Relationships among senior school students' self-efficacy, metacognition and their achievement in chemistry

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Abstract

Learners play very significant roles in the teaching–learning process. Irrespective of how teachers teach, learners often have their own ways of learning. Three hundred senior secondary school II students selected from 10 senior secondary schools in Ilorin, Nigeria participated in the study. Simple random sampling technique was used to select 30 students from each of the 10 purposively sampled senior secondary schools. Data were collected using three instruments, namely, Chemistry Self-Efficacy Questionnaire, Chemistry Metacognition Questionnaire and Chemistry Achievement Test with reliability indices of 0.83, 0.73 and 0.86, respectively. Answers were provided to four research questions each of which has a corresponding hypothesis. The hypotheses were tested at 0.05 level of significance using Pearson Product Moment Correlation, regression and analysis of variance. Findings from the study indicates significant positive relationship among senior secondary school students' Chemistry self-efficacy, metacognition and their achievement in Chemistry $F_{(2, 297)} = 332.482$, $p < 0.05$.

Keywords: Academic achievement, metacognition, self-efficacy, senior secondary schools.

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1. Introduction

The study of Chemistry has been of tremendous impact to the human life. It is a central science owing to the link it establishes between physical science and biological science. It plays very significant roles on both sides. This importance is exemplified in the need for a credit pass in Chemistry at the School Certificate level as a prerequisite for admission into most (if not all) science-based disciplines in the Colleges and Universities. Chemistry can be simply defined as a physical science in which the composition, structure, properties and changes that matter undergoes are studied. Olorundare (2011) defined chemistry as an 'enabling science' which requires both numeracy and concept formation that form sound basis for other disciplines. Thus, the importance of this subject is not limited to the physical products that emerge from its practice but also to the relevance of the application of its principles in other fields.

The importance of Chemistry underscores the need for it to be properly taught and properly learnt as these will facilitate appropriate learning outcomes that could engender its application in various fields to solve human problems. Two important psychological variables that could impact significantly on students' learning of Chemistry are self-efficacy and metacognition.

Self-efficacy and its role in science education cannot be over-emphasised. It is defined as 'beliefs in one's capabilities to organize and execute courses of action required to produce given attainments' (Bandura, 1997, p. 3). According to Safak, Oktay, Harun and Fulya (2016, p. 332), self-efficacy is 'the judgment of an individual on their own capability to organise events and succeed in delivering a certain performance'. Cappa-Ayden and Uzuntiryaki (2009, p. 3) defined Chemistry self-efficacy as the 'beliefs in one's ability to accomplish tasks related to chemistry'. Self-efficacy influences the amount of effort students put into activities and how well they persevere when faced with difficulties (Bandura, 1997; Pajares, 1996). Researchers reported that highly self-efficacious students mastered academic tasks more than their counterparts who are less self-efficacious (Britner, 2008; Kupermintz, 2002; Schunk, 1996). Also, it was established that students' career choices in science were significantly influenced by self-efficacy (Gwilliam & Betz, 2001). In spite of the crucial role that self-efficacy plays in science education, Pell and Jarvis (2001) reported a soaring figure of students lacking interest in science; hence, it is important to find ways of increasing senior secondary school students' chemistry self- efficacy.

According to Kuhn (1995), metacognition is learners' automatic awareness of their own knowledge and how well they are able to comprehend, manipulate and control their learning processes. Flavell (1979) described metacognition in terms of an individual's understanding of the way he learns, and which requires dynamic monitoring and eventual control of the processes. These definitions stress the executive significance of metacognition in controlling and regulating cognitive process. Executive control processes are those processes leading to the growth directed processing of information, the selection of actions and the implementation of task and cognitive processes (Flavell, 1985; 1987; 1999).

