Factors Affecting Trainees’ Performance in Organic Chemistry in Colleges of Education in Ghana

Stephen K. Amoako, Kwasi Oppong, Jonah A. Tabi, and Theophilus A. Ossei-Anto

ABSTRACT

This study aimed to investigate the underlying fundamental causes of trainees’ poor performance in organic chemistry. For the study, a descriptive survey design was employed. In all, 182 level 300 science students from four Colleges of Education in the Ashanti, Bono, Bono East and Ahafo regions which constitute the ASHBA zone were purposively selected. Participants in the study were given a set of self-created questionnaires to fill out in order to get their opinions on the perceived causes of trainees’ poor performance in organic chemistry. The data collected were analyzed quantitatively using factor analysis. The results from the study showed that teacher factors, student factors and school related factors affect trainee’s low performance in organic chemistry. It was therefore recommended that colleges must provide a conducive environment and teaching learning materials for teachers to use appropriate teaching methodology to help trainees enhance their performance.

Keywords: chemical phenomenon, organic chemistry, poor retention, synthesis, trainee performance.

I. INTRODUCTION

Creating strong learners is one of chemistry education’s objectives. Due to poor study habits, inconsistent routines, and inefficient practical lessons among Colleges of Education students offering chemistry, the objective of aiding students in acquiring scientific information and the necessary abilities may not have been attained. Chemistry is mostly a practical topic that necessitates the right demonstration of good study habits for an accurate assessment of current phenomena (Okoyeigbo et al., 2010).

One area of chemistry where trainees show a lot of challenges with respect to building authentic mental model is organic chemistry (Hanson, 2016). Adequate understanding of organic chemistry is a basic requirement for many graduate programs in human care. Organic chemistry is a key to the development of new products in society and for improving many more of them that we have become dependent on. It is the basis for the production of food flavors, plastics, cement, car tires, fuels, clothing, pharmaceuticals and house cleaning agents (Hanson, 2016).

Studies by Adu-Gyamfi and Appiah (2013), Boakye and Ampiah (2017), and Tajudeen (2015) have demonstrated that despite the fact that organic chemistry is a crucial part of the study of chemistry, students generally find it challenging to understand.

Hanson (2016) identified students’ inability to understand the nature of matter and how to connect among the representational levels of matter as the main limiting factor in their learning of chemistry in Ghana. Students are most of the time unable to understand thoroughly these representations and so form faulty and weak basis for further study in occurrences that bring about changes in the composition of substances, their properties, and reactions (Chemical Phenomena) especially in organic chemistry (Hanson, 2016).

Research conducted in Science Education by Taber (2018) found that the conceptualization of the chemistry aspect of science is indeed difficult for learners of science. The majority of our students essentially engage in rote learning and therefore appear to have difficulty in the understanding of some organic chemistry concepts. Niebuhr (2013) and Flick (2018) emphasized that college students’ knowledge of organic chemistry is often characterized by lack of coherence and attributed this to the abstract and highly conceptual nature of chemistry.

Coll (2014) asserted that students’ perception of organic chemistry is a major challenge to the study of chemistry as a discipline. Several factors contribute to this challenge. A number of these include their own preparedness, teachers’ content knowledge and preparedness, social factors (including home and school), and language. Korau (2006) pointed out poor conceptual foundation, incompetent teachers, large class size, student disinterest and psychological fear for chemistry as the main causes for the
The traditional face-to-face strategy commonly used by teachers has been identified as a contributing factor. Pahomov (2014) was of the view that the traditional face-to-face method commonly used by chemistry teachers is monotonous, thereby making learners passive listeners and prevents learners from active thinking and learning. Organic chemistry teaching can only be effective when students are willing, and the teacher makes use of appropriate methods and resources in teaching the students (Millar, 2014). The emphasis in organic chemistry education is on student participation in the learning process through exposure to a variety of learning activities. Since there is not much study in Ghana to find out the cause of trainees’ underperformance in the subject, it is considered pertinent to investigate the factors affecting trainees’ low performance in chemistry by involving all the stake holders. (Adu-Gyamfi et al., 2020).

A. Statement of the Problem

College of Education students performed least in chemistry in end of semester examinations, hence the reason other researchers have focused their attention on factors that affect low performance of students on chemistry in general (Hanson, 2016; Adu Gyamfi et al., 2020; Amoako, 2012). However, there are not many studies in the College of Education context that focused specifically on factors affecting low performance of students in organic chemistry.

The chief examiners report for chemistry theory for the Bed (Bachelor of Education) students have consistently voiced concerns of teacher trainees’ low performance on organic chemistry exam questions since the introduction of the Bed programs at the College of Education level. It frequently tagged organic questions as unfamiliar among students, so only a few students who chose to respond to such questions in the end-of-semester exams performed appallingly. (Institute of Education, 2018–2020).

