

Relationship between Adaptability and Chemistry Achievement among Students in Kenyan Secondary Schools

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Abstract The study investigated the relationship between adaptability and chemistry achievement among secondary school students in Rachuonyo South Sub-County, Kenya. The study was informed by the theory of Planned Behavior. The study adopted the Concurrent Triangulation Design. The study targeted all the 4400 Form Three students of the year 2019 in the 80 public secondary schools, 108 chemistry teachers and 80 guidance and counseling teachers in Rachuonyo South Sub-County. The study employed Research Questionnaires, Interview Schedules, achievement test, Focus Group Discussions and Document analysis Guide to gather information from participants. Face, construct and content validities of the questionnaires and interview schedules were determined by presenting and discussing the test items with two experts from Jaramogi Oginga Odinga University of Science and Technology in the Department of Psychology and Educational Foundation. The reliability of the four sub-scales were checked using split half method in which reliability is determined by administering the developed instruments once and scores of each half are recorded separately. Pearson's product moment correlation was used to calculate the correlation coefficient between the two halves and a reliability co-efficient of $r = 0.856$ was reported. The study involved gathering both quantitative and qualitative data. Questionnaires and document analysis yielded quantitative data while interview schedules yielded qualitative data. There was a significant moderate positive correlation ($n=442$; $r = 0.617^{**}$; $p < .05$) between Adaptability score and Achieved chemistry exam mean scores. Its recommended that the Ministry of Education should ensure that the study of adaptability skills is made compulsory and time tabled in all secondary schools in Kenya.

Keywords Adaptability, Chemistry achievement, Secondary school, Students, Kenya

1. Introduction

In modern societies, science appears to be a central aspect of our work and our everyday lives. Educators, policy makers and researchers are focusing on ensuring that science education continues to help citizens to become scientifically literate so that they can be able to engage with science and technology in their lives, and also to allow the societies to meet and overcome the new challenges they are facing (Tytler, 2014). The role of science education in the lives of individuals and in the advancement of science and technology for the development of mankind is very crucial. Scientific literacy, which is the gateway to achieve scientific

and technological advancement and economic survival, is achievable through science education. The influence of science on a nation and its citizens could be seen from the production of basic human needs to social, political, educational, technological and economic advancement. Chemistry is the branch of science that deals with the study of the composition and properties of matter, changes in matter, the laws and the principles that govern these changes (Ebbing, 1996).

According to Broman, Ekborg and Johnels (2011), many students in Sweden are incognizant of the relevance of chemistry subject. This has led to a drastic fall in the number of students pursuing chemistry based courses at higher levels. This arises from their perception of chemistry as a teacher-centered subject. Childs (2014), reported that, in Ireland, effective implementation of chemistry education is threatened by factors such as transition between levels of education, science background of students, diversity of the students' body, problem of science language and cognitive level of students. In China, implementation of the new senior

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secondary curriculum has not been going on well, indicating the problematic interaction between the teacher and the curriculum materials (Wang, 2010). Chen and Wei (2015) reported that chemistry curriculum implementation in China was faced with challenges of adaptation of curriculum materials by the teachers.

The Theory of Planned Behavior was proposed by Ajzen and Fishbein and suggests that behavior is determined by intentions, attitudes (beliefs about a behavior), and subjective norms (beliefs about others' attitudes toward a behavior) (Ajzen, 1991). The Theory of Planned Behavior (TPB) started as the Theory of Reasoned Action in 1980 to predict an individual's intention to engage in a behavior at a specific time and place. The theory was intended to explain all behaviors over which people have the ability to exert self-control. The key component to this model is behavioral intent; behavioral intentions are influenced by the attitude about the likely-hood that the behavior will have the expected outcome and the subjective evaluation of the risks and benefits of that outcome (Ajzen, 1991).