Metacognitive skills consist of those skills required for deliberate planning, monitoring, regulation and evaluation of cognitive process and its outcome (Eze, 2007). Metacognitive skills enable the learners to become aware, understand, monitor, control and manipulate their learning processes. These suggest that learners who possess appropriate metacognitive skills can organize, monitor and direct their own learning process (Eze, 2007). When students become more skilful in using metacognitive skills, they could acquire better confidence and learn more independently. Independent approach leads students to assume ownership of the learning processes as they become more aware of how well they could acquire their own intellectual needs and discover a lot of information on their own. It is therefore the duty of the educator to recognise, nurture and enhance the metacognitive capability of learners under their care (Alexander, Fabricius, Fleming, Zwahr & Brown, 2003).

The use of metacognitive skills has been suggested to be essential for learning. The skills ensure that learners will be able to interpret information appropriately, and for this to happen, they should

be able to give a deeper thought to their own thinking processes, select learning strategies that have proven to suit them best and make conscious effort to manage them as they engage in any learning activity (Flavell, 1987). This, in the opinion of the authors is essential for improving students' achievement in Chemistry.

Nigerian candidates have been performing below expectations in the School Certificate Chemistry Examinations conducted by the West African Examinations Council (Olorundare, 2014). In spite of efforts by educational researchers, government and non-governmental organizations to improve students' academic achievement especially in Chemistry, lesser attention seems to be devoted to the affective components learning such as students' self-efficacy and metacognition. Students' poor demonstration of ability in solving problems is a main source of worry to science educators. In the past decade, researchers have conducted many studies in the area of problem solving, still, many important areas still are still under-explored, and these include the area of students' self-efficacy and metacognition in chemistry.

Awareness of the relationships that exist among senior school students' self-efficacy, metacognition and their achievement in Chemistry could assist chemistry teachers in selecting and organising relevant and effective learning experiences that would facilitate better students' understanding of concepts. It could also assist school counsellors in providing appropriate guidance and counselling services to students who have learning difficulties in Chemistry, while at the same time providing guidance for science-related career choices. Furthermore, educators who specialise in the area of instructional design may find this study of benefit, especially when the design is premised on the basis of metacognitive theories.

1.1. Theoretical framework

The underlying theories for this study are as follows:

1. Social cognitive theory (Bandura, 1986)
2. The theory of metacognition (Flavell, 1999)
3. The Constructivist theory (Piaget, 1972)

Social cognitive theory

Social cognitive theory (Bandura, 1986) postulates that individuals have significant role to play in their own development, and that their performances matter a lot in this (Pajares, 2002). Self-beliefs provide individuals with the ability to manage their own thinking, feelings and doings. Self-efficacy has been described as a significant influencing variable in self-beliefs. Bandura (1997, p. 3) defined self-efficacy as 'beliefs in one's capabilities to organise and execute the courses of action required to produce given attainments'. Self-efficacy beliefs facilitate motivation, personal accomplishments and welfare (Pajares, 2002), making it a central phenomenon social cognitive theory.

Pajares (2002) stated that belief and reality do not match perfectly. According to Bandura (1997, p. 37), 'perceived self-efficacy is concerned not with the number of skills you have, but with what you believe you can do with what you have under a variety of circumstances'.

The theory of Metacognition

Flavell (1999) proposed four components of metacognition, namely: '(i) metacognitive knowledge, (ii) metacognitive experiences, (iii) goals or tasks and (iv) actions or strategies'. According to him, these components interact and the interactions determine individual's ability to control numerous cognitive enterprises.

A person's metacognitive knowledge is his knowledge about how he commits information into his memory. For instance, if I say 'I have a good knowledge of Chemistry, but Daniel has a better knowledge about elements'. This is a demonstration of metacognitive knowledge. Flavell believed that an individual's understanding of factors that work together to influence his ability to commit information into his memory make up the individual's metacognitive knowledge. To the researchers,

