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THE COMPARISON OF COLLEGE AND UNIVERSITY STUDENTS` LEARNING STRATEGIES FOR CHEMISTRY COURSES

Tolga GÖK
E-Mail:icemstoffice@gmail.com
Dokuz Eylul University

Özge GÖK
Dokuz Eylul University

ABSTRACT: It is essential to know, comprehend, apply, analyze, synthesize, and evaluate the physical science (chemistry, earth science, physics, etc.) for the science and engineering students. The purpose of this study was to compare the tendency of the higher education technical vocational school and engineering students to physical science. The research was conducted with 166 students. Data were collected using Learning Strategy Survey (LSS). Cognitive/metacognitive strategies (CMS) and resource management strategies (RMS) of the students were compared with the help of this survey designed for chemistry courses. The results presented that the usage of learning strategies of the higher education technical vocational school and engineering students were similar in terms of chemistry. The students` thoughts revealed that the chemistry is not accepted as a key-course for their major field and they preferred to memorize the content of the course without any comprehension. The detailed findings and suggestions were reported in the study.

Key words: chemistry, higher education, learning strategies

INTRODUCTION

Fundamental sciences (chemistry, physics, earth science, etc.) are mandatory courses and also essential to know and understand for engineering students and higher education technical vocational school students. Science students should remember, understand, apply, analyze, evaluate, and create necessary principles not only in major fields but also in fundamental sciences. This type of learning was reported to be a part of metacognitive process. The metacognitive process consists of three phases: a) developing a plan for approaching a learning task, b) monitoring the plan, and c) evaluating the results of the plan (Flavel, 1979; Schraw & Moshman, 1995; Schraw, Crippen, & Hartley, 2006). Many studies were conducted to determine/apply similar learning strategies both in science education (Cook, Kennedy, & McGuire, 2013; Lynch & Trujillo, 2011) and social science education (Karadeniz, 2010; Rao & Liu, 2011).

One of the pioneers in this area, Pintrich, Smith, Garcia, and McKeachine (1991), reported that learning strategy comprises of cognitive and metacognitive strategies-CMS- (rehearsal, organization, elaboration, critical thinking and metacognitive self-regulation) and resource management strategies-RMS- (help seeking, peer learning, effort regulation and time and study environment).

Rehearsal strategies (questioning techniques, visualization, quick writes, preprinted response cards, etc.) is based on memory enhancement by revisiting the content as many times as possible. *Organization strategies* (clustering, outlining, taking notes, selecting the main idea, mapping or connecting key ideas in learning material, etc.) covers selecting suitable information and construct connections among the information to be learned (Pintrich et al., 1991). *Elaboration strategies* (paraphrasing, summarizing, interpreting, effective note-taking, making analogies, etc.) are used to detailed investigation of new information for better understanding. *Critical thinking strategies* (reasoning, evaluating, problem solving, decision making, and analyzing) are based on solving problems, comprehending the connections between ideas, evaluating discussions, determining the importance and relevance of ideas/situations, etc. *Metacognitive self-regulation strategies* consist of planning process (self management, self determination, goal setting, etc.), monitoring process (self focusing, self reflection, self regulation, etc.) and regulating process (self assessment, self questioning, self criticism, etc.). It was claimed that these strategies enhances the awareness, knowledge, and control of cognition of students.

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*Corresponding author: Tolga GÖK- icemstoffice@gmail.com

The second part of the process covering both instructor and students are resource management strategies in which *help seeking strategy* encourages students to take the experts' support when they do not know a problem/ concept or content to be learned. *Peer learning strategy* provides learning by collaborating with peers (friends, classmates, etc.). *Effort regulation strategy* controls their effort and attention against distractions and uninteresting tasks (Pintrich et al., 1991). *Time and study environment strategy* helps student to manage and regulate their time and study environments. Pintrich *et al.* (1991) developed a learning strategy survey to determine even if students follow the strategies aforesaid.

In the present study, with the help of this survey, the cognitive and metacognitive learning strategies and resource management learning strategies were compared for both students of engineering and higher education technical vocational school. The two different levels of student groups were selected based on the achievement at the university entrance. Research questions were analyzed to fulfill the purpose of study.

1. Are CMS and RMS different for higher education technical vocational school and engineering students?
2. What is the reflection of these strategies to students learning process?

METHOD

Learning Strategy Survey (LSS) was used to determine the learning strategies of engineering and higher education technical vocational school students enrolled in introductory chemistry course. The research was performed in Torbali Technical Vocational School of Higher Education and Engineering Faculty at Dokuz Eylul University, Turkey. The study sample was consisted of 166 students. 49% of the students were engineering students (N=82). The survey was conducted to mining engineering students in faculty of engineering whose the education curriculum is similar to technical program. The rest of the students are higher education technical vocational school students (N=86). The survey was administered to Geotechnic and Drilling Technology, departments. The students were between 18 and 22 years of age.