In-depth studies into the poor performance of trainees in chemistry by educational researchers have been traced to about five main factors. One of them is their inability to answer questions based on organic chemistry coherently form. Some do not attempt to answer such questions at all. Others make feeble attempts at solution (Hanson, 2016). This study therefore sets out to be a model study that would provide the option for tutors to examine the factors that affect low performance of trainees in organic chemistry and unravel the trainees associated in debt difficulties.

B. Purpose of the Study

This study is aimed at investigating the factors that affect low performance of students in organic chemistry in Colleges of Education. The study will specifically examine the underlying factors influencing low performance of trainees on organic chemistry.

C. Research Question

What could be underlying factors that influence the low performance of trainees on organic chemistry?

D. Review of Literature

1) Factors that foster academic performance in chemistry

Academic performance is the demonstration of acquired knowledge or skills in academic subjects as indicated by test and examination results or grades given by the subjects’ teachers. It could also define it as any phrase used to describe a student's academic position. What you learn is the secret to your success in organic chemistry. Combining the components of a foreign language lesson with those of logic is how studying organic chemistry works, or mathematics.

A number of Studies have been done to pinpoint and evaluate the many variables that influence academic success in various learning institutions. Their research identifies the following variables as having a significant impact on students’ academic performance in various contexts: effort, prior education (Hanus & Fox, 2015), parents' education, family income, self-motivation, age of student, learning preferences (Sieg & Wang, 2018), class attendance, and entry requirements. A survey with a 60-item Likert-based questionnaire was completed, and a documentary analysis of the students’ final exam marks was done. The findings demonstrate that students’ learning outcomes were significantly influenced by their desire and curiosity, as evidenced by the scores they received on the subject’s final exams (Nja et al., 2019).
A 2013 study by Kusurkar et al. examined the role of motivation. Kpolovie et al. (2014) study on “Academic Achievement Prediction: Role of Interest in Learning and Attitude towards School” shows there is a significant correlation and multiple prediction of students’ academic achievement with the predictor variables. From the above literature reviewed, interest in organic chemistry is very important for academic achievement. Some researchers have conducted research and have found some methods to increase students’ interest. Magwilang (2016) researched on “correlation between chemistry learning motivation and students’ academic performances,” they discovered that students who responded to the questionnaire that was administered had high motivation in chemistry and that led to their high achievement in chemistry. This interest is extrinsic implying that the learning environment provided it. Aeschlimann et al. (2016) investigated how students in chemistry classes can be motivated to choose a career in science. The results of the research showed action-based learning and relevance to their career choice can stimulate their interest in chemistry. In that regard, Ajayi (2019), while writing on the topic “How to motivate Students to Love chemistry” believes that if there is a connection between chemistry to students’ “Everyday Life, they will be interested in chemistry.” This can be done by showing the chemistry behind their daily activities because it will stimulate their interest.

Fig. 1. Conceptual framework on factors affecting performance in organic chemistry.

**E. Methodology**

1) Research design

De Massis and Kotlar (2014), as evidenced by their concluding statement that “research design syndicates the structure of a study, the nature of the hypothesis, and the variables involved in the study,” it is clear that students’ desire and interest had a substantial impact on their learning outcomes. A descriptive survey design was used for this study’s research methodology. Additionally, according to McNabb (2015), survey research entails gathering information to test a hypothesis or provide an answer to a query regarding the views of a population on a certain subject. Additionally, it entails gathering information in order to test hypotheses or respond to specific inquiries about the state of the study’s subject at the moment. This study attempts to look into the variables influencing chemistry performance among pre-service teachers in Ghanaian Colleges of Education. This design has the benefit of allowing the subject to be examined in its entirely natural and unadulterated environment.

2) Population

The target population was all the level 300 student-teachers offering chemistry in all the Science Colleges of Education in ASHBA zone, in Ghana. The accessible population was however composed of all the trainees pursuing 4-year bachelor’s degree program in elective science at various levels in the four Colleges of Education within the Ashanti, Bono, Bono East and Ahafo Regions which constitute the ASHBA zone. In all, there are 278 level 300 student-teachers in the ASHBA zone (Institute of Education, University of Cape Coast). The enrolments of level 300 students who offer organic chemistry in the four science colleges are as follows in Table I:

<table>
<thead>
<tr>
<th>Name of College</th>
<th>Enrolment</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wesley</td>
<td>59</td>
<td>21.5</td>
</tr>
<tr>
<td>Mampong Technical</td>
<td>61</td>
<td>21.9</td>
</tr>
<tr>
<td>St. Joseph</td>
<td>88</td>
<td>31.7</td>
</tr>
<tr>
<td>Akrokeri</td>
<td>70</td>
<td>25.1</td>
</tr>
<tr>
<td>Total</td>
<td>278</td>
<td>100</td>
</tr>
</tbody>
</table>

3) Sample and sampling procedures

The very fact that we cannot use the entire population makes the operation involving sampling statistically vital. The samples were drawn from the four (4) Colleges of Education which offer elective science in the Ashanti, Bono, Bono East, and Ahafo regions in Ghana.