Flavell theory of metacognition outlines the various ways to acquire knowledge about cognitive processes. It enables learners to extract meaning form any learning material before them by deploring their thinking faculty, selecting appropriate skill of learning.
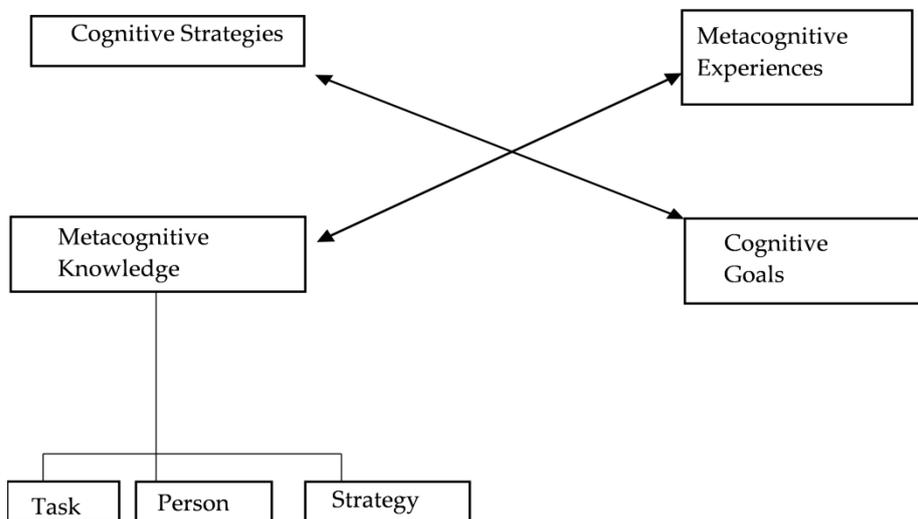

Figure 1. Metacognition model formulated by Flavell (1999)

Constructivism theory

According to Piaget (1972), there are two main facets in cognitive development; the process of knowing and that of acquiring abilities. He stated that the adaptation in learning is continuous and occurs through assimilation and accommodation. He described assimilation as a process in which the environment is manipulated to fit into already established cognitive structures, whereas accommodation occurs when the cognitive scheme is restructured as a result of exposure to new experiences. An example of assimilation would be seen when a school boy who has always been using pencil to write is giving a biro for the first time. Because the biro is shaped like a pencil, he simply attempts to write with it without any prompting. The schemes are called structures as they become the basis of more complex behaviours. When an individual's cognitive structure gets more complicated, they are arranged from specific to general (Huitt & Hummel, 2003).

The four stages in cognitive development as formulated by Piaget are 'Sensorimotor, Pre-operational, Concrete operational and Formal operational' Ojose (2008, p. 26). These stages are from infancy-2 years, 2–6/7 years, 6/7–11 years, and 11+ years, respectively.

Piagetian theory of cognitive development explains the processes that deal with intellectual skills development. The theory outlines the stages through which intellectual skills evolve. It emphasises that the ideal adult intellectual operation is characterised by capacity for abstract reasoning, preoperational logic and reasoning. At this stage, symbolic thinking is necessary problem solving in Chemistry.

The three variables of paramount interest in this research are self-efficacy, metacognition and students' achievement. Since according to Pajares (2002), self-efficacy establishes an avenue for learner motivation, achievements and satisfaction; and since the Socio-cognitive theory is about how individuals contribute to their own development (in this case through learning), self-efficacy could be explained within the purview of the socio-cognitive theory. Furthermore, its relevance to the Constructivist theory could be explained in terms of the role played by self-efficacy in the way learners construct new knowledge from the experiences they acquire in dealing with objects. The theory of

metacognition readily finds application in this study since metacognition is a major variable of interest. Both self-efficacy and metacognition contribute to students' achievement as represented by the eventual learning outcomes and capabilities they are able to attain, with their self-efficacy and metacognition playing significant roles.

1.2. Literature review

Some studies that have examined the variables of metacognition, self-efficacy and academic achievement, as well as the relationships among them exist. Nbina and Viko (2010) sought to find out how the self-efficacy of students, as well as their Chemistry achievements could be impacted by an instruction through metacognitive self-assessment technique. Using a non-equivalent control group pre-test and post-test design which involved a treatment and a control group, 192 in senior secondary school second year were involved in the study carried out in Port Harcourt, Nigeria. The results indicated students' chemistry achievement and self-efficacy were enhanced by instruction in the metacognitive self-assessment strategy.

