
EMOTIONAL INTELLIGENCE AND PROBLEM- SOLVING ACHIEVEMENT OF CHEMISTRY STUDENTS

By

Adigwe J. C.

Department of Science Education,

University of Nigeria Nsukka

Josephadigwe2013@yahoo.com

+2348063877572

ABSTRACT

This paper investigated the influence of emotional intelligence on problem solving achievement of secondary school chemistry students. The design of the study was ex post facto. The population was secondary school students in Nsukka Education Zone, who study chemistry. Stratified sampling technique was used to draw three urban and three rural schools from the three local government areas in the Education zone. The sample consisted of three hundred and ten students: one hundred and forty one male students and one hundred and sixty nine female students. Seven hypotheses guided the study, and two research instruments were used: (i) a chemistry problem solving test consisting of fifty multiple-choice items based on problem solving in chemical stoichiometry, and (ii) Bar-On EQ -i YV self-report scale. These tests were administered to all the subjects and were collected on the spot. 3x2x2 ANOVA and correlational analyses involving the achievement scores and the dimensions of emotional intelligence were made. It was found that : (i) emotional intelligence significantly influenced students' achievement in solving chemical stoichiometric problems, (ii) gender has no significant influence on the students' emotional intelligence, (iii) school location has no significant influence on the students' emotional intelligence, (iv) there is no significant interaction influence of gender and levels of emotional intelligence on students' achievement, (v) there is no significant interaction influence of school location and levels of emotional intelligence on students' achievement, (vi) there is no significant interaction influence of gender and school location on emotional intelligence of the students, and (vii) there is no significant 3-way interaction of gender, school location and levels of emotional intelligence on students' achievement. These findings were discussed and some recommendations were made among which are: (i) Chemistry teachers should acknowledge the relevance of emotional intelligence as a significant psychosocial factor in chemical education. (ii) The emotions and feelings of students in terms of stress, mood, and adaptability, intrapersonal and interpersonal psychological reactions in the chemistry classroom setting should be identified and understood by the teacher.

INTRODUCTION

Problem solving in chemistry is regarded as a very difficult intellectual task for secondary

school chemistry students because of its complex intellectual processes. As a result it is seen as one of the principal causes of scholastic failure in school chemistry (Baujoude & Barakat, 2003, Adigwe, 2014 & Chandrasegaran, Treaquist, Walddrip

& Chandrasegaran, 2008). Research reports (Bodner & Herron, 2002, Baujaoude & Barakat, 2000 & 2003, Jonassen, 2000 & 2004, Arova, 2007, Adigwe 2012 & 2014) on problem solving in quantitative chemistry indicate that students' failure to successfully solve problems was due to difficulties they experience in the crucial phases of problem solving processes. They were incapable of identifying, understanding and stating appropriate variable relationships, constructing appropriate problem solving plans and adapting appropriate strategies to solve chemical problem. Consequently, they could not check validity of relations; translate physical principles/ relations into appropriate mathematical relations formulae; transform rules/ formulae to solve problems. They were found to lack conceptual skills of chemistry and unable to work or reason within the problem restrictions and context. They lacked skills of logical analysis and organizing skills; and incapable of initiating problem solving approaches. They found it difficult to apply chemical knowledge/ skills and reasoning with data in solving problem. (Ferguson-Hessler & Brockamp 2001, Jonassen, 2004, Dahsan & Coll 2007, Adigwe, 2012 & 2014). They were unable to correctly recall/recognize integrate and generalize items of chemical knowledge/ skills, estimate and evaluate possible solutions and the solution process (Baujaoude & Barakat, 2003, Hollingworth & McLoughlin, 2005, Jonassen, 2004, Portrols & Lopez, 2008, Chandrasegaran, Treagust Waldrip & Chandrasegaran 2008). Thus solving quantitative chemical problems has been a major difficulty in secondary chemical education. These difficulties are cognitive in nature in that they require intellectual processes.

Research efforts have been directed at identifying some psychosocial variables that may

impede students' capabilities to correctly solve quantitative chemistry problems. Such studies have identified students' attitudes, anxiety, motivation, psychodynamics of evaluation, age- grade, interest and psychosocial factors that affect students' capabilities to solve quantitative chemical problems (Jonassen, 2000 & 2004; Sedlacek, 2004; Pertroules & Lopez, 2008, Alavi & Hoseini 2009, Longjohn, 2009 & Adigwe, 2014). These factors have been confirmed by these studies as intervening variables between students' capabilities to successfully solve the problems.