Literature on adaptability and academic achievement exists. For example, in Romania, Oana and Pop (2016) investigated cross-lagged associations between career adaptability and academic achievement, in a three-wave longitudinal study, testing the moderating role of adolescents' gender, school type, and age. Results showed positive associations between career concern and academic achievement. In Australia, Collie, Holliman and Martin, (2017) examined the extent to which students' adaptability is associated with their behavioral engagement at university, and the extent to which both are associated with subsequent academic achievement. Findings showed that adaptability was associated with greater positive behavioral engagement (persistence, planning, and task management) and lower negative behavioral engagement. In another study in Australia, Collie et al (2018) conducted a longitudinal study to investigate whether university students' adaptability predicts degree completion via behavioral engagement. Undergraduate students (N=186) were surveyed for their adaptability and behavioral engagement at degree commencement. Findings showed that adaptability predicts both positive and negative behavioral engagement, and that negative (but not positive) behavioral engagement predicts degree completion. Saleem, (2013) study, aimed at explored the level of social adaptation and its relationship with the achievement motivation of the secondary school students in Jordan. The study found many results, including: that the level of social adaptation and achievement motivation among secondary school students in the province of Jerash were high, and also showed the presence of a statistically significant positive relationship between the social adaptation and the achievement motivation among the secondary school students in the province of Jerash.

In USA, Duffy, Richard and Kelsey, (2015) examined the relation between the four components of career adaptability – concern, control, curiosity, and confidence and academic

satisfaction. These results suggested that for undergraduate students, feeling adaptable in one's career may link to greater levels of academic satisfaction due, in part, to greater feelings of control and confidence in one's career decision making. Havenga, (2012), explored the relationship between top academic achievement and certain characteristics of career adaptability of Grade 12 students in Pretoria, South Africa. Significant positive relationship was found between Grade 12 top academic achievement and certain characteristics of career adaptability. Titilayo, Oleyede and Adekunle, (2016) study sought to find out the relationship between chemistry students' self-efficacy and their academic achievement in senior Secondary schools in North-central, Nigeria. The findings revealed that no significant relationship existed between self-efficacy and academic achievement among chemistry students. Osuala and Ogomaka, (2005), reported that 60% of Nigeria secondary school chemistry teachers use the conventional method with occasional teacher dominated experiments that make students passive learners.

Chemistry has often proven to be a difficult subject for many students (Johnstone and Otis, 2006), containing many abstract concepts which are central to further learning in both chemistry and other sciences. A review of the achievement of students in Chemistry at the West African Senior School Certificate Examination (WASSCE) established that the failure rate in the subject has been quite high (Agbodeka, 2002). In South Africa, there has been a significant trend in students' failure in physical sciences in the National Senior Certificate (NSC) final examination, which is published in the bulletin of Department of Education. Particularly in the KwaZulu-Natal province, the decline in students' performance has been quite worrying over the past few years. In 2013, 50,332 wrote the NSC examination and the pass rate for physical science was 66.4%. In 2014, 45,143 candidates sat for the examination and 55.8% passed (NSC, Report, 2016).

Table 1. K.C.S.E performance in Physics, Chemistry and Biology in Rachuonyo South Sub-County, Kenya for the years 2012 – 2017

Year	Subject		
	Physics	Biology	Chemistry
2012	6.431	4.813	4.141
2013	7.231	5.709	4.338
2014	6.613	5.865	5.147
2015	7.019	6.314	4.740
2016	5.123	3.514	2.678
2017	4.967	2.110	2.642
Average mean	6.231	4.721	3.948

Source: Sub-County Director of Education Office, Rachuonyo South, 2018.

Research studies (Crosnoe, Johnson and Elder 2004; Abubakar and Oguguo 2011) reported that numerous factors contribute to academic performance that range from students' socio-economic background, learning environment, students' interest, attitude, guidance and

counseling, teaching methods, school entry modalities, age, gender, language, and religious affiliations amongst others. However, there is very little literature on possible correlation between students' adaptability and achievement in chemistry in Kenya more so in Rachuonyo South Sub-County. The results in table 1 show that the mean achievement in chemistry has been fluctuating and remains low in the sub-county.

