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CHEMISTRY SELF-EFFICACY BELIEFS AS PREDICTORS OF STUDENTS' METACOGNITIVE SKILLS WHEN SOLVING CHEMISTRY PROBLEMS

Research Article

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Abstract

This paper aims to explore (1) students' chemistry self-efficacy beliefs and metacognitive skills during problem solving in chemistry, (2) a potential significant difference of chemistry self-efficacy beliefs and levels of metacognitive skills in accordance with subject fields and, (3) the level of chemistry self-efficacy beliefs as a predictor of metacognitive skills in the course of solving problems. For the specified purposes, "Metacognitive Activities Inventory" and "College Chemistry Self-Efficacy Scale" were administered to 80 undergraduate students, majoring in the Departments of Chemistry and Chemistry Education. This study employed the correlational research model as a type of quantitative research design. The results of the study revealed that students maintained high levels of chemistry self-efficacy as well as metacognitive skills when solving problems in chemistry. Regarding their subject fields, it was observed that there was a significant difference merely in scores of "self-efficacy for psychomotor skills (SPS)" beliefs. The analyses also showed that the levels of students' metacognitive skills during problem solving predicted solely the variable of "self-efficacy for cognitive skills (SCS)", which meant 18.7 % of the total variance.

Keywords: Self-efficacy beliefs, undergraduate students, psychomotor skills, cognitive skills, metacognitive skills, chemistry

1. Introduction

The role of two psychological constructs, namely self-efficacy and metacognition is significant in the process of learning chemistry (Oyelekan, Jolayemi & Upahi, 2019). These variables influence learning, academic success, the use of learning strategies, anxiety as well as motivation (Bandura, 1997; Britner & Pajares, 2001; Ferrell, Phillips & Barbera, 2016; Linnenbrink & Pintrich, 2002; Locke &Latham, 1990; Sungur, 2007). The concept of 'metacognition', originally coined in Flavell's studies, is defined as one's knowledge about their own cognitive processes and the use of current knowledge in monitoring these processes (Flavell, 1979). According to Hennesey (1999), metacognition refers to consciousness of one's own thinking as well as one's conceptions, a vigorous monitoring of cognitive processes and an effort to manage one's cognitive processes regarding future learning. Metacognition, comprised of two core elements, namely metacognitive knowledge and metacognitive experience, entails essential executive skills in order to monitor and regulate one's own cognition. Metacognitive knowledge can be described as what individuals know about their own cognitive processes. Metacognitive experiences involve the processes that allow one to assess and regulate one's cognition (Flavell, 1979; 2000). Note that metacognition has also been dealt with as 'knowledge of cognition" and "regulation of cognition" (Nietfeld, Cao & Osborbe, 2005; Pintrich, 2002; Schraw & Dennison, 1994; White & Frederiksen, 2005). The former refers to awareness of one's own cognition

(Pintrich, 2002; Schraw & Moshman, 1995) while the latter is considered as the sum of skills in planning, monitoring one's cognition and evaluating of those processes (Schraw, 1998).

Wallece, Prain and Hand (2004) maintain that learners are supposed to acquire metacognitive skills for a variety of reasons such as better explanations, constructions of solid evidence, argumentations of claims and evaluation and interpretation of the data based on addressed research questions. Metacognitive skills involve a range of processes such as the plan and implementation of learning activities systematically, monitoring of one's own learning processes along with the evaluation and reflection on them (van der Stel & Veenman, 2014). Metacognition is of importance in the acquisition of and implementation of permanent learning as well as efficient learning, critical thinking and problem solving (Hartman, 1998). One of the significant components that impact metacognitive processes is self-efficacy belief (Locke & Latham, 1990; Zimmerman, 2000a; 2011).