Mgbemena, Achufusi and Inomiesa (2013) determined in physics, how self-regulated learning and metacognitive learning cycle impacted on the performance of High School students in Anambra State, Nigeria. The study was quasi-experimental, involving a control group and two treatment groups. 325 students were taught Physics for 5 weeks and data was obtained them using a Physics Achievement Test. Findings from analysis of variance (ANOVA) analysis revealed better achievement by the self-regulated learning group over the metacognitive learning cycle group who in turn achieved better than the lecture method group.

Baanu, Oyelekan and Olorundare (2016) sought to find out the relationship that existed between students' self-efficacy and their performance in Chemistry. An ex-post facto research, 1,150 third-year senior secondary school chemistry students participated in the study. The findings established positive relationship between the two variables but the relationship was not significant. The study concludes that students' self-efficacy needs to be complemented with a host of other factors to achieve high academic achievement in Chemistry.

Bernacki, Nokes-Malach and Aleven (2015) examined learners' self-efficacy variability and relation to behaviour, performance and learning. The study sought to find out whether self-efficacy varied reliably across problems; how the performances of the learners related to their subsequent self-efficacy indicators; whether these indicators predicted their performance in future and how their previous performance related to how their self-efficacy varied. The study involved 107 nineth grade students selected from a high school in the Mid-Atlantic United States. The students were enrolled in algebra class that made use of the Cognitive Tutor Algebra (CTA) software produced by Carnegie Learning to complement the regular classroom algebra lessons. The students were provided with laptops and directed to complete some CTA units at their own pace during two algebra lessons per week. Students' self-efficacy was assessed using an automated prompt incorporated into the Cognitive Tutor Software while their learning behaviours were assessed using a log-file generated by the software. Data were analysed using Path analysis. Findings indicate among others that students whose self-efficacy improved also had improvement in solving Mathematics problems subsequently.

In their own study, Chouinard and Roy (2008) examined the changes that occurred in the achievement goals of secondary school students in Mathematics viz-a-viz their competence belief and utility value. Using attitudinal scales to measure these variables, they found out that boys experienced a greater decrease over time in motivation in Mathematics but that girls showed a more positive attitude towards Mathematics than boys at older age.

Mavereach and Amrany (2007) conducted a study on the effect that metacognitive instruction had on students' Mathematics achievement and regulation cognition. The study involved 61 Israeli high school students. Thirty one students were exposed to treatment, i.e., metacognitive instructions while the other 31 students were not exposed to any obvious metacognitive procedure. Three kinds of

instrument were used: Mathematics Achievement Test, metacognitive awareness questionnaire and interviews. The results showed that the treatment group outperformed the control group in Mathematics.

The study conducted by Miles, Blum, Staats, and Dean (2003) investigated the effect of training in metacognitive skills on computer science (CS) application among college students. Participants were 210 students in New York High School. The Metacognitive Skills Inventory (MSI) was the instrument used for the study. The higher the score in the MSI, the higher the metacognitive skills. The findings of the study showed those groups exposed to training on MS performed better than those who were not.

Biryukov (2006) studied the effect of metacognitive skills on problem-solving. Specifically, the study investigated the metacognitive behaviours of the students in problem solving among others and analysed the skills utilised providing solutions to combinatory problems. The study was conducted with 48 first and second year pedagogical college students, using combinatory problem in Mathematics. Mean and *t*-test statistics were used to analyse the result. All the participants were asked to solve two combinatory problems that were presented to them on a list of paper. The result of the analysis and comparison of students' reflective self-reports on metacognitive training of their problem solving abilities in the two combinatory problems shows that those exposed to metacognitive experience performed better than those who were not exposed to it.

