UNIVERSITY STUDENTS’ PERFORMANCE IN ORGANIC CHEMISTRY AT UNDERGRADUATE LEVEL: PERCEPTION OF INSTRUCTORS FROM UNIVERSITIES IN THE SADC REGION

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Organic Chemistry is a challenging subject and students often fail to perform well in it. Both students and instructors have their own views about Organic Chemistry teaching and learning. The study reports the opinion of instructors on the performance of students in this subject. The Organic Chemistry instructors from different universities in the SADC (Southern African Development Community) region responded to a questionnaire prepared by the researchers. The analysis of the questionnaire suggested that conducting tutorial and laboratory sessions are important to students’ success in Organic Chemistry. The students’ prior knowledge helped in learning the subject and presence of anxiety/phobia affects their performance. The instructors also felt that the students feel time constraint in completion of the course in the allocated time. The most popular method of instruction was lecture method using chalk and board followed by demonstration method using models. The instructors have given various reasons for under performance in the subject and suggested ways on how to improve Organic Chemistry teaching and learning that are described in the paper.

INTRODUCTION

Organic Chemistry courses are considered difficult from students’ point of view and their performance in this subject is relatively low. The students are expected to understand, master and apply the course material in problem solving. The abilities to manage information and to reason analytically, both deductively and inductively are essential requirements for success in Organic Chemistry. The instructors believe that if one learns fundamental principles and theories one will be able to make applications as needed. Dzama and Osborne (1999) have reported about the poor performance of African students in Science. They found the absence of vocational incentives as the main cause of it. The research work in Organic Chemistry Education has been conducted mainly in American and European universities relates to problem solving, misconceptions about the subject and assessment methodologies. Maruto and Camusso (1996) have assessed the knowledge acquired in an Organic Chemistry course using a multiple-choice exercise. The results were used to research areas that should be reinforced in order to improve the quality of the teaching-learning process. The application of metatasks for organizing prevenient knowledge in Organic Chemistry has been described by Fountain (1997). Bradley and co-workers (2002) have described the importance of cooperative learning in the Organic Chemistry course in which the lecture component diminishes in the first semester and essentially vanishes in the second. Carpenter and McMillan (2003) also describe the incorporation of a cooperative learning technique in Organic Chemistry. They used Learning teams that were overwhelmingly accepted by the students as it helped them in reinforcement of concepts through peer instruction. The knowledge space theory has been used for tracking the development of students’ conceptual understanding of Organic Chemistry in second year (Taagepera and Noori 2000). This study has shown that the students’ knowledge base increases but the cognitive organization of the knowledge is weak and misconceptions persist even after two years of college chemistry. Nash and co-workers (2000) measured conceptual change in Organic chemistry. Their results indicate that significant change in students’ knowledge structure occurred during the semester.

Organic Chemistry is a component of the first year General Chemistry curriculum and a separate course from second year level onwards of the undergraduate program of most of the African universities. The
difficulties in Organic Chemistry teaching and learning surface in various academic meetings in the SADC region that has given Organic Chemistry recognition as a difficult subject. To the best of our knowledge, there has been no effort from Africa to find out the cause of students’ underperformance in the subject.

We recently surveyed the students to find out their views on the performance in Organic Chemistry (Mahajan and Singh 2004). In this paper, we report on the survey carried out with Organic Chemistry instructors in the SADC region to determine what factors they perceive influential to students’ performance in Organic Chemistry.

PURPOSE OF THE STUDY
The purpose of this study was to find out reasons influencing Organic Chemistry performance of undergraduate students in the SADC region as perceived by their instructors in different universities. The objectives of the study were:

- To find the demographic data of the respondents.
- To find out the reasons perceived by instructors on Organic Chemistry teaching and learning.
- To find the methods of instruction used by Organic Chemistry instructors at undergraduate level in the SADC region.
- To enumerate reasons given by the instructors for underperformance of students in the subject.
- To outline suggestions made by the instructors on how to improve Organic Chemistry teaching and learning in the region.