Emotional intelligence is a psychosocial factor that has recently emerged in psychology and education literatures intelligence, a non-cognitive factor, has eluded a specific definition. However, it has been defined in a general sense as an individual's ability to perceive, integrate and understand emotion in a manner that enables him/her to facilitate his/her thought-processes and promote personal growth and development. This factor differs from intelligence quotient (IQ), which is cognitive in nature. It is part of multiple intelligence and it includes both interpersonal intelligence, which is one's capability to understand intentions, motivations and desires of other people, and intrapersonal intelligence, which is one's capability to understand oneself, appreciate one's feelings, fears and motivations. (Farooq, 2003, Dunn, 2003, Day & Carroll, 2004, Akbas, & Khan, 2007, Jaeger, & Eagan, 2007 Gardiner, 2010, & Mohammed, Aijaz & Saria, (2011) hypothesized that the traditional type of intelligence has failed to fully explain the various notions of performance ability in intellectual functioning. The notion of affective dimension in intellectual functioning, emotional intelligence, has gained a wider acceptance in education and psychology. This is believed to

significantly account for variation in intellectual functioning. The definitions and variable constructs of emotional intelligence are varied. In the view of Mayer, Salovey, & Caruso.(2000), it is the ability to monitor or assess one's own and others feelings and emotions, to discriminate among them and to apply this emotional information to guide one's reasoning process and actions

The various definitions of emotional intelligence (E.I.) have been applied to build three models of emotional intelligence E.I): (a) Ability-based emotional intelligence model, (b) mixed emotional social intelligence model, and(c) trait emotional intelligence model. The ability-based emotional intelligence model views E.I. as an ability of an individual to process emotional information and relate the process to cognitive capabilities. It emphasizes four types of capabilities: (a) perceiving and differentiating emotions in one's self and others; (b) applying emotional tools to facilitate cognitive processes like thinking and solving problems; (c) understanding and comprehending emotions; and (d) managing the emotional characteristics of one's self and those of other in order to attain cognitive processes. The mixed emotional social intelligence model of Goleman (1998) views E.I. as a range of competency and skill levels which motivates one's performance. It emphasizes: (a) self-awareness, which is one's ability to understand his/her emotion and its impact on his physical and mental actions, and rationalization to guide situations, (b) social-awareness, which is sensing, understanding and reacting to others' emotions, while recognizing the social relations. (c) self-management, which is one's ability to control his/her emotions, the corresponding impulses and adjusting to variations in environmental situations, and (d) managing

relations, which is the ability to manage psychosocial conflicts, mentor, influence and foster the growth and development of others. It therefore emphasizes understanding of one's emotions and those of others in the environment, relating psychosocially well with them in order to successfully manage environmental demands (Bar-On 2006). The trait model of Petrides & Furnham, 2003 & 2011), conceptualized self-perceptions in one's capability to identify, understand, process and apply emotional information to attain desirable behavioural adjustment in order to achieve cognition. Although there are some differences amongst these models, a central theme of managing emotional information, knowledge and skills in order to achieve cognitively effective management of situations, whether in the learning process, industry and other forms of psychosocial setting are commonalities of all the models.

The measurement of E.I. varied according to its different definitions, construct attributes and models. There are thus, different instruments for measuring E.I. (Sirhan, 2007, Tai, Sadler & Lochr, 2005 and Banya, 2005). Petrides, Furnham & Frederickson (2004) classified the measurement approaches into ability-based and trait-based E.I. measures. The models that view E.I. as ability or competency/ skills based constructed ability-based instrument for assessing emotional intelligence quotient (EIQ). Ability-based E.I. tests are measures similar to I.Q. tests in that they are based on performance measures similar to solving problems. The Mayer-Salovey-Caruso (2000) emotional intelligence test (MSCEIT) is an ability-based test, whose shortcoming as other ability-based test, is that they have no right or wrong responses so items cannot be objectively scored. There is the Bar-On (1997) emotional intelligence

quotient inventory, the short-form (Bar-On SEIQ) and youth version Bar-On EQ-IYV. The latter is specifically designed for young people of age 7-18 years. It has sixty (60) items that can be administered in a short-time interval. It contains an inconsistency index which indicates whether respondents responded randomly, and a positive impression scale which tends to indicate whether a respondent have attempted to present him or herself in a favorable and socially desirable manner. However, it is subject to cultural bias (Johnstone, 2005), and as a trait-based E.I. Q test, it is dependent on respondents accurate self-awareness and honesty.

Research studies outside Nigeria (Bar-On 2006, Mahyuddin, Abdullah, Roslan, Elias & Suleiman 2007; Katyl & Awasthi, 2005; Low & Nelson, 2005; Jaeger & Eagan 2007; Jaeger, 2003 & 2004; Parker, Duffy, Wood, Bond & Hogan, 2005; Parker, Summerfield, Hogan & Majcski, 2004; Pritchard & Wilson, 2003, Sedlacek, 2004 & Gardiner 2010) observed that emotional intelligence measures of students were related to their academic achievement in various subject domains. Students who had higher than average EQ were in general more successful in academic work than those who had below average in EQ. They were also more successful in adjusting to environmental demands and pressure. Although some studies (Audrey & Jeagan, 2007) found that correlations between academic achievement and emotional intelligence were weak, varied and in some instances insignificant due to issues of subject-matter domains and characteristics of operationalised achievement measures. In Nigeria studies by Uzoechi, Kurumeh & Azuka (2013), Azuka, (2010), Nwadinigwe & Azuka- Obieke (2012), Yomi (2007), Adeoye, (2010) found relationships between

emotional intelligence and academic achievement of students.