Some other studies have come up with similar results. For instance, a report by Buehl and Alexander (2001) indicated that students believed that their metacognitive strategy use significantly influenced their ability to solve work through academic tasks. So also, Sungur's (2007) study showed that students who are self-efficacious would possibly deploy strategies that enable them to control their own cognition. Also, Pintrich, Smith, Garcia, and McKeachie (1993) established positive relationship between high self-efficacy among learners and their use of cognitive and metacognitive strategies. Literatures also suggest that self-efficacy has a positive link to many adaptive outcomes like persistence, achievement goals, metacognitive strategy use and actual achievement (Linnenbrink & Pintrich, 2002; Pintrich & Schunk, 2002).

In the modern day world, emphasis has been shifting from teacher-centred learning processes to student-centred learning processes. As could be seen from the preceding empirical evidences, learners' self-efficacy and metacognition play significant role on their ability to learn. The study reported here has been able to further re-affirm the importance of these two variables and the need to adopt instructional strategies that develop learners in both areas.

1.3. Research questions

The following questions were addressed in this study:

i. What relationship exists among senior secondary school students' Chemistry self-efficacy, metacognition and their achievement in Chemistry?
ii. What relationship exists between senior secondary school students' Chemistry self-efficacy and their metacognition?
iii. What relationship exists between senior secondary school students' Chemistry self-efficacy and their achievement in Chemistry?
iv. What relationship exists between senior secondary school students' Chemistry metacognition and their achievement in Chemistry?

1.4. Research hypotheses

The research hypotheses for the study are listed as follows:

i. No significant relationship exists among senior secondary school students' Chemistry self-efficacy, metacognition and their achievement in Chemistry.
ii. No significant relationship exists between senior secondary school students' Chemistry self-efficacy and their metacognition.
iii. No significant relationship exists between senior secondary school students' Chemistry self-efficacy and their achievement in Chemistry.
iv. No significant relationship exists between senior secondary school students' Chemistry metacognition and their achievement in Chemistry.

2. Methods

This is a correlational study of the survey type. A total of 300 senior secondary school II students selected from ten schools in Ilorin, Kwara State, Nigeria participated in the study. Simple random sampling method was used to select thirty students from each of the 10 purposively sampled senior secondary schools. In the end, 191 males and 109 females were involved in the study as there were more males than females in the schools.

Data were collected using three instruments namely Chemistry Self-Efficacy Questionnaire (CSEQ), Chemistry Metacognition Questionnaire (CMQ) and Chemistry Achievement Test (CAT). The CSEQ comprised 20 items which were formulated to assess the students' Chemistry self-efficacy. It is eclectic and was adapted from three sources: Science Self-Efficacy Scale developed by Lent, Lopez and Bieschke (1991), Students' Self-efficacy Questionnaire, developed by Baanu, Oyelekan and Olorundare (2016) and Generalised Self-Efficacy Scale (Schwarzer & Jerusalem, 1995). The second instrument is a Chemistry Metacognition Questionnaire (CMQ), which required the respondents to report about themselves on a five point Likert scale ranging from "5 = strongly agree" to "1 = strongly disagree" comprising 25 items. It was used to assess students' Chemistry metacognition, and their use of various cognitive skills. The third instrument named CAT is a compilation of senior secondary school Chemistry questions. It is made up of 25 multiple choice questions covering the topics in the senior school Chemistry syllabus.

The instruments were validated by two lecturers in the Department of Science Education, University of Ilorin and an Educational Psychologist from the Department of Counsellor Education in the same university. In addition, the grammar structure was examined by a lecturer in the Department of Arts Education in the same university. The reliability of the questionnaires were determined using a test-retest method of two weeks' interval, in which the instruments were administered to thirty chemistry students from another school not involved in the main study. Using Pearson Product Moment Correlation statistic, the reliability indices of 0.83, 0.73 and 0.86 were obtained for the instruments, respectively. Four research questions were raised which generated four corresponding research hypothesis. The hypotheses were tested at 0.05 level of significance using Pearson Product Moment Correlation, regression and ANOVA.