METHODOLOGY
The survey research methodology was used for this study. The questionnaire was sent by email to Organic Chemistry instructors in the universities of the SADC region (Angola, Botswana, Democratic Republic of Congo, Lesotho, Mauritius, Malawi, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zimbabwe and Zambia). The instructors from Botswana, Lesotho, Mauritius, South Africa, Swaziland, Zimbabwe and Zambia responded. The instructors were asked to rate the importance of fourteen statements in Section A of the questionnaire on a 5-point Likert scale on which 5 indicated that they strongly agreed with the statement and 1 indicated that they strongly disagreed with the statement. The fourteen statements were selected from the literature (Maroto and Camusso 1996, Berdonosor et al. 1999) and our experience of Organic Chemistry teaching in the region. In Section B, respondents had to indicate the methods of instruction used during their lectures. In Section C, the respondents were asked to indicate their demographic information such as gender, highest educational level and teaching experience. The two open-ended questions were asked to seek information from instructors on reasons for under-performance in Organic Chemistry and suggestions on how to improve Organic Chemistry teaching and learning in the region. The content validity of the instrument was established in consultation with two educationists from the Department of Agricultural Economics, Education and Extension, Botswana College of Agriculture. The data collected was analyzed using SPSS (Statistical Packages for Social Sciences) for Windows. To interpret the data, an overall mean of 3.5 or above was taken to denote agreement with all the statements and mean below 3.5 was considered to denote disagreement.

FINDINGS AND DISCUSSION
Demographic Information
The majority of instructors from the universities in SADC region who responded to the questionnaire have teaching experience of more than 5 years (Table 1). All the instructors had PhD in Organic Chemistry. The respondents comprised of 33 % female and 67 % male.
Table 1. Teaching experience in years.

<table>
<thead>
<tr>
<th>Experience in years</th>
<th>Valid percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 5</td>
<td>7 %</td>
</tr>
<tr>
<td>5 – 10</td>
<td>33 %</td>
</tr>
<tr>
<td>11 – 15</td>
<td>27 %</td>
</tr>
<tr>
<td>16 – 20</td>
<td>0 %</td>
</tr>
<tr>
<td>Above 20</td>
<td>33 %</td>
</tr>
</tbody>
</table>

Perceived factors influencing Students’ Performance in Organic Chemistry
The reasons influencing students’ performance in Organic Chemistry as perceived by the instructors have been analyzed and presented in Table 2. These factors are discussed in the succeeding paragraphs.

Prior knowledge and Sequential Learning
In the SADC region, the secondary school Chemistry curriculum has a sizable portion of Organic Chemistry. The Organic Chemistry course in the first year of undergraduate program is built on this foundation. With regard to statement 1, a mean value of 4.4545 (Table 2) was obtained that indicates the instructors agreed with the statement. This finding is in agreement with Ausubel’s (1982) study that indicated a positive relationship between learning and prior knowledge. The requirement of sequential study has been advocated by Felder and Silverman (1988).

Providing detailed Organic Chemistry course outline, modes of assessment and extra handouts/notes in Organic Chemistry
Majority of instructors distribute the course outline and assessment methods at the beginning of the course. The instructors also provide extra handouts during the semester. However there might be a difference in opinion among them about how much these affect the students’ performance. This led us to investigate the opinion of instructors on the impact of distribution of these course related materials on students’ performance. The instructors agreed with the statement 2 (Mean = 3.7500, Table 2) relating to the distribution of course outline at the beginning of the semester and students’ performance. The course outline helps students to familiarize themselves with the topics prior to the lectures and even plan their time. The instructors disagreed with statement 3 (Mean = 3.0833, Table 2) that disclosing of assessment methods at the beginning of the course would improve the students’ performance. The provision of supplemental material such as handouts and notes helps in improving their performance as statement 9 has a mean of 3.9167 (Table 2).

Time constraint in completion of the course in the allocated time
A mean value of 3.8182 (Statement 4, Table 2) suggests that the instructors agree with students feeling of time constraint in completion of the Organic Chemistry course in the allocated time. The paucity of time thus affects their performance during assessment tests and examinations. However, the reason for time constraint was not clear from this study because curriculum designing takes time factor into consideration (Zielinski et al. 2001) and instructors do consider it so as to give the best delivery of course material in the allotted time.