As significant correlations have been found amongst cognitive mind, emotional mind and students' achievement, it can be hypothesized that the students operate at two different levels, cognitive and emotive, in learning situations. Emotional intelligence appears, therefore to be the missing link in the equation of factors that determine students' academic achievement. Could emotional intelligence influence students' capabilities to solve quantitative problems in chemistry? Could one hypothesize this view in that various strategies have been employed to enhance students' capabilities to solve stoichiometric problems in chemistry to no avail? West African Examination Council (WAEC, 2004-2011) still express the poor chemistry achievement of students in these examination. Programmes on students' attitudes, teaching methods, learning difficulties, and use of educational media did not significantly improve their problem solving achievements (Brodner & Herron, 2002, Bukat, 2004, Jonasse, 2004, Okeke, 2011, Okonkwo, 2014, Okonkwo & Adigwe, 2014 & Adigwe, 2014). It appears that attention should now be turned to emotional intelligence as a factor in learning that could influence students' capabilities to solve quantitative chemistry problems. In what ways does one's ability to perceive one's emotions and those of others, and integrate the emotional information, knowledge/skills to facilitate thought-processes influence one's capability to solve quantitative chemical problems? As emotions are believed to influence thought – processes of an individual, it could be that significant achievement by students in chemical problem solving will depend on their capability to manage their emotional intelligence.

An extensive review of chemical education literature indicated that influence of emotional intelligence on chemical problem solving has not been explored. On the basis of the above controversy, postulation and the strong recommendation of Uzoechi, Kurumeh & Azuka (2013) that studies on emotional intelligence be carried out in various subject areas in Nigerian secondary education curriculum to ascertain its relationship with academic achievement, it becomes important to investigate if there is any significant influence of emotional intelligence on students' achievement in solving chemical problems.

Chemical stoichiometry was chosen for the study because it is the area where Nigerian secondary chemistry students have the greatest learning difficulties, Baujaoude & Barakat, 2000 & 2003, Arova, 2007, Okonkwo & Igboegwu, 2012, Adigwe, 2005, 2012 & 2014). It is also important to investigate whether there are any significant gender and school location influences on levels of emotional intelligence of students; and whether students' gender and school location have any significant interactive influence on students' emotional intelligence.

PURPOSE OF STUDY

The purpose of this study is therefore to investigate the influence of emotional intelligence on problem solving achievement of secondary school chemistry students, and identify the influences of gender and school location on students' emotional intelligence.

Hypotheses

The following hypotheses were therefore advanced to guide the study:

- i. There are no significant differences among the problem solving achievement mean scores of high, medium and low emotional intelligent students.
- ii. There is no significant difference between the emotional intelligence mean scores of male and female chemistry students.
- iii. There is no significant difference between the emotional intelligence mean scores of rural and urban school students.
- iv. There is no significant interaction influence of gender and emotional intelligence on students' achievement in solving chemical problems.
- v. There is no significant interaction influence of school location and emotional intelligence on students' achievement in solving chemical problems.
- vi. There is no significant interaction influence of school location and gender on emotional intelligence of the students.
- vii. There is no significant interaction influence of emotional intelligence, gender and school location on students' achievement in solving chemical problems.

METHODOLOGY

Research Design

Ex-post facto designs was employed in this study as it examined the relationship between students' achievement in solving chemistry problems and students' emotional intelligence; and examine the influences of gender and school location on the students' emotional intelligence.

Population and Sample

The population comprised senior secondary class III students in Nsukka education zone of Enugu State, Nigeria, who offered chemistry at West African Senior Secondary Certificate Examinations of 2012-2013 academic sessions. This zone was chosen because a previous study reported poor chemistry achievement in schools in the zone (Okonkwo & Igboegwu, 2012). The sampling technique consisted of stratified random sampling to draw three rural and three urban schools from the three local Government areas in the Education zone. All the chemistry students in the sampled schools were used for the study. On the whole there were 310 students: 141 male and 169 female students.

Instrument

Two types of tests were employed in the study: (i) A chemistry test consisting of fifty (50) multiple-choice items based on stoichiometric chemistry problems developed by this researcher, and (ii) Bar-On EQ-iYV self-reports scale. The later was used in this study because of its advantages over the ability-based MSCEIT as reported in some studies (Jaeger & Eagan 2007, Johnstone, 2005, Low and Nelson, 2005). It was found that the ability-based measures, eg MSCEIT measures have poor reliability and validity characteristics (Ciarochi, Chan & Caputi, 2000) Bar-On EQ-iYV is a trait-based approach to measure individual's emotional intelligence in a way that the measures show how the individual copes with life situations(Day & Carroll,2004).It can be objectively scored. It has five dimensional scales and fifteen (15) subscales or clusters. The five scales are: (i) intrapersonal scale, which relates to self-management; abilities of self-awareness, assertiveness, self-regard and

actualization; (ii) interpersonal scale, which relates to skills of empathy social responsibility and interpersonal relations (iii) adaptability scale, which relates to ability to be flexible, realistic and to solve problems with a systematic approach; (iv) stress management scale, which relates to ability to tolerate stress and impulse control, and (v) general mood scale relating to optimism, contentedness, happiness or spirit of elation.