The researchers visited the schools and sought the consent of the school Principals, Head of Science Department and the chemistry teachers, to engage their students in the study. An informed consent form was distributed to the respondents to seek the consent of the parents for the involvement of their children in the research in line with research ethics. After approval from the participating schools, the researchers personally administered the research instruments to the students. In doing this, the researchers first explained clearly the terms self-efficacy and metacognition to the students, illustrating with examples after which the questionnaires were administered to them. After forty minutes, the CSEQ and CMQ were retrieved from the students. The students observed fifteen minutes

break after which the CAT made up of 25 multiple choice questions was administered to the students spanning a time frame of 30 minutes.

The data obtained were subjected to descriptive and inferential statistics. Research hypotheses 1 was analysed using multiple regression and ANOVA, whereas hypotheses 2–4 were subjected to Pearson Product Moment Correlation statistic.

3. Results and discussion

The data obtained are presented and explained as follows:

Research Question 1: What relationship exists among senior secondary school students' Chemistry self-efficacy, metacognition and their achievement in Chemistry?

Hypothesis 1 was formulated from research question 1.

HO$_1$: No significant relationship exists among senior secondary school students' Chemistry self-efficacy, metacognition and their achievement in Chemistry.

Table 1 gives detail analysis of the results obtained in respect of research question 1 and hypothesis 1 based on multiple regressions. The "*R*" column represents the value of *R*, i.e., the multiple correlation coefficients. The relationship '*R*' among self-efficacy, metacognition (Predictors Variables) and chemistry achievement (Criterion Variable) is 0.831 which indicates a good level of prediction or a strong positive correlation among the variables. The R^2 value is a part of variance derived from the dependent variable, which the independent variables could be used to explain. The R^2 value of 0.691 shows that the independent variables could be used to explain 69.1% of how the CAT (which is the variable) varied.

Table 1. Multiple regression analysis among chemistry metacognition, self-efficacy and chemistry achievement test

Model	R	R^2	Adjusted R^2	Standard error of the estimate
1	0.831[a]	0.691	0.689	0.445

[a] Predictors (Constant): Metacognition and Self-Efficacy

[b] Dependent Variable: CAT.

The *F*-ratio in the ANOVA Table 2 as produced by multiple regression analysis through SPSS 20 puts the overall regression model to test as to whether it is a good fit to predict the levels of the dependent variables, [F (2, 297) = 332.482, *p* < 0.05], which is statistically significant.

Table 2. ANOVA results displayed for multiple regression analysis

Model	Sum of square	df	Mean square	F	Sig[b]
Regression	131.809	2	65.904	332.482	.000
Residual	58.871	297	198		
Total	190.680	299			

p < 0.05.

[a]Predictors (Constant): Metacognition and Self-Efficacy.

[b]Dependent Variable: CAT.

Table 3 presents the unstandardized (B) and standardized (Beta) regression coefficients, the *t*-value and the corresponding *p*-value for each variable. It can be concluded that the most important indicator to predict Chemistry Achievement is Chemistry Metacognition with (beta = 0.45; *t* = 9.99; *p* <

0.05) against that of Chemistry Self Efficacy with a very small difference (beta = 0.447; t = 9.83; $p <$ 0.05). The implication of this is that students who possess high Chemistry self-efficacy and metacognition would achieve better than those who lack both as was indicated by the predictive value of 69.1% as shown on Table 1 under column R^2. The hypothesis is rejected because the students' Chemistry self-efficacy and metacognition predicted their achievement in Chemistry.

Table 3. Standardized and unstandardized coefficients table for regression analysis

Models	Unstandardised coefficients		Standardised coefficients	t	Sig
	B	Standard error	Beta.		
1 (Constants)	0.349	0.83		4.205	0.00
Metacognition	0.445	0.45	0.454	9.993	0.00
Self-efficacy	0.451	0.46	0.447	9.831	0.00

The multiple regression which gave R = .831 among the three variables implies that where there were high Chemistry self-efficacy and metacognition among students, they were complemented with better academic achievement. A similar result was reported by Bernacki, Nokes-Malach and Aleven (2015) who found out that students who experienced increase in self-efficacy in Mathematics also experienced improvements in the achievement in the subject. So also, Nbina and Viko (2010) found out that when metacognitive self-assessment strategy was used in teaching Chemistry, the achievement and self-efficacy of the students in the subject is improved, thus establishing positive relationship among the three variables. Similar results were reported by Pajares, Britner and Valiante (2000), Hoffman and Spatariu (2008), Levin, Sabar and Libman (1991), Elliot and McGregor (2001) and Alci and Yuksel (2012).

