive learning strategies, metacognitive learning strategies and time-resource management strategies and T-test results

Variables		Traditional classroom (N = 52)		Non-traditional classroom (N = 79)		t(p)
		Mean	SD	Mean	SD	
Cognitive learning strategies	Rehearsal	3.58	.74	3.62	.63	–.391(.696)
	Organization	2.65	.82	2.99	.78	–2.38(.018)
	Elaboration	2.70	.74	3.12	.64	–3.87(.000)
	Critical Thinking	2.46	.58	2.81	.71	–2.96(.000)
Metacognitive learning strategies		2.40	.63	3.33	.60	–8.5 (.000)
Time-Resource Management Strategies	Time and Study Environment	2.61	.69	3.01	.61	–3.51 (.001)
	Help seeking	3.04	.79	3.31	.63	–2.16 (.032)
	Peer learning	2.68	.60	2.81	.65	–1.19 (.233)

5. CONCLUSION

The main purpose of the study was to investigate differences between students' self-regulated learning strategies which are cognitive learning strategies (rehearsal, organization, elaboration, critical thinking), metacognitive learning strategies, time-resource management strategies (time and study environment strategies, peer learning strategies, help seeking strategies) in traditional and non-traditional mathematics classroom. Therefore, the conclusions of the present study which centered on the research questions are suggested as follows:

The first main research question deals with the cognitive learning strategy and the analysis affirm that students have more effective use of various learning strategy which are organization, elaboration and critical thinking when learning and use of ICT. Students in both traditional and non-traditional classroom more use rehearsal strategy but there is no significant difference.

The second research question is the difference between metacognitive strategies of students in experimental and control groups. The analysis affirms that there is a significant difference. Other words, students who participated in the ICT-based "Mathematics-1" course use more desirable metacognitive learning strategies than students who participated in the traditional classroom.

Third, present study implied that students who participated in ICT-based course, more effective manage learning environment and create study schedules, and seek help.

These results imply that if teachers effectively manage their teaching strategies in the ICT based Mathematics-1 course then students may be use more powerful cognitive,

metacognitve learning strategies, and more appropriate time and resource management strategies.

REFERENCES

Balanskat, A.; Blamire, R. & Kefala, S. (2006). *The Impact Report: A Review of Studies of ICT Impact on Schools in Europe*. European Schoolnet, Dec. 11, 2006. http://www.nesse.fr/nesse/activities/research-mapping/digital-technologies/bibliography/Balanskat2006

Butzin, S. (2001). Using instructional technology in transformed learning environments: An evaluation of project CHILD. *Journal of Research on Computing in Education* **33(4)**, 367–373.

Davaanyam, T. (2013). The structural relationships among Mongolian students' attitudes toward mathematics, motivational beliefs, self-regulated learning strategies, and mathematics achievement. Ph. D. Dissertation. Jeonju, Jeonbuk, Korea: Chonbuk National Unversity.

De Corte, E.; Verschaffel, L. & Op't Eynde, P. (2000). Self-regulation: A characteristic and a goal of mathematics education. In: M. Boekaerts, P. R. Pintrich & M. Zeidner (Eds.), *Handbook of Self-Regulation*. (pp. 687–726). San Diego, CA: Academic Press. ME **2001e.**03788

Flavell, J. H. (1999). Cognitive development: Children's knowledge about the mind. *Annual Review of Psychology* **50**, 21–45.

Pape, S. J. (2005). Interventions that support future mathematics learning: Developing self-regulated learners in K–12 classrooms. In: S. Wagner (Ed.), *Prompt Intervention in Mathematics Education*, (pp. 77–97). Columbus, OH; Ohio Department of Education.

Pape, S. J. & Smith, C. (2002). Self-regulating mathematics skills. *Theory Pract.* **41(2)**, 93–101. ME **2003c.**02056

Pintrich, P. R. (1988). A process-oriented view of student motivation and cognition. In: J. S. Stark & L. A. Mets (Eds.), *Improving Teaching and Learning Through Research. New Directions for Institutional Research*, 57. (pp. 65–79). San Francisco: Jossey-Bass.

Pintrich, P. R. & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology* **82**, 33–40.

Pintrich, P. R. & Garcia, T. (1991). Student goal orientation and self-regulation in the college classroom. In: M. L. Maehr & P. R. Pintrich (Eds.), *Advances in Motivation and Achievement: Goals and Self-Regulatory Processes.* (pp. 371–402). Greenwich, CT: JAI Press.

Pintrich, P. R.; Smith, D. A. F.; Garcia, T. & McKeachie, W. J. (1993). Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ). *Educational and Psychological Measurement* **53**, 801–813.

Underwood, J. (2009). *The Impact of Digital Technology: A Review of the Evidence of Digital Technologies on Formal Education*. Coventry, UK: Becta,

Wang, K. S. & Davaanyam, T. (2012). The influences of mathematics motivated beliefs, test

anxiety and cognitive learning strategies on mathematics achievement of Mongolian high school graduating students, *International Journal of Creativity & Problem Solving (사고 개발)* **8(1)**, 151–172.

Weinstein, C. E., & Mayer, R. E. (1986). The teaching of learning strategies. In: M. Wittrock (Ed.), *Handbook of Research on Teaching*. (pp. 315–327). New York: MacMillan.

Zimmerman, B. J. (2001). Theories of self-regulated learning and academic achievement: An overview and analysis. In: B. J. Zimmerman & D. H. Schunk (Eds.), *Self-Regulated Learning and Academic Achievement: Theoretical Perspectives*. (pp. 1–37). Mahwah, NJ: Erlbaum.