Self-efficacy belief, a key player in science education (Kirbulut, 2014) and one of the most important predictive constructs of student success (Ferrell et al., 2016), is a critical variable in close connection with cognition and emotions (Bandura et al., 2003). Self-efficacy, a determinant of behavior in Bandura's general model of Social Cognitive Theory, has also been examined as an effective, predictive variable for academic motivation and learning performance of students (Kirbulut, 2014; Wu, 2013). Perceived self-efficacy, belief in the possession of sufficient skills to perform a task (Bandura, 1994), also involve the anticipations of the individuals that affirm they could overcome difficult tasks (Palmer, 2006). Self-efficacy belief is a significant indicator of performance that contributes to one's planning goals and regulating action plans in order to attain those objectives (Dykeman, Wood, Ingram & Herr, 2003). Self-efficacy is a kind of competence made up of belief in the ability to meet specific goals/tasks and achieve those expectations (Ormrod, 2006). However, self-efficacy belief, determinant of one's thinking, behaviors and feelings (Bandura 1994), should be handled in a particular area. That is, one with high self-efficacy in one domain might show low self-efficacy in other areas (Cassidy & Eachus, 2002). The level of self-efficacy varies according to the environment, conditions, type of task and degree of difficulty, as well as the level of one's command over their subject. (Bandura, 1997; Zimmerman, 2000b). Against this background, it is highly suggested that self-efficacy should be measured at the optimal level of specificity within a specific domain (Bandura, 1997). In this sense, the current study has been designed to focus on Chemistry Education. Regarding data collection tools, 'College Chemistry Self-Efficacy Scale' was administered to investigate students' self-efficacy and 'Metacognitive Activities Inventory' was employed to examine the levels of metacognition awareness during problem solving in chemistry.

Chemistry self-efficacy has been defined as one's beliefs about their skills to carry out assigned chemistry tasks (Çapa Aydın & Uzuntiryaki, 2009). According to Summers (2009, p.13), chemistry self-efficacy is "the belief that one has in the ability to perform tasks or behaviors associated with the acquisition of chemistry theory and skills". Self-efficacy beliefs, critical to academic success, particularly regarding motivational aspects (Snyder & Lopez, 2002), plays an important role in increasing students' engagement in chemistry (Garcia, 2010). Previous research has shown that self-efficacy, a motivational aspect of learning, is significant for the improvement of metacognitive strategies (Locke & Latham, 1990; Kirbulut, 2014; Zimmerman, 2000a; 2011). It has been well-documented in the existing literature that self-efficacy impacts cognitive and metacognitive processes, management of cognitive and metacognitive strategies. Moreover, there is a positive correlation between self-efficacy and metacognition (Ghonsooly, Khajavy & Mahjoobi, 2014; Kahraman & Sungur, 2011; Kanfer & Ackerman, 1989; Landine & Stewart, 1998;

Nasri, Saleh Sedghpour & Cheraghian Radi, 2014; Pajares, 2002; Sungur, 2007; Tembo & Ngwira, 2016), that is, they are distinct but related constructs.

While plenty of literature exists on science self-efficacy, much less is known of chemistry self-efficacy (Summers, 2009). There are a number of studies conducted in different fields that focus on the relation between metacognition and self-efficacy (Bozgün & Pekdoğan, 2018; Cera, Mancini & Antonietti, 2013; Coutinho, 2008; Ghonsooly et al., 2014; Kirbulut & Uzuntiryaki-Kondakci, 2019; Moores, Chang & Smith, 2006; Tian, Fang & Li, 2018; Valencia-Vallejo, López-Vargas & Sanabria-Rodríguez, 2019; Yıldız & Akdağ, 2017). It is noteworthy that there is an increase in the research conducted in the field of chemistry education as well on topics such as development of chemistry self-efficacy scale, employment of metacognitive strategies in accordance with the levels of chemistry self-efficacy, self-regulation of metacognition and predictive power of chemistry self-efficacy in critical thinking (Avargil, 2019; Çapa Aydin, Uzuntiryaki & Demirdöğen, 2011; Çapa Aydın & Uzuntiryaki, 2009; Dalgety, Coll & Jones, 2003; Hayat & Shateri, 2019; Kirbulut, 2014; Kirbulut, 2019; Uzuntiryaki & Çapa Aydın, 2009; Uzuntiryaki-Kondakçı & Çapa-Aydın, 2013). The scales deployed in the aforementioned studies tend to focus on a rather broad area. In this sense, the contribution of this study to the existing literature is in exploring how chemistry self-efficacy beliefs impact students' metacognitive skills in the course of solving problems, and thus furthers our understanding of the value of self-efficacy in-service training programs (i.e. Department of Chemistry Education) with a close inspection of a related construct, i.e. metacognition. Moreover, the scales used in the present study are designed for domain-specific (i.e. Chemistry and Chemistry Education) purposes, thereby assessing primarily chemistry/chemistry education students' awareness of the matter at hand. In this sense, the current data collection tools show where the current study stands in relation to previous research.