For the years 2012-2016, the mean score for chemistry was the lowest of all the three science subjects taken at K.C.S.E. In the year 2017, there was a drastic drop in performance of the three science subjects in the sub-county. Notably, Chemistry was above Biology but registered a mean score of 2.642 which is a grade D plain. However, on average for the years 2012-2017, the mean score for chemistry was still the lowest, with a mean score of 3.948. The present study investigated the relationship between adaptability and chemistry achievement among secondary school students in Rachuonyo South Sub-County, Kenya.

2. Research Methodology

The study adopted the Concurrent Triangulation Design. In this design, qualitative and quantitative data are collected concurrently in one phase. The data is analyzed separately and then compared and combined. An example would be if a researcher collected survey data and interview data at the same time and compared the results. This method is used to confirm, cross-validate or corroborate findings (Creswell, 2013). It is often used to overcome a weakness in one method with the strengths of another. The study targeted all the 4400 Form Three students of the year 2019 in the 80 public secondary schools, 108 chemistry teachers and 80 guidance and counseling teachers in Rachuonyo South Sub-County.

The study employed Research Questionnaires, Interview Schedules, achievement test, Focus Group Discussions and Document analysis Guide to gather information from participants. Face, construct and content validities of the questionnaires and interview schedules were determined by presenting and discussing the test items with two experts from Jaramogi Oginga Odinga University of Science and Technology in the department of psychology and educational foundation. The reliability of the four sub-scales were checked using split half method in which reliability is determined by administering the developed instruments once and scores of each half are recorded separately. Both descriptive and inferential statistics methods was used in data analysis and presentation of the research findings. Qualitative data from interviews with chemistry teachers, guidance and counseling teachers and focus group discussions were transcribed, coded and analyzed using Thematic Analysis.

3. Findings & Discussions

To establish whether there was any statistical significant

relationship between adaptability and chemistry achievement among secondary school students in Rachuonyo South Sub-County, Kenya, the researcher computed a bivariate Pearson's Product-Moment Coefficient of Correlation between the scores of the two variables. The SPSS output Table 2 shows the correlation results.

Table 2. Correlations between adaptability and chemistry achievement

		GRADE AND SCORE IN CHEM	Adaptability Scale
GRADE AND SCORE IN CHEM	Pearson Correlation	1	.617**
	Sig. (2-tailed)		.000
	N	442	442
Adaptability Scale	Pearson Correlation	.617**	1
	Sig. (2-tailed)	.000	
	N	442	442

** . Correlation is significant at the 0.01 level (2-tailed).

From Table 2, it is evident that although there was a moderate positive correlation ($n=442$; $r = .617^{**}$; $p < .05$) between Adaptability Scale and Achieved chemistry exam mean scores, it was statistically significant. Given that the p -value was less than .05, we reject the null hypothesis, H_0 , and accept the alternative hypothesis, H_a , that "*There is a significant relationship between adaptability and chemistry achievement among secondary school students in Rachuonyo south sub-county, Kenya*". It is therefore concluded that there is statistically significant positive relationship between adaptability and chemistry achievement. This means that a student who is more adaptable is therefore likely to initiate higher chemistry achievement.

Qualitative analysis were also reported on the relationship between adaptability and chemistry achievement and two themes emerged. The first theme was peer learning improves adaptability. Peer learning is an educational practice in which students interact with other students to attain educational goals (King, 1999). Peer learning is mutually beneficial and involve the sharing of knowledge, ideas and experience between the participants. It is a way of moving beyond independent to interdependent or mutual learning (Boud, 1988). In the context of the current study, peer learning can help students learn chemistry more effectively. At a time when chemistry teaching/learning resources are stretched and demand for chemistry teachers are increasing, it offers students the opportunity to learn from each other. It gives students considerably more practice and help them take responsibility of their own learning. Peer learning is an important addition to the repertoire of teaching and learning activities that can enhance the quality of education hence improve chemistry achievement. A chemistry teacher commenting on how adaptability influence chemistry achievement had this to say:

CT6: *For our students to meaningfully adapt to chemistry concepts, we must embrace peer learning. Most students learn faster when they are actively involved in the teaching/learning process and peer teaching creates this conducive learning environment where students freely express their opinions, test ideas and ask for or offer help when it is needed. This will help improve performance in chemistry in our schools.*