The instrument was edited by making the language of the text simpler for understanding of the senior secondary class iii students. It was then pilot tested with a sample of one hundred (100) students from ten (10) schools in the study area, but outside the sampled schools. It was found to have the following parametric characteristics: (i) overall test had a test-retest index of reliability of 0.68, (ii) intrapersonal scale had a reliability of 0.72, (iii) interpersonal scale had a reliability index of 0.41 (iv) adaptability scale had a reliability index of 0.69, (vi) general mood had a reliability index of 0.63. This instrument had been used extensively in previous on emotional intelligence studies for example, Bar-On,(2002), Parker, Summerfield, Hogan & Majcski (2004) , Parker,Duffy, Wood, Bonds & Hogan (2005 & 2006), Pritchard & Wilson, (2003), Rozell, Pettijohn & Parker (2002), Jaeger, (2003 & 2004), Jaegar & Eagan, (2007) & Johnstone, (2007).

PROCEDURE

The two tests were administered to the subjects in the sample. The problem solving test was administered first followed by the emotional intelligence test. This order was intended to get students to face the problem solving situation first and then to report their emotional dispositions as they solved the problems.

TREATMENT OF DATA

The statistical data for emotional intelligence and problem solving were collated according to gender and school location variables. The students' emotional intelligence scores were categorized into high (>70%), medium(>50%) and low (<49%) levels, in order to investigate its influence on problem solving achievement of the students. 3x2x2 ANOVA was done using problem

solving scores as dependent variable and levels of emotional intelligence, gender and school location as independent variables and (ii) correlational analyses of scores of the five (5) scales of emotional intelligence dimensions and problem solving achievement scores were done in order to investigate the relationships of each dimension and the achievement scores.

Table 1: Achievement mean and standard deviation scores x Emotional levels x sex x school locations.

E.I.	S.L.	M			F			Grand Total		
		N	X	S.D	N	X	SD	N	X	SD
High	Urban	6	66.00	5.51	1	64.00	3.12	7	65.71	5.09
	Rural	8	67.50	6.21	4	65.00	2.00	12	66.67	5.21
	Total	14	66.86	5.75	5	64.80	1.79	19	66.32	5.04
Medium	Urban	83	32.39	12.72	90	32.13	11.06	173	32.25	11.85
	Rural	31	46.45	14.19	64	30.63	10.31	95	35.79	13.82
	Total	114	36.21	14.50	154	31.51	10.75	268	33.51	12.67
Low	Urban	6	30.29	6.87	7	33.14	11.00	14	31.71	8.94
	Rural	7	37.40	5.81	3	16.00	14.42	3	16.00	14.42
	Total	7	30.28	6.87	10	28.00	13.98	17	28.94	11.36
Grand Total	Urban	96	34.33	14.56	98	32.53	11.41	194	33.42	13.06
	Rural	45	50.77	15.50	71	31.94	13.29	110	38.62	16.70
	Total	141	39.08	16.56	169	32.28	12.20	310	35.30	14.67

E.I=emotional intelligent. S.L=school location. M=male. F=female. significance of the differences 3x2x2 ANOVA was done.

Table 1 presents mean and standard deviation scores of problem solving achievement of students according to three (3) levels of emotional intelligence by gender and school locations. It indicates that high emotional intelligent students achieved higher than the medium and low emotional intelligent students. While the students at medium level achieved higher than the low emotional intelligent students. This indicates that emotional intelligence may have influence on problem solving achievement of the students. In order to test the

Results in table 2 indicate that (i) emotional intelligence have a significant influence on problem-solving achievement of students (F-ratio = 38.47, $P < 0.045$). There were significant differences in problem solving achievement of students with different levels of emotional intelligence. Hypothesis 1 was therefore rejected; (ii) there was no significant difference between the emotional intelligence scores of male and female students (F-ratio = 0.188 $P < 0.05$). Hypothesis 2 was therefore accepted. Emotional intelligence is

not dependent on sex of students; (iii) there was no significant differences between the emotional intelligence scores of rural and urban students (F-ratio = 0.05 $P > 0.05$). Hypothesis 3 was therefore accepted. Emotional intelligence is not dependent on school location; (iv) there was no significant interaction influence of gender and levels of emotional intelligence on students' problem solving achievement (F-ratio = 1.211, $P > 0.05$). Hypothesis 4 was therefore accepted; (v) there was significant interaction influence of school location and levels of

emotional intelligence on students' achievement in problem solving. (F-ratio = 3.13, $P < 0.05$). Hypothesis 5 was therefore rejected; (vi) there was no significant interaction influence of school location and gender on emotional intelligence of the students (F-ratio = 0.0588, $P > 0.05$). Hypothesis 6 was accepted; (vii) there was no significant influence of gender, school location and levels of emotional intelligence on students' achievement on problem solving (F-ratio: 1.065, $P > 0.05$). Hypothesis 7 was therefore accepted.

Table 2: Results of 3x2x2 ANOVA of EI scores x gender x school locations.