Individuals are supposed to have confidence in the ability to have command in their own fields in order to attain some designated level of performance (Azar, 2010). Self-efficacy is key to defining what metacognition truly means (Paris & Winograd, 1990) and metacognition is of importance in solving problems and comprehending chemistry topics (Cooper, Sandi-Urena & Stevens, 2008; Cooper & Sandi-Urena, 2009; Kaberman & Dori, 2009; Kipnis & Hofstein, 2008; Rickey & Stacy, 2000; Sandi-Urena, Cooper & Stevens, 2011; Schraw, Brooks & Crippen, 2005; Tsai, 2001), which manifests that these two concepts are related constructs. Set against this background, the current study is an attempt at (1) an investigation of students' chemistry self-efficacy beliefs and metacognitive skills during problem solving in chemistry, (2) a potential significant difference of chemistry self-efficacy beliefs and levels of metacognitive skills regarding subject fields, and (3) the level of chemistry self-efficacy beliefs in predicting metacognitive skills during problem solving. Thus, the contribution of this study to the existing literature is in exploring such matters. This study seeks to address the following research questions:

1- What are the levels of students' chemistry self-efficacy beliefs and metacognitive skills when solving problems in chemistry?

2- Is there a significant difference in students' chemistry self-efficacy beliefs and metacognitive skills during problem solving based on subject fields (i.e. Chemistry vs. Chemistry Education)?

3- Are the levels of students' chemistry self-efficacy belief a significant predictor of metacognitive skills during problem solving in chemistry?

2. Method

2.1. Research model

The current study employs correlational research model to investigate the impact of students' chemistry self-efficacy levels on metacognitive skills when solving problems in chemistry. The aim of this quantitative research model is to explore the relationship between two or more variables, and thus to draw conclusions based on the potential relations (Creswell, 2007; Gay & Airasian, 2000; Karasar, 2010).

2.2. Participants

Participants were undergraduate students (n= 80), majoring in Chemistry and Chemistry Education at a public university located in Ankara. The number of Chemistry students was 49, while 31 students were majoring in Chemistry Education. The age of the students ranged from 21 to 26, with the average age calculated as 23.03 (SD=1.174). There were 16 male and 64 female students. All participants completed major area courses except courses (i.e. laboratory and other major courses) offered in senior year. Participants granted informed consents to participate willingly in the study and for the recruitment of the participants, convenience sampling was used in the present study.

2.3. Instruments

The data on which this study is based come from two scales: (1) Metacognitive Activities Inventory and (2) College Chemistry Self-Efficacy Scale. Participants were given 40 minutes to complete the task.

2.3.1. Metacognitive activities inventory (MAI):

The inventory, developed by Sandi-Urena (2008) and Cooper and Sandi-Urena (2009), was translated into Turkish and (culturally) adapted by Dinçol Özgür, Temel and Yılmaz (2018). The inventory aimed at exploring students' metacognitive skills during problem solving in chemistry, consisting of two subscales, namely positive subscale (19 items) and negative subscale (7 items). Composed of a total of 26 items, the measure employed a 5-point Likert scale that ranged from "strongly disagree" to "strongly agree." The Cronbach alpha coefficient was used to assess internal reliability. Internal consistency analysis showed that Cronbach's alpha was (0.885) for the positive subscale and (0.776) for the negative subscale, thereby indicating acceptable reliability. The inventory had a high level of internal consistency as measured by Cronbach's alpha (0.847) (Dinçol Özgür et al., 2018). The use of metacognitive skills (MS) when solving chemistry problems was calculated as a MS-total score in the present study.

2.3.2. College chemistry self-efficacy scale (CCSS):

The CCSS was developed by Uzuntiryaki and Çapa Aydın (2009) to assess college students' self-efficacy beliefs in performing chemistry tasks. The CCSS consisted of 21 items and three dimensions, rated on a scale from "very poorly (1)" to "very well (9)." The dimensions were labelled as "self-efficacy for cognitive skills (SCS-12 items)", "self-efficacy for psychomotor skills (SPS-5 items)", and "self-efficacy for everyday applications (SEA-4 items)". The Cronbach alpha coefficients for the SCS, SPS and SEA scores were calculated as .92, .87 and, .82, respectively (Uzuntiryaki & Çapa Aydın, 2009).

2.4. Data Analysis

The data analysis was conducted within a quantitative framework, based on descriptive statistics, independent sample t-test and multiple linear regression analyses. Prior to data analyses, realizations of assumptions were controlled. Before the conduct of multiple linear regression analyses, normality, linearity, homoscedasticity and multicollinearity, which were the assumptions of the current analyses, were examined for analytical purposes.

3. Results

Table 1 illustrates means scores of students' chemistry self-efficacy beliefs and metacognitive skills when solving problems.