The selection of the colleges depended on the distance of the schools to one another in order to remove knowledge dissemination and contamination effect, and the willingness of the colleges principals and teachers to cooperate in the study. The colleges were distant from each other to minimize their interactions. In all the sampled colleges, level three hundred students’ offerings chemistry were selected. This is because the chemistry of carbon is taught in level 100 and 200 according to the chemistry theory course outline for Colleges of Education in Ghana.

The sample for the study comprises 182 level 300 students from the Colleges of Education. This information is derived from the Krejcie and Morgan (1970) Table I for calculating sample size; however, the suggested sample size was increased from 162 to 180 to account for attrition rate. All of the Colleges of Education in the ASHBA zone were chosen as part of the study’s sample process using a multi-stage sampling technique because they represent the proper population from whom the researcher can acquire the study’s data.
4) Research instrument

In this study questionnaire, and test were used. The purpose of the questionnaire was to find out the trainees’ impressions of the teaching and learning of organic chemistry and the factors which affect their performance in the Colleges of Education. Agyeman (2020) claims that questionnaires are extremely effective in eliciting information due to the relative simplicity of responding to them and handling the results, which are frequently gathered from quite large samples. The test was used to assess the trainees’ fundamental understanding of organic chemistry.

5) Validity and reliability of the instrument

To ensure the face and content validity of the instruments, the instruments were validated by giving it to two experienced college chemistry tutors for critique and suggestions which were used to modify the final version of the instruments.

6) Ethical Consideration

There exists some sort of relationship between the researcher and the participants. This can raise varied ethical concerns with respect to privacy issues, honesty and open interactions and misrepresentations (Shaw & Holland, 2017). Due to the expected ethical issues that will arise, inconspicuousness, secrecy and assent informed issues must be taken into account for considerations (Tracy, 2019). Confidentiality conveys varied meanings for researchers and the participants involved. Most respondents expect confidentiality to be in the form of hiding secrets and be revealed in certain situations. Confidentiality involves amplification of the result from the study (Flick, 2018).

7) Data Collection Procedure

The administration of the Colleges of Education used for the study received a letter of introduction prepared by the dean of the Department of Science and Mathematics education at the University of Cape Coast. The letter outlined the study’s objectives and requested the college administration’s cooperation. Permission and support were then sought from the teachers and trainees to conduct the study. Briefing sections on how to respond to the questionnaire were held with the trainees at the various colleges’ Assembly Hall.

F. Data Analysis

The data that were gathered for this investigation were reviewed, revised, and coded. The statistical package for service solutions (SPSS) software, version 20, was used to statistically analyze the collected data. Factor analysis was explored to analyze data for the research Question.

II. RESULTS AND DISCUSSION

In this section, the data obtained from the various instruments used in the three phases of the study have been presented with respect to the formulated research questions (RQ). The data have been presented in tabular and graphical forms, as well as identified themes, based on classroom experiences of the trainees.

The results from the Table II revealed that respondents from Akrokerri were 29%, Mampong Technical College of Education 24%, St Joseph 29%, and Wesley 19%. More than two thirds (81%) of the respondents had an age range 21–26.

This was followed by 15–20 of 14%, 27–31 4% and above 31 1%. Females dominated the study representing more than two-thirds (73%) and males 27%. The results further indicated that Christianity were 95% whereas Islam were 5%. With the exception of Mampong Technical College of Education, which is all men, the rest of the colleges of education had both males and females.

<table>
<thead>
<tr>
<th>College of Education</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akrokerri</td>
<td>52</td>
<td>29%</td>
</tr>
<tr>
<td>Mampong Technical</td>
<td>43</td>
<td>24%</td>
</tr>
<tr>
<td>St Joseph</td>
<td>52</td>
<td>29%</td>
</tr>
<tr>
<td>Wesley</td>
<td>35</td>
<td>19%</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15–20</td>
<td>26</td>
<td>14%</td>
</tr>
<tr>
<td>21–26</td>
<td>147</td>
<td>81%</td>
</tr>
<tr>
<td>27–31</td>
<td>8</td>
<td>4%</td>
</tr>
<tr>
<td>Above 31</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>50</td>
<td>27%</td>
</tr>
<tr>
<td>Female</td>
<td>132</td>
<td>73%</td>
</tr>
<tr>
<td>Religion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Christianity</td>
<td>173</td>
<td>95%</td>
</tr>
<tr>
<td>Islam</td>
<td>9</td>
<td>5%</td>
</tr>
</tbody>
</table>

RQ 1: What are the underlying factors that influence low performance of trainees on organic chemistry?