Source	Dependent Variable	SS	Df	MS	F	Sig.
Corrected model	CAT scores	26489.132*	10	2648.913	20.027	0.000
	E.I. scores	6244.537*	10	624.454	25.796	0.000
Intercept	CAT scores	89587.991	1	89587.991	677.313	0.000
	E.I. scores	172287.684	1	172287.684	7117.033	0.000
Gender	CAT scores	218.455	1	218.455	1.652	0.200
	E.I. scores	4.562	1	4.562	0.188	0.665
School location	CAT scores	11.340	1	11.340	0.086	0.770
	E.I. scores	1.276	1	1.276	0.05	0.819
E.I. levels	CAT scores	10175.832	2	5087.916	38.466	0.000
Gender x location	CAT scores	160.219	1	160.219	1.211	0.272
	E.I. scores	14.229	1	14.229	0.588	0.444
Gender x E.I. levels	CAT scores	255.080	2	127.540	0.964	0.382
	E.I. scores					
location x E.I. levels	CAT scores	823.490	2	411.745	3.113	0.046
Gender x location x E.I levels	CAT scores	140.904	1	140.904	1.065	0.303
Error	CAT scores	38755.026	306	132.270		
	E.I. scores	7092.884	310	24.208		
Total	CAT scores	444112.000	309			
	E.I. scores	1086244.000				
Corrected total	CAT scores	65244.958	309			
	E.I. scores	13337.421				

a. $R^2=0.406$ (Adjusted $R^2=0.386$); b. $R^2=0.468$ (Adjusted $R^2=0.450$)

Table 3: Relationships of emotional dimensions and achievement in problem solving

Subscale	Σ	$\bar{X}$	SD	r^2
Total E.I.	10943.0	35.30	14.67	0.62*
Intrapersonal	2286.84	7.38	1.20	0.71*
Interpersonal	2146.84	6.93	6.31	0.33
Stress	2237.24	7.22	5.83	0.58*
Adaptability	2196.24	7.08	5.72	0.51*
Mood	2216.84	7.15	3.11	0.54*

N = 310 *p <0.05.

Table 3 presents the relationships of emotional dimensions and problem solving achievement of the students. It revealed that four of the dimensions, intrapersonal stress, adaptability and general mood had positive significant relationships with the students' achievements in problem solving.

SUMMARY OF FINDINGS

- (1) Emotional Intelligence significantly influences students' achievement in solving chemical problems.
- (2) There was no significant gender difference in emotional intelligence of the chemistry students.
- (3) There was no significant difference in the emotional intelligence of rural and urban school students.
- (4) There was no significant interaction influence of gender and levels of emotional intelligence on students' achievement in solving the chemical problems.
- (5) There was no significant interaction influence of school location and levels of emotional intelligence on students' achievement in solving chemistry problems.
- (6) There was no significant interaction influence of school location and gender on emotional intelligence of the students.

- (7) There was no significant 3-way interaction of gender, school location and levels of emotional intelligence on students' achievement in solving chemical problems.

DISCUSSION

The findings of this study have indicated that emotional intelligence relates significantly to students' capabilities to solve chemical problems. This finding supports the findings in related previous studies, where it was found that emotional intelligence was significantly related to students' academic achievement (Goleman, 1998; Jaeger, 2003 & 2004; Mayer, Salovey, & Caruso, 2000; Zin, Wersberg, Wang, & Walberg, 2003; Osterman, 2001; Farooq, 2003; Smith, 2004; Bar-On, 2006; Jaeger & Eagan, 2007; Mahyuddin, Abdullah, Elias & Suleiman, 2007; Yomi, 2007; Alavi & Hoseini, 2009; Gardiner, 2010; Adeoye, 2011; Hassan, 2010; Azuka, 2010; Mohammed, Aijaz & Saria, 2011 and Nwadinigwe & Azuka-Obieke, 2012). It was further observed that significant positive relations exist among the emotional intelligence dimensions and students' achievement in problem solving. Intrapersonal, stress, adaptability and mood emotional dimensions had significant relationships with achievement. These appear to be responsible for the observed significant influence of emotional intelligence and students' academic achievement. Mahyuddin et al. (2007) found that the capability to acquire basic skills (reading,

writing and arithmetic), which are cognitive skills, by primary school children was significantly related to their emotional intelligence. Children with high emotional intelligence quotient (EIQ) had better acquisition of basic skills than those with low emotional intelligence quotient. Azuka, (2010) found significant positive correlation between emotional intelligence and Nigerian students' achievement in mathematics. Nwadinigwe & Azuka, (2012), Yomi, (2007) & Adeoye, (2010) also had the same results with Nigerian samples, the difference being in different subject domains. Thus, Nigerian students' capabilities to solve chemical problems are positively related to their emotional intelligence. Another factor, therefore, in academic success of Nigerian students is emotional intelligence. The students' capacities to manage stress, intrapersonal emotions, emotional adaptability to learning environment and general mood significantly relate to their success in solving quantitative problems in chemistry. They therefore seem to relate to teaching, learning and classroom interactions emotionally. Hence, their emotions seem to bear on their degree of learning, scope and depth of understanding, retention and general educational attainment.

Problem solving in chemical stoichiometry, a cognitive process, therefore has emotional component. The student problem solver therefore brings his/her emotional characteristics to bear on the intellectual process of solving the problems. This tends to suggest that there are emotional components of a cognitive ability, and cognitive components of emotional capability; both interwoven influence the academic performance of the students. The processes of problem understanding /representation, construction of problem solving plan, executive operations/ structural processes and evaluation of the problem process/solution seems to be emotion laden. These intellectual processes involved in solving stoichiometric

problems in chemistry are therefore tainted with emotional reactions. This study has therefore shown that the successful problem solvers have high emotional intelligence than the unsuccessful solvers. Jaeger et al, (2001) found that this influence continued as the students progressed in their academic programme. It implies therefore that the teaching of chemical problem solving must take the relationship between academic achievement and emotional intelligence into consideration. In this study gender and school location were found to have insignificant relationships with students' emotional intelligence.