Table 1. *Descriptive results of students' scores on SSCS and MAI*

CCSS and MAI	N	Minimum	Maximum	$\bar{X}$	SD	Skewness	Kurtosis
SCS	80	62.00	97.00	80.34	7.94	-.027	-.728
SPS	80	10.00	45.00	35.31	7.15	-.705	.507
SEA	80	22.00	36.00	27.95	3.19	.008	-.618
MS-total	80	71.00	124.00	100.65	12.51	-.330	-.488

As visible from Table 1, the mean and standard deviation scores for chemistry self-efficacy beliefs for the dimension of SCS were calculated as $\bar{X}$=80.34 and SD=7.94, respectively. For the dimension of SPS, it was $\bar{X}$=35.31 and SD=7.15 and for the dimension of SEA, it was measured as $\bar{X}$=27.95 and SD=3.19. Regarding the levels of metacognitive skills during chemistry problem solving, these two parameters emerged as $\bar{X}$=100.65, SD=12.51. Considering the lowest and highest scores students attained through CCSS and MAI as well as the mean scores, it might be concluded that the levels of self-efficacy in SCS, SPS and SEA were rather high as are the levels of metacognitive skills in the course of problem solving.

The results of the independent samples t-test, which examined a potential significant difference between chemistry self-efficacy beliefs and metacognitive skills based on subject fields (i.e. Chemistry vs. Chemistry Education), are presented in Table 2.

Table 2. *T-test results of students' CCSS and MAI scores based on subject fields*

CCSS and MAI	Group	N	$\bar{X}$	SD	df	t	p
SCS	Chemistry	49	80.53	7.95	78	.272	.787
	Chemistry Education	31	80.03	8.05			
SPS	Chemistry	49	37.20	6.65	78	3.136	.002
	Chemistry Education	31	32.32	6.97			
SEA	Chemistry	49	28.24	2.56	78	.943	.351
	Chemistry Education	31	27.48	4.01			
MS-total	Chemistry	49	100.79	11.83	78	.130	.897
	Chemistry Education	31	100.41	13.71			

The analysis of the test demonstrated that there is a significant difference in only scores of SPS beliefs t(78)=3.136, p<0.01 when subject fields are taken into consideration. It was also observed that students majoring in Chemistry Department attain higher scores ($\bar{X}$= 37.20) on SPS beliefs compared to the students of Chemistry Education ($\bar{X}$=32.32).

Multiple regression analysis was conducted to determine the levels of chemistry self-efficacy beliefs (SCS, SEA, SPS) as predictors of metacognitive skills when solving chemistry problems. Prior to the conduct of the analysis, the satisfaction of the assumptions was controlled. The values of skewness and kurtosis for variables are given in Table 1.

These values fell between +2 and -2, indicating the normality of the given dataset (George & Mallery, 2010). It should be noted that firstly, binary correlations between independent variables can be used to recognize a potential problem with multicollinearity. Values over 0.70 (Tabachnick & Fidell, 2001) and 0.80 might indicate multicollinearity while values above 0.90 clearly indicate an important problem with multicollinearity (Büyüköztürk, 2009; Pallant, 2010). It has also been well-established that when tolerance value is higher than 0.10 and VIF values are less than 10, no problems with multicollinearity comes to the fore (Pallant 2010). All these values are presented in Table 3.

Table 3. *Correlations, Tolerance and VIF values of variables*

Variables	Correlations				Tolerance	VIF
	1	2	3	4		
1.SCS	1	.68**	.65**	.43**	.408	2.449
2.SPS		1	.53**	.32**	.514	1.944
3.SEA			1	.25*	.558	1.791
4.MAI-Total				1		

**p<.01 *p<.05

The results of the multiple regression analysis, which address the third research question, are given in Table 4. The method of “Enter” was conducted before making predictions on the potential dominancy of certain variables on the model.

Table 4. *Results of regression analysis for score predictions of metacognitive skills*

Variables	B	Std. $Error_B$	β	t	p
Constant	49.273	14.227		3.463	.001
SCS	.687	.254	.436	2.704	.008
SPS	.105	.252	.060	.415	.679
SEA	-.269	.540	-.069	-.497	.620
R= .437, R^2=.191, F(3,76)=5.983, p<.01					

As illustrated in Table 4, SCS, SPS and SEA, taken together, function as a predictor of students’ metacognitive skills [F(3,76)=5.983, p<.01]. As such, independent variables (i.e. SCS, SPS and SEA) all together explain 19.1 % of scores of metacognitive skills. On the other hand, the variables SPS and SEA are not significant predictors of scores on metacognitive skills. Thus, the analysis was reconducted to determine the predictive power of the SCS as the sole variable. The SCS as the predictor of students’ metacognitive skills explain 18.7 % of the total variance [R(SCS)= .433, R2=.187, F(1,78)=17.95, p<.01].