A regression analysis by Coutinho (2008) revealed that metacognition did not facilitate the relationship between self-efficacy and students' achievement, but a related study showed that self-efficacy significantly facilitated the relationship between students' metacognition and their achievement. Coutinho, therefore, concluded that when students possess effective metacognitive strategies, their belief in their ability to successfully accomplish a task could be enhanced.

Research Question 2: What relationship exists between senior secondary school students' Chemistry self-efficacy and their metacognition?

Hypothesis 2 is formulated from research question 2.

HO₂: No significant relationship exists between senior secondary school students' Chemistry self-efficacy and their metacognition.

Table 4 gives detailed analysis of results obtained for research hypothesis 2, which sought to find out if there existed a relationship between students' metacognition and their self-efficacy. The Pearson Product Moment Correlation statistic was used to determine if there existed a relationship between the two variables. The result shows that there was a strong positive correlation between students' metacognition and self-efficacy (r = 0.704 and $p < 0.05$). Also, since the p-value of 0.000 is less than 0.05, it implies that there was statistically significant relationship between these two variables, hence research hypothesis 2 was rejected.

Table 4. Correlation analysis between chemistry self-efficacy and metacognition

		CMQ	CSEQ
CMQ	Pearson	1	0.704*
	Sig. (2-tailed)		0.000
	N	300	300
CSEQ	Pearson	0.704*	1
	Sig. (2-tailed)	0.000	
	N	300	300

*Correlation is significant at the 0.05 level (2-tailed).

This result indicates that a students' understanding of how he learns could in turn result in a better self-efficacy in going about a chemistry task. This attests to the finding of Pintrich, Smith, Garcia, and McKeachie (1993) which indicated a positive correlation between the use of metacognitive instructional strategies and high levels of self-efficacy; and that of Buehl and Alexander (2001) who reported that students' believed they were able to carry out some tasks successfully because they utilised metacognitive strategy. This finding also concurs with that of Linnenbrink and Printrich (2003), Sungur (2007) and Hoffman, and Spatariu (2008) who affirmed that self-efficacy is positively linked to metacognitive strategy use. However, Alci and Yuskel (2012) found significant difference between students' self-efficacy and metacognition.

Research Question 3: What relationship exists between senior secondary school students' Chemistry self-efficacy and their achievement in Chemistry?

Hypothesis 3 was formulated from research question 3.

HO₃: No significant relationship exists between senior secondary school students' Chemistry self-efficacy and their achievement in Chemistry.

Table 5 presents the results of the relationship between students' self-efficacy and their chemistry achievement. Pearson Product Moment Correlation statistic was used to find out whether there existed a relationship between the two variables. Since the p-value of 0.000 is less than 0.05 level of significance ($r = 0.766$ and $p < 0.05$), it implies that there was a strong positive relationship between students' self-efficacy and their chemistry achievement which was also significant. The research hypothesis was rejected because there was a significant relationship between Chemistry students' self-efficacy and their achievement in Chemistry.

Table 5. Correlation analysis between chemistry self-efficacy and chemistry achievement test

		CSEQ	CAT
CSEQ	Pearson	0.776*	1
	Sig. (2-tailed)	0.00	
	N	300	300
CAT	Pearson	1	0.776*
	Sig. (2-tailed)		0.00
	N	300	300

Correlation is significant at the 0.05 level (2-tailed).

