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The effect of different metacognitive skill levels on preservice chemistry teachers' motivation

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Abstract

The purpose of this study was to determine the metacognitive skill levels and motivation of preservice chemistry teachers and to investigate the effect of different metacognitive skill levels on their motivation. The study was conducted during 2014-2015 spring semester. In this research, survey method was used to reveal the effect of different metacognitive skill levels on motivation. The population of this study was comprised of preservice chemistry teachers attending the faculty of education. The Chemistry Motivation Scale which was developed by Glynn, Brickman, Armstrong and Taasoobshirazi (2011) and adapted into Turkish by Sen and Yılmaz (2014) was applied to determine preservice chemistry teachers' motivation. The Metacognitive Activities Inventory (MCA-I) which was developed by Cooper and Sandi-Urena (2009) and adapted into Turkish by Temel, Dinçol and Yılmaz (2011) was applied to determine metacognitive skill levels. The results revealed that there was a statistically significant difference between preservice chemistry teachers grouped on the basis of differing levels of metacognitive skills on intrinsic motivation and self-determination.

Keywords: Metacognitive skill levels, motivation, preservice chemistry teachers.

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1. Introduction

Learners' being successful in their learning process, their developing learning abilities, finding ways of solving the problems they encounter, and teachers' being able to design effective teaching environments are all dependent on determining the factors influential in learning. Factors influencing individuals' learning were analysed in the studies conducted in the field of education, and the relations of these factors with students' achievement as well as their relations within themselves were researched. In this way, efforts were made to determine the levels of effects of these factors on students' achievement. One of the frequently researched and analysed concepts in the literature is "self-regulated learning" (Sakız, 2014).

Self-regulated learning is an active and constructive process in which students set their own learning objectives and try to regulate their cognition, motivation and behaviours, and in which they are orientated and restricted by contextual properties surrounding them (Pintrich, 2000). Self-regulated learning is composed of three basic components - namely, cognition, metacognition and motivation. Cognition includes skills necessary for coding, memorising and recalling. Metacognition involves skills enabling learners to monitor and understand their cognitive processes. And motivation involves attitudes and beliefs affecting the development and use of cognitive and metacognitive skills (Schraw, Crippen & Hartley, 2006). Individuals' achievement emerges in consequence of the interaction between these three components. The reason for this is that unless students are motivated to use their cognitive and metacognitive skills, these skills do not have any importance (Pintrich & De Groot, 1990). Schraw and Dennison (1994) point out that there is a strong interaction between cognition and metacognition, and that cognition and metacognition together help students to self-regulate. According to Dinsmore, Alexander and Loughlin (2008), self-regulated learning is rather related with human behaviours and involves the interaction between environment and the learner whereas metacognition involves the learner's self-reflective cognitive process.

Metacognition is defined by Flavell (1979) as knowledge and cognition about cognitive phenomena. According to Brown (1987), however, metacognition is individuals' control of their knowledge about the cognitive systems they possess and of these systems. Thus, the importance of metacognition in the learning process becomes apparent. Individuals describe what the task or the problem is by means of metacognition, they choose the best strategy to perform the task, find the appropriate sources in time, activate their prior knowledge, and focus on how to use their attention to perform the task (Saban & Saban, 2008). For individuals to be responsible for the learning process, for the importance of the task they take on, for the sense of self-efficacy and for achievement targets, metacognition should be in interaction with motivation (Palincsar & Brown, 1987 as cited in Saban & Saban, 2008). If learners' expectations are met and if they see their efforts and the strategies they effectively use as the cause of their achievement, their motivation will rise. When they plan their learning, monitor their progress and acquire the skills to evaluate their efforts to develop strategies for use in the future and their achievement; their self-regulated skills will also develop (Driscoll, 2005). Studies performed in relation to metacognition indicate that metacognition is an important predictor of academic performance (Dunning, Johnson, Ehrlinger & Kruger, 2003; Dunslosky & Thiede 1998; Kruger & Dunning 1999; Thiede, Anderson & Therriault, 2003).

It was claimed in studies available in the literature that there should be positive correlations between motivation and the use of metacognition in order for students to achieve success (Biggs, 1985; Kurtz & Borkowski, 1984; Stipek, 1982). Moreover, Veenman, Van Hout-Wolters and Afflerbach (2006) stress that the relations between students' cognition, contextual factors, motivation, epistemological beliefs and learning abilities should be researched. Based on this idea, this research aims to analyse the correlations between preservice chemistry teachers' metacognition and motivation. It is believed that determining whether or not there are any differences between preservice chemistry teachers' motivations according to their levels of metacognition skills will contribute significantly to the literature.

1.1. Purpose of the study

The purpose of this study was to determine the metacognitive skill levels and motivation of preservice chemistry teachers and to investigate the effect of different metacognitive skill levels on their motivation. This study aims specifically at answering the following question:

1. Is there a significant difference between motivation of preservice chemistry teachers according to different metacognitive skill levels?