4. Conclusion and Discussion

The current study sets out to investigate the students' chemistry self-efficacy beliefs and metacognitive skills during problem solving in chemistry; a potential significant difference of chemistry self-efficacy beliefs and levels of metacognitive skills regarding subject fields, and the level of chemistry self-efficacy beliefs in predicting metacognitive skills when problem solving. As the previous literature review has indicated, the level of self-efficacy varies in accordance with particular environments, conditions, command of the matter at hand and task types. Therefore, self-efficacy should be measured at the optimal level of specificity within a specific domain (Bandura, 1997; Zimmerman, 2000b). The data for the current study come from "Metacognitive Activities Inventory (MAI)" and "College Chemistry Self-Efficacy Scale (CCSC)". Both scales are designed distinctively for the fields of Chemistry and Chemistry Education. In the development of the CCSC, the researchers closely examined the components attributed to chemistry self-efficacy, and then following the related studies in Science and Chemistry Education, they constructed the items based on the dimensions of "(1) self-efficacy for knowledge/comprehension-level skills, (2) self-efficacy for higher-order skills, (3) self-efficacy for psychomotor skills, and (4) self-efficacy for everyday applications". The analyses have shown that the scale is composed of three dimensions, namely "self-efficacy for cognitive skills, self-efficacy for psychomotor skills, and self-efficacy for everyday applications". It has also been observed that the dimensions of "self-efficacy for knowledge/comprehension-level skills and self-efficacy for higher-order skills" are combined in the dimension of "self-efficacy for cognitive skills" (Uzuntiryaki & Çapa Aydın, 2009). Notice that those dimensions, part of the scientific literacy, are critical to success in the field of Chemistry (Chiappetta, Sethna & Fillman, 1993; DeBoer, 2000; Uzuntiryaki & Çapa Aydın, 2009).

The study has revealed that students have high levels of self-efficacy in the dimensions of SCS, SPS and SEA as the levels of their metacognitive skills are. Students with high self-efficacy tend to select more challenging tasks, persevere more and show better resilience not to give up easily (Pajares, 1997). It has been well-established in the literature that undergraduate students tend to have high levels of MAI (Cooper et.al., 2008; Cooper & Sandi-Urena, 2009). In their study, Dikmen and Tuncer (2018) found the average scores of the university students' metacognitive thinking ability quite high. In a similar vein, Tüysüz (2013) maintained that gifted students are likely to show higher levels of metacognition with regards to problem solving skills. Considering the levels of high school students' chemistry self-efficacy, they tend to score mediocrely on chemistry self-efficacy for cognitive skills and attain quite lower scores on self-efficacy for chemistry laboratory (Yılmaz & Dinçol Özgür, 2019).

According to Dalgety and Coll (2006a), students do not maintain high self-efficacy in the entire field of Chemistry, and they might get skeptical about their own abilities to meet specific advanced tasks such as offering private lessons and designing an experiment. Graham, Bohn-Gettler and Raigoza (2019) found that SCS and SEA levels of undergraduate students are above the average. Their study also has demonstrated that the levels of SCS, SPS and SEA beliefs show a positive correlation both with one another and with the levels of metacognitive skills. Taking the current relationship into consideration, the levels of metacognitive skills tend to diminish in intensity towards the levels of SCS, SPS and SEA beliefs. In their study, Uzuntiryaki and Çapa Aydın (2009) found that there is a positive, moderate relationship between SCS beliefs of the students and their academic success in chemistry. The authors also maintained that a positive, weak relation exists between students' SPS and SEA beliefs and their academic performance in chemistry.

The present study has shown that there is a significant difference merely in the scores of SPS beliefs based on the subject fields students were majoring (i.e. Chemistry vs. Chemistry Education), and the difference seems to be in favor of Chemistry students. Bandura (1997) states that students interpret previous experiences on the task at hand and cultivate beliefs regarding their own abilities to meet specific goals and expectations. In this regard, considering the importance of earlier experiences, the reason why chemistry students' beliefs on their abilities for the laboratory practices emerged higher than students of Chemistry Education might be related to the previous experiences these students have engaged in regularly, thereby in turn boosting their self-efficacy more. More specifically, the curriculum covered in the Department of Chemistry relies on more laboratory classes (i.e. compulsory and elective) than that of the Department of Chemistry Education.