This means that a student who is highly self-efficacious about a chemistry task could be able to successfully carry out a task that will lead to improved Chemistry achievement. This finding also agrees with Zeldin, Britner, and Pajares (2008), Schwarzer and Jerusalem (1995), Nbina and Wagbara (2012), Bandura, Barbaranelli, Caprara and Pastorelli (1996) and Hodges and Murphy (2009). However, the finding differs slightly from that of Baanu, Oyelekan and Olorundare (2016) who found a non-

significant positive relationship between students' self-efficacy and their academic achievement in Chemistry. Similarly, a study by Al-baddareen, Ghaith and Akour (2015) indicated that self-efficacy did not have significant effect on academic motivation which is normally expected to enhance better academic achievement in students. In the same vein, Alci and Yuksel (2012) found out that self-efficacy did not predict students' academic performance.

Research Question 4: What relationship exists between senior secondary school students' Chemistry metacognition and their achievement in Chemistry?

Hypothesis 4 is derived from research question 1.

HO$_4$: No significant relationship exists between senior secondary school students' Chemistry metacognition and their achievement in Chemistry.

Table 6 shows the results obtained in respect of hypothesis 4. The Pearson Product Moment Correlation statistic was used to determine if there existed a relationship between the two variables. The result shows a strong positive correlation between the students' metacognition and their chemistry achievements (*r*=.769 and *p*<0.05). Also, since the p-value of 0.000 is less than 0.05 level of significance, it means that there was statistically significant relationship between students' metacognition and chemistry achievement test. Hence, the research hypothesis was rejected.

Table 6. Correlation analysis between chemistry metacognition and chemistry achievement test

		CMQ	CAT
CMQ	Pearson	.769*	1
	Sig. (2-tailed)	0.00	
	N	300	300
CAT	Pearson	1	.769*
	Sig. (2-tailed)		0.00
	N	300	300

Correlation is significant at the 0.05 level (2-tailed).

This result indicates that a high metacognition about a chemistry task would lead students to a better achievement in Chemistry. A similar study conducted by Mgbemena, Achufusi, and Inomiesa (2013) indicated that students taken through the metacognitive learning cycle performed better in Physics than those who were not taken through the cycle. Miles, Blum, Staats, and Dean (2003) also found out that metacognitive skills were a good predictor of students' achievement. Similar results were reported by Santrock (2001), Alci and Yuksel (2012), Schunk and Zimmerman (1994) and Bernacki, Nokes-Malach and Aleven (2015). Al-baddareen, Ghaith and Akour (2015) also found out that metacognition had significant effect on academic motivation. A high academic motivation is expected to lead to a better academic achievement.

In addition to establishing relationship among metacognition, self-efficacy and students' achievement in Chemistry, the findings of this study appears to have a semblance to the findings of related studies conducted not only in Mathematics and other science subjects, but with studies conducted in other locations and populations. When this happens, it not only confers some sort of additional reliability on earlier findings, it also gives room for more acceptable generalisations. This discussion has therefore not limited the value of this study to Chemistry education alone, but has taken a little step forward in providing some useful information for Science Education in general.

4. Conclusion and recommendations

The conclusion from this study is that the independent variables of self-efficacy and metacognition influence each other and both also have influence on students' achievement in Chemistry. It would,

therefore, be beneficial if Chemistry teachers would assist their students in improving their self-efficacy by spurring them into understanding how they learn the subject. Helping students to develop their Chemistry problem solving skills could equally go a long way in improving their achievement. All these imply that instructional strategies that facilitate students' better understanding of how they learn (metacognition), engage as well as improve their self-efficacy would assist in improving their achievement in Chemistry.

On the basis of the outcome of this study, the following recommendations are advanced:

1. Chemistry teachers should take some time in advancing their own knowledge of metacognition and self-efficacy as this would assist them in enabling their students to advance their Chemistry knowledge.
2. Chemistry teachers should assist their students in developing their chemistry self-efficacy and metacognition as a way of improving their Chemistry achievement.
3. Chemistry teachers should consider the use of self-regulated learning and metacognitive learning cycle as a way of improving students' self-efficacy and metacognition.
4. School counsellors should pay more attention to students' self-efficacy and metacognition in diagnosing the cause of poor academic achievement across subjects.
5. Researches should be conducted to locate other existing instructional strategies that enhance students' metacognition and self-efficacy so that such could be recommended for Chemistry instruction.

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