These findings differed from results of previous studies (Katyl & Awasthi, 2005; Jaegan et al, 2007; Mahyuddin et al, 2007 & Alavin & Hoseini, 2009). They found significant gender differences in emotional intelligence. Girls were found to have higher level of emotional intelligence than boys. This difference was ascribed to the facts that girls are superior to boys in perceiving emotions and non-verbal perceptions. According to Mahyuddin et al, (2007) girls receive significantly more education of emotions than the boys from their parents. This could make them more emotionally stable and competent than their male counterpart. Boys exhibit strong personality traits than girls, and as such their emotional needs are neglected, while attention are given to those of the girls (Wing & Love, 2001; Dun, 2002; Katyl & Awasthi, 2005 & Jaegan et al, 2007). However, Can, (2002) found significant gender difference in emotional intelligence in favour of the boys.

This study did not find significant difference in emotional intelligence of rural and urban school students. Previous studies did find significant difference in emotional intelligence of the rural and urban school students (Mahyuddi et al, 2007 & Katyl & Awasthi, 2005). They found that the rural school students had higher level of emotional intelligence than

the urban school students. The reason advocated for this difference was that the rural school students in Malaysia had developed spirit of cooperation, community team work and they had family cooperation. Gender and school location had no significant influence on emotional intelligence, and they had no significant interaction influence on emotional intelligence of the students. Gender and levels of emotional intelligence had no significant influence on students' achievement. Also school location and levels of emotional intelligence had no significant interaction influence on students' achievement. The 3-way interaction influence was not significant

CONCLUSION

It can be concluded that emotional intelligence is a significant factor in students' achievement in solving quantitative chemical problems. However, gender and school location do not significantly influence students' emotional intelligence. The reasons for these observations are not clear, as sex and location variables had significant influences in other cultures. Emotional intelligence may therefore be culture bound.

RECOMMENDATIONS

As emotional intelligence has been found to significantly relate to students' capabilities to solve chemical problems, the following recommendations are made in order to improve their achievement through enhancement of this psychosocial characteristic:

- (i) Chemistry teachers should acknowledge the relevance of emotional intelligence as a significant psychosocial factor in chemical education.

- (ii) The emotions and feelings of students in terms of stress, mood, and adaptability, intrapersonal and interpersonal psychological reactions in the chemistry classroom setting should be identified and understood by the teachers.
- (iii) Teachers should endeavor to understand the emotional reactions of students to instructional materials and entire chemistry learning environment, and identify where interventions may be required,
- (iv) As teachers plan chemistry lessons, tests and examinations the emotional understanding, skills and capabilities of students should be put into consideration,
- (v) Teachers should endeavor to create chemistry learning environment that enhances students capabilities to utilize emotional intelligence in cognitive fields, and integrate the two aspects of emotional and cognitive intelligences to successfully solve chemistry problems, and
- (vi) Teachers should initiate classroom practices that aid students to understand and manage their emotional intelligence in chemistry learning situations.

It is recommended that further studies be carried out in other areas of chemistry, particularly qualitative areas of the subject to find out whether there is any influence of emotional intelligence on

students' achievement in those areas. Teachers should start to think of how to incorporate elements of human emotional characteristics into chemistry teaching.

REFERENCES

- Adeoye, H. (2010). Emotional intelligence and self-efficacy as determinants of academic achievement in English Language among students in Oyo State senior secondary schools. Retrieved October 21, 2011 from <http://www.faqs.org/periodicals/2010031973238831.html>.
- Adigwe, J. C. (2005) Influence of Ethnicity, Formal Reasoning and cognitive Styles on Students' Achievement in Balancing Chemical Equations. *Review of Education*, 16, 2, 21-31.
- Adigwe, J. C. (2012) Influence of mathematical reasoning skills on students' achievement in chemical stoichiometry. *Review of Education*, (23), 1, 1-22.
- Adigwe, J.C. (2013) Influence of cognitive Style, Formal Reasoning and Sex on Students' Achievement in Chemical Bonding. *Review of Education*, 24, 1, 9-24.
- Adigwe, J. C. (2014). Teaching Problem solving in chemical stoichiometry. *Review of Education* 27, 1, 15-35.
- Alavi, H. R. & Hoseini, A. R. (2009). Effect of educational factors on the academic performances of University students in Chemistry. *Chemical Education Journal* (13), 2, 10-15.
- Arova, A. (2007). Examining the problem-solving achievement of eight-grade students. TIMSS.2003. Retrieved from TIMSS & PIRLS International study center, Boston College, USA
- Azuka, B. F. (2010). The relationship between emotional intelligence and academic achievement of senior secondary school students in Mathematics in FCT, Abuja. Unpublished M.Ed. thesis. Keffi: Nassarawa State University.
- Audrey, J & Eagan, M. (2007). Exploring the value of emotional intelligence: A means to improve academic performance. *NASPA Journal* (44), 3, 512-537.
- Akbas, Sh. & Khan, A. (2007). Affective factors that influence Chemistry achievement and the power of these factors to predict Chemistry achievement II. *Journal of Turkish Science Education*. (12), 3, 23-31.
- Banya, S. (2005). Study of factors affecting attitudes of young female students towards Chemistry at high school level. Unpublished Ph.D. dissertation. Mississippi: University of Southern Mississippi.
- Bar-On, R. (1997). *The Emotional Intelligence Quotient Inventory (EQ-i): A test of Emotional intelligence*. Toronto: Multi Health Systems.