The analyses have shown that the levels of students' metacognitive skills during problem solving statistically significant predict solely the variable of SCS, which accounts for 18.7 % of the total variance. A close look at the items of SCS dimension indicates that the dimension includes self-efficacy beliefs in the ability to solve chemistry problems as well as explain chemistry-related concepts. Self-efficacy is a key term in science education, and perceived self-efficacy also influences cognitive/metacognitive processes and academic motivation (Locke & Latham, 1990; Kirbulut, 2014; Zimmerman, 2011). Previous literature has shown that high level of self-efficacy has an important effect on the use of certain cognitive/metacognitive strategies (Pajares, 2002; Pintrich & De Groot, 1990), which are strategies for successfully completing the required tasks. As has been mentioned before, the data collection tools employed in the current study were designed distinctively for the fields of Chemistry/Chemistry Education, which thus contributes to the current majors. Moreover, to the best of our knowledge, no other studies have yielded the same results as our research has presented. Hayat and Shateri (2019) suggest that self-efficacy as an indicator of performance is critical to the use of metacognitive learning strategies. Kahraman and Sungur (2011) maintain that there is a positive correlation between self-efficacy and use of metacognitive strategies; elementary students with high self-efficacy levels tend to use metacognitive strategies, and thus their self-efficacy functions as a determinant of employment of metacognitive strategies in science classes. Similarly, Kirbulut (2014) puts forward that students with high chemistry self-efficacy tend to be more aware of their own cognitive skills as well as regulation of these cognitive processes. In brief, earlier research has demonstrated that self-efficacy and metacognition are distinct but related constructs. The significance of self-efficacy to metacognitive skills, the impact of high levels of self-efficacy on the use of a range of cognitive and metacognitive strategies and the relation of high self-efficacy levels with the use of metacognitive strategies have been well-established in the existing literature (Kahraman & Sungur, 2011; Pajares, 2002; Paris & Winnograd, 1990; Pintrich & De Groot, 1990; Sungur, 2007; Tembo & Ngwira, 2016; Zimmerman, 2000a; Zimmerman, 2011). The purpose of the current study was to advance understanding of the intricate relationship between self-efficacy and metacognition. More precisely, the study was an attempt at an investigation of the impact of chemistry self-efficacy beliefs on the metacognitive skills when solving problems. Therefore, it is believed that the study will contribute to the existing literature in the field of Chemistry Education.

5. Limitations and Recommendations

There are limitations to the extent to which general claims can be made on the basis of data that derive from a small sample size. The scope of the current study is one institution, a public university in Turkey, which makes it difficult to arrive at any broad generalizations concerning the matter at hand. Another limitation of the study is that as the research focuses on only chemistry self-efficacy beliefs as determinants of metacognitive skills, expanding the angle to other research topics such as motivation and self-regulation skills may advance our understanding of student performance attainments.

Metacognition plays an important role in solving problems as well as comprehending chemistry topic (Cooper & Sandi-Urena, 2009; Kaberman & Dori, 2009; Kipnis & Hofstein, 2008; Sandi-Urena et al., 2011; Tsai, 2001). Previous research has indicated that metacognitive skills are key to permanent learning, enhancement of success, better questioning skills (Azevedo, Grene & Moos, 2007; Desoete, 2008; Vrugt & Oort, 2008). On the other hand, self-efficacy beliefs are determinants of success anticipation. Moreover, in chemistry and other fields, self-efficacy, a determinant of behavior indirectly affecting performance, has been found a predictive construct for academic success (Uzuntiryaki & Çapa Aydın, 2009).

The relationship between self-efficacy and student success has been investigated in the literature (Andrew, 1998; Britner & Pajares, 2001; Dalgety & Coll, 2006b; Hampton & Mason, 2003; Lau & Roeser, 2002). It has been concluded that self-efficacy and metacognition, distinct but related constructs, are key players in education. Veenman, Van Hout-Wolters and Afflerbach (2006) maintain that metacognitive knowledge and skills can be fostered through suitable teaching activities. The current study extended understanding of self-efficacy, and based on the results, it is suggested that educational settings must be designed to promote students' self-efficacy beliefs as well as to foster their awareness of metacognitive skills. This has important implications for educators as they should not neglect the motivational aspects of these constructs for academic success, and they should thus manage teaching processes through effective instructional materials.

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