The learning strategies survey (LSS) part of the Motivated Strategies for Learning Questionnaire (MSLQ) developed by Pintrich *et al.* (1991) was used in the study. The Turkish version of the LSS, consisting of 36 items, modified and translated into Turkish by Buyukozturk, Akgun, Ozkahveci, & Demirel (2004) was conducted. The learning strategies section consisted of "cognitive and metacognitive strategies (rehearsal-6 items, organization-6 items, elaboration-4 items, critical thinking-4 items, and metacognitive self-regulation-3 items)" and "resource management strategies (help seeking-5 items, peer learning-3 items, effort regulation-3 items, and time and study environment-2 items)". Students rated each item on a 7-point Likert-type scale (ranging from 1 = not at all true of me, to 7 = very true of me). Statistical analysis results (Explanatory Factor Analysis-EFA, Confirmatory Factor Analysis-CFA) of the LSS performed by Buyukozturk *et al.* (2004) are presented below.

According to EFA, LSS was comprised of nine factors with eigenvalues greater than 1.00, the factor loadings of the items were found to be 0.38 and over, and the total variance was 53.45%. The results of CFA include Chi-Square Goodness of Fit "X^2" (4.73), Root Mean Square Error of Approximation "RMSEA" (0.066), Goodness of Fit Index "GFI" (0.80), Adjusted Goodness of Fit Index "AGFI" (0.77), Normed Fit Index "NFI" (0.97), Root Mean Square Residuals "RMR" (0.22), and Standardized Root Mean Square Residual "SRMR" (0.06). The Cronbach's α values were calculated between 0.41 and 0.75 (Buyukozturk et al., 2004). These results are reasonable for a survey used in low-risk research (Hutcheson & Sofroniou, 1999).

The collected data were analyzed by IBM-SPSS Statistics 22. The frequency distributions, means and standard deviations of engineering and higher education technical vocational school students' values were calculated and independent-samples *t*-test was conducted to the statistical difference of means between students according to the statements. The difference between students was considered significant with *p* values less than 0.05. The students were given approximately fifteen minutes to fill out the questionnaire.

RESULTS AND FINDINGS

The results of cognitive and metacognitive strategies and resource management strategies of higher education technical vocational school students (TVSS) and engineering students (ES) were given in Table 1.

Table 1. Descriptive Statistical Values of Higher Education Technical Vocational School and Engineering Students Related to Cognitive and Metacognitive Strategies (CMS)

Factor	Group	N	M	sd	*t*-value	df	*p*-value
Rehearsal	ES	82	28.52	7.13	0.063	164	p>0.05
	TVSS	84	28.45	7.62			
Organization	ES	82	29.47	6.77	1.610	164	p>0.05
	TVSS	84	31.28	7.67			
Elaboration	ES	82	18.79	4.97	0.858	164	p>0.05
	TVSS	84	19.48	5.45			
Critical Thinking	ES	82	16.56	5.12	0.507	164	p>0.05

	TVSS	84	17.00	5.99			
Metacognitive Self-Regulation	ES	82	13.24	4.66	1.249	164	p>0.05
	TVSS	84	14.08	3.98			

Note: M mean; sd standard deviation; df degree of freedom

Mean values for cognitive and metacognitive strategies calculated for engineering students are 28.52 (sd =7.13) for rehearsal, 29.47 (sd=6.77) for organization, 18.79 (sd=4.97) for elaboration, 16.56 (sd=5.12) for critical thinking, 13.24 (sd=4.66) for metacognitive self-regulation and higher education technical vocational school students are 28.45 (sd=7.62), 31.28 (sd=7.67), 19.48 (sd=5.45), 17.00 (sd=5.99), and 14.08 (sd=3.98), respectively. Independent-samples *t*-test was conducted to the statistical difference of means between engineering and higher education technical vocational school students for cognitive and metacognitive strategies. The differences in the values between the students were not statistically significant for rehearsal [df =164, t=0.063, p>0.05], organization [df =164, t=1.610, p>0.05], elaboration [df =164, t=0.858, p>0.05], critical thinking [df =164, t=0.507, p>0.05], and finally metacognitive self-regulation [df =164, t=1.249, p>0.05].
Table 2 shows the findings of resource management strategies of higher education technical vocational school and engineering students.