- Bar-On, R. (2000). *Emotional Intelligence Quotient Inventory, youth version: Technical Manual*. Toronto: Multi Health Systems.
- Bar-On, R. (2002). *Bar On Emotional Quotient Inventory Short-form (EQ-iS): Technical Manual*. Toronto: Multi Health Systems.
- Bar-On, R. (2006). The impact of emotional intelligence on subjective well-being. *Perspectives in Education*, (25), 2, 41-62.
- Baujaoude, S. & Barakat, H. (2000). Students' problem-solving strategies in stoichiometry and their relationship to conceptual understanding and learning approaches. *Electronic Journal of Science Education*, retrieved from <http://unr.edu/homepage/crowther/ejse/ejsev7n.3html>.
- Baujaoude, S. & Barakat, H. (2003). Secondary school students' difficulties with stoichiometry. *School Science Review*, (18), 296, 91-98
- Bodner, G.M. & Herron J.D.(2002) in Gilbert,J. K., Dejong,D. Just, R., Treagust, D. F. & Vandriel, J. H. (eds). *Chemical education Research- based practice*. Dordecht: Kluwer academic publishers
- Bukat,R.(2004). Pedagogical knowledge as a way towards applied research in chemistry education. *Research & practice*, 5, 3, 215-218.
- Chandrasegaran, A., Treaquist, D., Walddrip, B. & Chandrasegaran, A. (2008). Students' dilemmas in reaction stoichiometric problem-solving: Deducing the limiting reagent in chemical reactions. *Chemical Education Research and Practice*, (10), 14-23.
- Ciarochi, J., Chan, A. & Caputi, P. (2000). A critical evaluation of the emotional intelligence construct. *Personality and Individual Differences*, (28), 539-565.
- Crossman, (2007). Factors influencing the assessment perceptions of training teachers. *International Education Journal*.(45),4, 56-6.
- Dahsan, C. & Coll, R.K. (2007). Thai grade 10 and 11 students' understanding of stoichiometry and related concepts. *International Journal of Science & Mathematics Education*. Retrieved from; <http://www.springerlink.com/content/35281870U068w20k>
- Day, A. & Carroll, S. (2004). Using an ability-based measure of emotional intelligence to predict individual performance, group performance and group citizenship behaviours. *Personality and Individual Differences*, (36), 6, 1443-1458.
- Dunn, S. (2003). Ten signs of emotional intelligence. Retrieved from <http://www.self-growth.com>.
- Gardiner, H. (2010). Factors that predict academic achievement at the University level. Retrieved November 10, 2011 from [http:// MichaelGardiner@SBCGIOBA](http://MichaelGardiner@SBCGIOBA).

- Goleman, D. (1998). *Working with emotional intelligence*. New York: Bantam Books
- Hassan, M. (2010). Emotional intelligence and self-esteem as predictors for success in teaching practice exercise. *Academic Leadership Journal*, (8), 3, 214-228
- Hollingworth, R. & McLoughlin, C.(2005). Developing metecognitive and problem solving skills of science students in higher education in McLoughlin, C. & Taji, A.(eds) *Teaching in the Sciences : Learner-centred approaches*. New York: Haworth Press Inc.
- Jaeger, A. (2003). Job competencies and curriculum: An inquiry into emotional intelligence in graduate professional education. *Research in Higher Education*, (44), 6, 615-639.
- Jaeger, A. (2004). The place of emotional growth in professional education. *Journal of Public Administration Education*, (10), 1, 43-61.
- Jaeger, A. & Eagan, M. (2007). Exploring the value of emotional intelligence: A means to improve academic performance. *NASPA Journal*, (44), 2, 512-537.
- Johnstone, S. (2005). Measuring and boosting emotional intelligence of E2E learners - A research report. London: Learning and Skills Council. Retrieved June 18 from <http://www.lsc.org.uk>.
- Jonassen, D.(2000). Toward a design theory of problem-solving. *Educational Technology: Research & Development*, 48, 63-85. Retrieved from cat.inist.fr/?aModele=afficheNG&cpsidt=14199030.
- Jonassen, D. H. (2004) *learning to solve problems: An instructional design guide*. New York: John Wiley & sons Inc. retrieved from www.pfeiffer.com
- Katyal, S. & Awasthin, E. (2005). Gender differences in emotional intelligence among adolescents of Chandigarh. *Journal of Human Ecology*, (17), 2, 153-155
- Longjohn, I .T. (2009). Effects of game method of teaching on students' achievement in chemistry. *Journal of Science Teachers' Association of Nigeria*, 44, 182, 85-92.
- Low, G. & Nelson, D. (2005). *Emotional intelligence: The role of trans-formative learning in academic excellence*. Texas: Study Magazine, spring edition.
- Low, G. & Nelson, D. (2005). *Emotional intelligence: Effectively bridging the gap from high school to college*. *Texas Study of Secondary Education*, (13), 7-10.
- Mayer, J., Salovey, P. & Caruso, D. (2000). Emotional intelligence as zeitgeist, as personality and as a mental ability. In R. Bar-On & J. Parker (eds.) *the handbook of emotional intelligence: Theory, development, assessment and application*

at home, school and in the workplace.
California: Jossey Books.