2. Method

2.1. Study Group

A total of 80 preservice chemistry teachers attending the Department of Chemistry Education of the Education Faculty in the 2014-2015 academic year participated in the study. In total, 64 female and 16 male preservice chemistry teachers submitted a completed questionnaire for this study. Of the 80 preservice chemistry teachers, 12 were first grade, 13 were second grade, 14 were third grade, 17 were fourth grade and 24 were fifth grade. Preservice teachers' ages ranged from 19 to 25 years. Participants in the study came from low- to high-socioeconomic families.

2.2. Data Collection Tool

Metacognitive Activities Inventory (MCA-I), a 5-point Likert type instrument developed by Cooper and Sandi-Urena (2009) and adapted into Turkish by Temel, Dinçol and Yılmaz (2011), was used to assess preservice chemistry teachers' metacognitive skill levels. The inventory included 23 items. After the factor analysis, the reported Cronbach's alpha coefficient for the whole questionnaire was .92.

Chemistry Motivation Scale, which was developed by Glynn, Brickman, Armstrong and Taasoobshirazi (2011) and adapted into Turkish by Sen and Yılmaz (2014) was applied to determine preservice chemistry teachers' motivation towards chemistry. The scale consists of 25 items in 5 subscales: intrinsic motivation, self-efficacy, self-determination, grade motivation, and career motivation. Sen and Yılmaz (2014) reported the coefficient alphas for the instrument as .75, .88, .79, .79, and .89 for the intrinsic motivation, self-efficacy, self-determination, grade motivation, and career motivation, respectively.

3. Findings

Firstly, three groups were formed in this study by using the grouping method developed by Cooper, Sandi-Urena and Stevens (2008). Descriptive statistics for each group are shown in Table 1. Accordingly, there are 21 preservice chemistry teachers in the low group, 37 preservice chemistry teachers in the intermediate group, and 22 preservice chemistry teachers in the high group.

Table 1. Metacognitive skill groups of preservice chemistry teachers.

Metacognitive skill groups	N	Mean	SD	Minimum	Maximum
Low group (L-Group) those participants below the mean value minus one standard deviation	21	65,48	13,61	33,00	81,00
Intermediate group (I-Group) composed by those whose score is between these extremes	37	87,78	4,47	75,00	94,00
High group (H-Group) participants with scores above the mean score plus one standard deviation	22	103,23	5,68	95,00	115,00

One-way MANOVA test was employed in determining the effects of preservice chemistry teachers' levels of metacognitive skills on their intrinsic motivation, their self-efficacy, self-determination, grade motivation, and career motivation for chemistry. An examination of the one-way MANOVA analysis results demonstrated that students' intrinsic motivation, their self-efficacy, self-determination, grade motivation and career motivation differed significantly according to their levels of metacognitive skills $F(10.\ 146)=2.06$, $p=.03$; Wilks Lambda (Λ)=.77; Partial Eta Squared=0.123, and the effect size was large.

Table 2. MANOVA Follow-Up Pairwise Comparisons for Dependent Variables

Dependent Variable	Group	Mean	SD	df	F	Sig.	Partial Eta Squared
	L-Group	18,00	4,42				
Intrinsic motivation	I-Group	18,81	4,17	2	6,17	0,00	0,14
	H-Group	22,09	3,84				
	L-Group	18,19	5,33				
Self-efficacy	I-Group	18,87	3,29	2	2,16	0,12	0,05
	H-Group	20,68	4,12				
	L-Group	17,00	4,14				
Self-determination	I-Group	18,81	3,54	2	5,33	0,01	0,12
	H-Group	20,96	4,51				
	L-Group	17,76	5,76				
Grade motivation	I-Group	20,27	4,00	2	2,09	0,13	0,05
	H-Group	20,59	6,02				
	L-Group	18,05	5,17				
Career motivation	I-Group	18,46	4,65	2	2,84	0,06	0,07
	H-Group	21,32	5,68				

According to the dependent variable in Table 2, preservice chemistry teachers' intrinsic motivation scores (*F*(2. 77)=6.17, *p*<.05, partial eta squared=.0.14) and their self-determination scores (*F*(2. 77)=5.33, *p*<.05, partial eta squared= .12) differ significantly according to their levels of metacognitive skills. Yet, their self-efficacy scores (*F*(2. 77)=2.16, *p*>.05, partial eta squared=.0.05), grade motivation scores (*F(2. 77)=2.09, p>.05, partial eta squared=.0.05*), and career motivation scores (*F*(2. 77)=2.84, *p*>.05, partial eta squared= .07) do not differ significantly according to their levels of metacognitive skills.