Table 2. Descriptive Statistical Values of Higher Education Technical Vocational School and Engineering Students Related to Resource Management Strategies (RMS)

Factor	Group	N	M	sd	*t*-value	df	*p*-value
Help Seeking	ES	82	21.34	5.08	0.452	164	p>0.05
	TVSS	84	21.67	4.51			
Peer Learning	ES	82	13.08	3.87	0.601	164	p>0.05
	TVSS	84	13.48	4.69			
Effort Regulation	ES	82	11.53	3.23	0.925	164	p>0.05
	TVSS	84	12.04	3.84			
Time and Study Environment	ES	82	7.96	3.25	1.667	164	p>0.05
	TVSS	84	8.79	3.28			

Mean values for resource management strategies calculated for engineering students are 21.34 (sd =5.08) for help seeking, 13.08 (sd=3.87) for peer learning, 11.53 (sd=3.23) for effort regulation 7.96 (sd=3.25) for time and study environment, and higher education technical vocational school students are 21.67 (sd=4.51), 13.48 (sd=4.69), 12.04 (sd=3.84), and 8.79 (sd=3.28), respectively. Independent-samples *t*-test was conducted to the statistical difference of means between engineering and higher education technical vocational school students for resource management strategies. The differences in the values between the students were not statistically significant for help seeking [df =164, t=0.452, p>0.05], peer learning [df =164, t=0.601, p>0.05], effort regulation [df =164, t=0.925 p>0.05], time and study environment [df =164, t=1.667, p>0.05].
Table 3 demonstrates the findings of learning strategies higher education technical vocational school and engineering students.

Table 3. Descriptive Statistical Values of Higher Education Technical Vocational School and Engineering Students Related to Learning Strategies

Factor	Group	N	M	sd	*t*-value	df	*p*-value
Cognitive and Metacognitive Strategies-CMS-	ES	82	106.59	19.03	1.158	164	p>0.05
	TVSS	84	110.30	22.11			
Resource Management Strategies-RMS-	ES	82	53.91	8.54	1.382	164	p>0.05
	TVSS	84	56.01	10.84			
Learning Strategies	ES	82	159.40	24.97	1.604	164	p>0.05
	TVSS	84	166.32	30.26			

Mean values for learning strategies calculated that engineering students are 106.59 (sd =19.03) for cognitive and metacognitive strategies, 53.91 (sd=8.54) for resource management strategies, 159.40 (sd=24.97) for general learning strategies, and higher education technical vocational school students are 110.30 (sd=22.11), 56.01 (sd=10.84), and 166.32 (sd=30.26), respectively. Independent-samples *t*-test was conducted to the statistical difference of means between engineering and higher education technical vocational school students for general learning strategies. The differences in the values between the students were not statistically significant for cognitive and metacognitive strategies [df =164, t=1.158, p>0.05], resource management strategies [df =164, t=1.382, p>0.05], and general learning strategies [df =164, t=1.604, p>0.05].

CONCLUSION

The cognitive-metacognitive strategies and resource management strategies of higher education technical vocational school and engineering students were examined in this research. The study was performed on 166 volunteer students.

The findings showed that approximately 65% of all students used cognitive and metacognitive strategies while learning. The results were similar for strategies of rehearsal, organization, elaboration, critical thinking, and metacognitive self regulation. There was no significant difference between engineering students and higher education technical vocational school students.

When the findings of the research were evaluated from the survey on cognitive and metacognitive learning strategies, it could be listed as follows: the students (a) do not revisit the fundamental concept(s)/principle(s) of the chemistry needed for rehearsal learning strategy, (b) do not like taking notes, focusing on the main idea of the concept(s) and connecting concepts with the principles needed for organization learning strategy, (c) do not perform deeper learning for the chemistry course, (d) do not comprehend the fundamental principles of the chemistry related with their research area needed for elaboration learning strategy, (e) would prefer to memorize concept(s)/principle(s) than to use critical thinking learning strategies (reasoning, evaluating, problem solving, decision making, etc.), (f) do not plan, monitor, and regulate the process needed for the metacognitive self-regulation learning strategies, (g) only aim getting a good grade instead of learning the course.

60% of the students used resource management strategies while learning. When findings of help seeking, peer learning, effort regulation, and finally time and study environment strategies of students were evaluated, the results were similar. The statistical differences between the engineering students and higher education technical vocational school students were not significant.

When the findings of the research were evaluated from the survey on resource management learning strategies, it could be presented as follows: the students (1) help their peers or classmates regarding the concept/principle when they do not understand the subjects in the class instead of getting assistance from the instructors, (2) use frequently use help seeking and peer learning strategies, (3) regulate their study time and environment for studying based on spare time except of daily necessities (part-time job, transportation, etc.).

In general, approximately 60% of the all students used learning strategies. It is surprising that even though the academic achievement in entrance exam is different for engineering and higher education technical vocational school students, similar trends of learning strategies were found. Findings reflected that the majority of the students did not enjoy learning and studying fundamental courses such as chemistry. Students showed more interest on technical courses than science courses.

RECOMMENDATIONS

It should be noted that the awareness of engineering or technical majored students on the importance of science courses was obtained to be low. The perception of the students could be enhanced by various active learning methods (inquiry based learning, peer led team learning, peer led guided inquiry, peer-instruction, problem-based learning, etc.), educational technologies (applets, simulations, etc.), hands-on activities based on simple chemistry experiment, project competitions on fundamental science, discussion daily-life aspect of the topics on chemistry.

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