2 Factors that influence low performance of trainees on organic chemistry:

Table III indicates that the means for each of the items of each factor appear to be reasonable as each of the items is measured on a 4-point Likert scale. The total of each of the factors were computed based on factor analysis and from Table III, questions related to teacher factors recorded the highest mean of 61.1056 with a standard deviation of 10.27309. This indicated the prevalence of questions on teacher factors in the Likert scale questions. The least was school factors with a mean of 28.0549 and a standard deviation of 4.73698

<table>
<thead>
<tr>
<th>Factors</th>
<th>Mean</th>
<th>STD. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learner factors</td>
<td>48.0165</td>
<td>6.15138</td>
</tr>
<tr>
<td>School factors</td>
<td>28.0549</td>
<td>4.73698</td>
</tr>
<tr>
<td>Teacher factors</td>
<td>61.1056</td>
<td>10.27309</td>
</tr>
</tbody>
</table>

Table IV shows the correlation matrix of the factors that influence low performance of trainees on organic chemistry. The determinant value for this set of factors was 0.430, which is greater than the necessary 0.00001. Therefore, multicollinearity is not a problem for these data. To sum up, all factors in this study correlate well and none of the correlation coefficients are particularly large.
The KMO statistic varies between 0 and 1. A value of 0 indicates that the sum of partial correlations is large relative to the sum of correlations, indicating diffusion in the pattern of correlations (hence, factor analysis is likely to be inappropriate). A value close to 1 indicates that patterns of correlations are relatively compact and so factor analysis should yield distinct and reliable factors. Garg and Garg (2013) recommend accepting values greater than 0.5 as acceptable (values below this should lead you to either collect more data or rethink which variables to include). Furthermore, values between 0.5 and 0.7 are mediocre, values between 0.7 and 0.8 are good, values between 0.8 and 0.9 are great and values above 0.9 are superb (Dayaratne & Wijethunga, 2015). For these data the value is 0.687, which falls into the range of average and as such the factor analysis is appropriate for these data. Bartlett’s measure tests the null hypothesis that the original correlation matrix is an identity matrix. For factor analysis to work some relationships between variables is needed and if the R-matrix were an identity matrix then all correlation coefficients would be zero. Therefore, this test needs to be significant (have a significance value less than 0.05). A significant test indicates that the R-matrix is not an identity matrix; therefore, there are some relationships between the variables. For these data, Bartlett’s test is highly significant (p<0.001), and therefore factor analysis is appropriate.

Table V shows the eigenvalues associated with each factor represent the variance explained by that particular linear component and also displays the eigenvalue in terms of the percentage of variance explained (so, factor 1 explains 69.230% of total variance). It should be clear that the first factor which is learner factors explain relatively large amounts of variance (especially factor 1) whereas subsequent factors explain only small amounts of variance. There was also extraction of all factors with eigenvalues greater than 1, which leaves with one factor. The eigenvalues associated with the learner factor are again displayed (and the percentage of variance explained) in the columns labelled Extraction Sums of Squared Loadings. The values in this part of Table V are the same as the values before extraction.

The scree plot is shown in Fig. 2 with a thunderbolt indicating the point of inflexion on the curve. This curve begins to tail off after one factor and as such it can be concluded that one factor was predominant to influence the performance of teacher trainees.

III. CONCLUSION

It was discovered from the examined literature that factors such as learner, school and teacher affect students’ performance. For effective teaching and learning at education colleges require taking into account student, school, and instructor characteristics. Understanding how students integrate knowledge, encouraging self-reflection, metacognition, and acceptance of alternatives while they engage in interactive activities can all help students build real-world science concepts. Tutors in colleges must consider and use techniques that offer a more effective approach in helping trainees gain understanding of organic chemistry concepts as compared to traditional methods of teaching.

IV. RECOMMENDATIONS

Per study’s findings, it is suggested that colleges must provide a conducive environment and teaching learning resources for teachers to use appropriate teaching methodology to help trainees enhance their understanding of organic chemistry and enable them to compete adequately in choosing careers which are chemistry oriented. Monitoring and evaluation will also be necessary to track student’s chemistry performance, give ongoing information on direction of change, pace of change and generation of appropriate results regarding chemistry by trainees.

FUNDING

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metacognition, and acceptance of alternatives while they engage in interactive activities can all help students build real-world science concepts. Tutors in colleges must consider and use techniques that offer a more effective approach in helping trainees gain understanding of organic chemistry concepts as compared to traditional method of teaching.

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CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

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