Mayer, J. & Salovey, P. (1997). What is emotional intelligence? In P. Salovey & D. Sluyter (eds.) *Emotional development and emotional intelligence: Educational applications*. P. 3-31. New York: Basic Books.

Mayer, J., Caruso, D. & Salovey, P. (2000). Emotional intelligence meets traditional standards for intelligence. *Intelligence*, (27), 4, 267-298.

Mohammed, R., Aijaz, A. & Saria, I. (2011). Impact of emotional intelligence on academic achievement of prospective teachers in the subject of English Language in India. Retrieved October 2012 from <http://www.languageinindia.com>.

Mahyuddin, R., Abdullah, M. Roslam, S., Elias, H. & Suleiman, T. (2007). The relationship between emotional quotient and acquisition of basic skills among primary school children. *The International Journal of Learning*, (14), 7, 49-55.

Nwadinigwe, I. & Azuka-Obieke, U. (2012). The impact of emotional intelligence on academic achievement of senior secondary school students in Lagos, Nigeria. *Journal of Emerging Trends in Educational Research and Policy*, (3), 4, 395-401

Okeke, D.J. (2011). Effect of mind mapping teaching strategy on students' interest, retention and achievement in senior secondary

school chemistry. An unpublished PhD Thesis. Nsukka: University of Nigeria.

Okonkwo, G. I. (2014). Effect of simulation –game teaching strategy on students' interest in environmental concepts in chemistry. *Review of Education*, 25,1,160-169.

Okonkwo, G.I. & Igboegwu, E.N. (2012). Influence of gender and school on students' achievement in chemistry. *Journal of Research in Education*, 1,1, 9-14.

Okonkwo, I.G. & Adigwe, J.C. (2014). Effect of concept mapping teaching strategy on students' interest in environmental concepts in chemistry. *Review of Education*, 25,1,40-60.

Parker, J. Summerfield, L., Hogan, M. & Majcski, S. (2004). Emotional intelligence and academic success: Examining the transition from high school to university. *Personality and Individual Differences*, (36), 163-172.

Parker, J., Duffy, J., Wood, L., Bond, B. & Hogan, M. (2005). Academic achievement and emotional intelligence: Predicting the successful transition from high school to university. *Journal of First-Year and Students in Transition*, (17), 1, 67-78.

Petrides, K. & Furnham, A. (2001). Trait emotional intelligence: Psychometric investigation with reference to establishment of trait taxonomies. *European Journal of Personality*, (15), 425-445.

- Petrides, K. & Furnham, A. (2003). Trait emotional intelligence: Behavioral validation in two studies of emotion recognition and reactivity to mood induction. *European Journal of Personality*, (17), 39-75.
- Petrides, K., Furnham, A. & Frederickson, N. (2004). Emotional intelligence: *Psychologist*, (17), 10, 281-301.
- Portoles, J.J. & Lopez, V.S. (2008). Types of knowledge and their relations to problem solving in science: Directions for practice. *Educational Science Journal* 6, 5, 23-34. Retrieved from sislo.jpce.ul.pt/pdfs/6_eng_therarticles.pdf.
- Pritchard, M. & Wilson, G. (2003). Using emotional and social factors to predict students' success. *Journal of College Student Development*, (44), 11, 18-26.
- Rozell, E. Pettijohn, C. & Parker, R. (2002). An empirical evaluation of emotional intelligence: The impact on management development. *Journal of Management Development*, (21), 4, 272-289.
- Sedlacek, W. (2004). Beyond the big test: Non cognitive assessment in higher education. San Francisco: Jossey-Bass.
- Schutte, N., Malouff, J., Hall, L., Haggerty, D., Cooper, J., Golden, C. & Dornheim, L. (1998). Development and validation of a measure of emotional intelligence. *Personality and Individual Differences*, (25), 2, 167-177.
- Sirhan, Gh. (2007). Learning difficulties in Chemistry. *Journal of Turkish Science Education*, (2), 4, 2-20.
- Smith, M. (2004). An emotional intelligence intervention for academic at-risk high school students. Unpublished doctoral dissertation. Texas A&M: University of Corpus Christi.
- Tai, R., Sadler, P. & Loehr, (2005). Factors influencing success in introductory college Chemistry. *Journal of Research in Science Teaching*, (42), 9, 987-1012.
- Yomi, (2007). Fostering academic achievement in secondary schools through self-efficacy and emotional intelligence training. *Journal of African Educational Research Network*, (7), 2, 150-156.
- Uzoechi, B., Kurumeh, M. & Azuka, B. (2013). Emotional intelligence: A tool for improving the academic achievement of secondary school students in Mathematics. *Journal of Mathematical Science Education*, (2), 1, 220-231.
- West African Examination Council (WAEC) (2004-2011) Chief Examiners' Reports. Yaba, Lagos.

ACKNOWLEDGEMENT

I am grateful to Constance Chukwuka for her assistance in fieldwork.