Table 3.Multiple Comparisons

Dependent Variable		(I) Group	(J) Group	Std. Error	Sig.
Intrinsic motivation	Tukey HSD	L-Group	I-Group	1,13	0,76
			H-Group	1,27	0,01
		I-Group	L-Group	1,13	0,76
			H-Group	1,12	0,01
		H-Group	L-Group	1,27	0,01
			I-Group	1,12	0,01
Self-determination		L-Group	I-Group	1,09	0,23
			H-Group	1,21	0,01
		I-Group	L-Group	1,09	0,23
			H-Group	1,07	0,12
		H-Group	L-Group	1,21	0,01
			I-Group	1,07	0,12

Because the condition for variance equation is attained in Table 3, the Tukey test results for the dependent variables of intrinsic motivation and self-determination are shown. Post-hoc comparisons using the Tukey HSD test indicated that the mean score of intrinsic motivation for high group *(M = 22,09, SD = 3,84)* was significantly different from low group (M = 18,00, SD = 4.42) and intermediate group *(M = 18,81, SD = 4,17)*. There was no statistically significant difference in mean scores between low group and intermediate group. Also, post-hoc comparisons indicated that the mean score of self-determination for high group *(M = 20,96, SD = 4,51)* was significantly different from low group *(M = 17,00, SD = 4.14)* and intermediate group *(M = 18,81, SD = 3,54)* did not differ significantly from either low group or high group.

4. Conclusion and Discussion

A total of 80 preservice chemistry teachers were included in the research, and 26.25% of them were in the low group, 46.25% were in the intermediate group, and 27.5% were in the high group according to their levels of metacognitive skills. Whether or not there were any differences between the motivation (intrinsic motivation, self-efficacy, self-determination, grade motivation, and career motivation) of preservice chemistry teachers with differing levels of metacognitive skills was checked through one-way MANOVA analysis. The findings obtained in consequence demonstrated that preservice chemistry teachers' intrinsic motivation and self-determination scores differed significantly according to their levels of metacognitive skills. Thus, it was found that the intrinsic motivation scores of preservice chemistry teachers with high levels of metacognition were higher than those with low and intermediate metacognition levels. On examining preservice chemistry teachers' self-determination scores, it was again found that metacognition had an influence. Accordingly, the self-determination scores of teachers with high levels of metacognition were higher than those with low metacognition levels. On the other hand, it was also found that intermediate group did not differ significantly from the low or the high group in terms of self-determination scores. Research available in the literature demonstrates that motivation has an important role in student metacognition (Dembo & Eaton, 2000; Landine & Stewart, 1998; Neber & Schommer-Aikins, 2002; Pintrich & De Groot, 1990; Shu-Shen,2002; Sungur, 2007; Sungur & Senler, 2009; Tung-hsien, 2004; Valle et al., 2003).

It was another finding in this research that there were significant differences between preservice chemistry teachers' self-determination scores. Self-determination means students' control of their belief in learning science. Reeve, Hamm and Nix (2003) define self-determination as having alternatives and individuals' control over what to do and how to do it. For instance, if students believe that they have control over their learning such as choosing the laboratory subjects, their motivation increases. Having higher self-determination scores means having higher motivation for those who are in the high group.

It was also found in this research that metacognition had effects on preservice chemistry teachers' intrinsic motivation. Learners with higher intrinsic motivation will use more metacognitive activities than those with lower intrinsic motivation. Thus, learners who can use metacognitive strategies more in their academic life will be more successful. Besides, it is also pointed out in the literature that there is a strong relationship between intrinsic motivation and the use of metacognitive strategies (Pintrich & Groot, 1990).

In this current study, it was found that there were not significant effects of metacognition on self-efficacy. This is a finding different from the ones obtained in the literature (Pintrich & De Groot, 1990; Pintrich & Garcia, 1991; Pintrich, Smith, Garcia & McKeachie, 1991; Sungur, 2007). The correlations between metacognition and self-efficacy were first described by Flavell (1987). Paris and Winograd (1990) also emphasized the importance of self-efficacy in their definition of metacognition.

It was found in consequence of this study that preservice chemistry teachers' grade motivation and career motivation did not differ according to their levels of metacognitive skills. This result was not surprising because both of these variables - in which learning objectives to attain more concrete goals such as grade and career are available - are a part of extrinsic motivation. According to Pintrich et al. (1991), extrinsic factors such as grade, reward, performance, comparing oneself with classmates and competition play important roles in the learning process of students who have higher extrinsic motivation.

Zusho, Pintrich and Coppola (2003) reported that motivational beliefs such as self-efficacy beliefs, task value beliefs, and goal orientation affected outcomes such as choices, effort, persistence and achievement. Therefore, motivation is an important component for achievement and an individual characteristic, it should be expected to influence learners' achievement through metacognitive skill levels. However, in the literature, there was no more study about evidence of a significant relationship between metacognitive skill levels and motivation. For this reason, this study will contribute the literature about the relationship between the metacognitive skill levels and motivation, especially preservice chemistry teachers' motivation. At the end of this study, results as a consequence of differences in the individual characteristics show that preservice chemistry teachers had the different metacognitive skill levels. In addition, when looking at the results of the current study it can be concluded that preservice chemistry teachers with different metacognitive levels had different motivational level. In other words, in this study, motivation depends on the preservice chemistry teachers' metacognitive skill levels. Thus, chemistry teacher educators should consider the different metacognitive skill levels of preservice chemistry teachers and designing educational programs that promote motivation.

As different from the literature, this study found that there were no significant correlations between self-efficacy and metacognition. Therefore, in later studies to be conducted results for the correlations between these two variables can be generalized by making the sample bigger and by working with preservice chemistry teachers of diverse branches.

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