Commenting on the same, a student in the Focus Group Discussion (FDG) had this to say:

FGD2S7: *I would encourage our teachers to allow us have more peer teaching sessions especially in difficult topics such as mole concept. Some of us are good in calculations and we can help others to also improve because when you see a classmate answer a question correctly you get encouraged that you can also do it. I believe this will improve our performance in chemistry.*

Other respondents added:

CT11: *Adaptability is key for students to pass chemistry. For this to be realized, a lot of emphasis should be placed on student centered approaches to teaching/learning such as group work and peer learning. This will help our students develop communication, interpersonal and teamwork skills and consequently improve in their chemistry achievement.*

GCT3: *For me, peer learning is the way to go. Let the students see one of them handle a concept effectively. This enables them to find effective peers to emulate and develop self-directed learning skills that lays foundation for future learning.*

The excerpts from CT6, FGD2S7, CT11 and GCT3 implied that peer learning is an effective way of improving adaptability amongst the students and consequently improve chemistry achievement. These findings agree with Murithi *et al* (2016) study which investigated determinant factors for persistent poor performance of students in chemistry in KCSE in Kwale district, Kenya. The findings revealed that attitudinal adaptation had a positive impact on academic achievement. However, findings by Murithi also showed that there were no significant differences in the impact between boys and girls in boarding secondary schools within Meru County in Kenya.

The second theme was that Group work / cooperative learning improves adaptability. Group work / cooperative learning is a method of instruction that gets students to work together in groups (Caruso and Woolley, 2008). Group work involves students working collaboratively on set tasks, in or out of the classroom. In the current study, it was reported that, students who are frequently engaged in group work are more adaptable and perform better in chemistry.

A chemistry teacher commenting on the same had this to say:

CT10: *Group discussions enhance student learning through the collaborative processes, which allow students to tackle more complex chemistry problems than they could on their own. It enables students to pool knowledge and skills, which enables them to break complex tasks into parts and steps.*

Other respondents the students in focus group discussions and chemistry teachers who also believed group work make students more adaptable to learning chemistry reiterated:

GCT5: *Chemistry is a practical subject therefore teaching strategy is key. I would advocate for active involvement of learners. Group work and other learner centered approaches refine understanding through discussion and explanation.*

FGD3S4: *Group discussion is motivating. Some of us fear teachers and therefore cannot ask teachers questions when they are teaching, but when left with fellow students they talk freely and participate actively in group discussions. As far as I am concerned, group discussions can improve our performance in chemistry.*

CT8: *I think our approach to teaching chemistry is sometimes not right. There are some topics which call for more learner involvement but you find that we still use teacher centered approaches such as lecture method. Let us embrace learner centered approaches such as group projects, discussions and more class experiments. This would make learners more adaptable to chemistry concepts hence improve their performance.*

The sentiments expressed by CT10, GCT5, FGD3S4, and CT8 implied that group discussion enhances adaptability and consequently chemistry achievement. Group work can help students develop a host of skills that are increasingly important in enhancing chemistry achievement. Properly structured group projects can reinforce skills that are relevant to both group and individual work. Positive group experiences contribute to student learning, retention and overall chemistry achievement. This study agrees with Collie *et al* (2017) study which examined the extent to which students' adaptability is associated with their behavioral engagement at university, and the extent to which both are associated with subsequent academic achievement.

4. Conclusions & Recommendations

The findings on the study revealed that adaptability positively influences chemistry achievement among students in Rachuonyo south sub-county, Kenya. Adaptability enables students to adjust to the changing learning environment and cope accordingly to the challenges therein. It was therefore concluded that students with high adaptability are likely to have a high chemistry achievement than those with low levels of adaptability. The Ministry

of Education should ensure that the study of life skills/self-management skills is made compulsory and time tabled in all secondary schools in Kenya. This will enable students to develop some of the indicators of a person with high self-initiative such as; high sense of self-drive, self-awareness, insight and personal motivation and consequently improve their chemistry achievement.

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