Conducting laboratory sessions/tutorials in Organic Chemistry
High mean values of 4.6667 and 4.4167 for statements 5 and 6 (Table 2) indicate that tutorial and laboratory sessions are the most important and greatly improve the performance in Organic Chemistry. Rosenthal (1987) has also emphasized on usefulness of lab sessions in understanding of the subject. The writing assignments have been proved successful in learning Organic Chemistry (Wilson 1994).
Presence of anxiety/phobia for Organic Chemistry

From Table 2, a mean value of 4.3333 (Statement 7) indicates that the instructors believe that the presence of anxiety/phobia affects students’ understanding in the subject. A lower success rate in Chemistry has been reported for the students with anxiety for the subject in comparison to those with no anxiety (Westerback et al. 1992). The Russians have reported the presence of chemophobia (Berdonosor et al. 1999) among students. Eddy (2000) also reported about chemophobia in a college classroom. Probably due to this anxiety the students consider Organic Chemistry as a problematic science. From our observations (Mahajan and Singh 2001) the anxiety/phobia for this subject among students has been a major factor affecting their performance.

Organic Chemistry as a complicated and a challenging course

A mean value of 3.9090 (Statement 8, Table 2) indicates that instructors believe that students’ understanding of Organic Chemistry as a complicated and challenging course, affects their performance. It has been well established that students find Organic Chemistry complicated and challenging (Katz 1996).

Demonstrations using models

It is evident from a mean value of 4.0833 (Table 2) for statement 10 that demonstration using models improves students’ performance. Molecular models are used for explaining the three dimensional structures of organic molecules (Baker et al. 1998). These are helpful for students in visualizing and thus improve their understanding of Organic molecules.

Use of active learning methods like short exercises during lectures

The mean value for the statement 11 is 4.1667 (Table 2). Writing promotes critical thinking and provides a method for student discovery and growth (Bean 1996). Active learning methods (Kovac 1999) during lectures such as concept tests and problem sheets have been proved to be successful in improving the grades. The instructors in the SADC region also agreed to this statement and found them useful.

Use of examples from day to day life during lectures

This statement has a mean of 4.4167 (Table 2) that shows the instructors agree that students find the course interesting if examples from day to day life are cited. There are more than 7 million organic compounds such as foodstuffs (proteins, carbohydrates, vitamins, fats), fuels, fabrics, wood, paper, plastics, soaps, detergents, cosmetics, medicines and explosives.

Use of lecture outlines, concept maps, diagrams

A high mean value of 4.3333 (Table 2) proves that lecture outlines, concept maps, diagrams are helpful in Organic Chemistry learning. The use of lecture outlines, summary sheets, line diagrams, concept maps (Regis et al. 1996) during lectures have resulted in improvement in chemical education.

Group discussions

This statement 14 has a mean value of 3.9167 (Table 2). Instructors agree that group discussions are helpful in understanding of the subject and improve the students’ performance. Although in chemistry classrooms, the lecture is the dominant teaching mode but multiple teaching methods are being used (Francisco et al. 1998). Group discussions, cooperative learning methods are becoming popular as active involvement of students improves their understanding.
Table 2. Factors influencing students’ performance in Organic Chemistry as perceived by the instructors.

<table>
<thead>
<tr>
<th>Statements</th>
<th>Mean</th>
<th>Std Error</th>
<th>Ranking</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Students’ prior knowledge in Organic Chemistry improves their understanding and learning ability in the subject.</td>
<td>4.4545</td>
<td>0.2070</td>
<td>2</td>
<td>Agree</td>
</tr>
<tr>
<td>2. Providing a detailed Organic Chemistry course outline at the beginning of the semester improves their performance.</td>
<td>3.7500</td>
<td>0.2500</td>
<td>10</td>
<td>Agree</td>
</tr>
<tr>
<td>3. Providing modes of assessment of Organic Chemistry course at the beginning of the semester improves their performance.</td>
<td>3.0833</td>
<td>0.2599</td>
<td>11</td>
<td>Disagree</td>
</tr>
<tr>
<td>4. The students feel any time constraint in completion of the Organic Chemistry course in the allocated time.</td>
<td>3.8182</td>
<td>0.3522</td>
<td>9</td>
<td>Agree</td>
</tr>
<tr>
<td>5. Conducting tutorial sessions in the subject for practice of concepts improves their performance.</td>
<td>4.6667</td>
<td>0.1421</td>
<td>1</td>
<td>Agree</td>
</tr>
<tr>
<td>6. Conducting laboratory sessions in Organic Chemistry improves their understanding.</td>
<td>4.4167</td>
<td>0.2599</td>
<td>3</td>
<td>Agree</td>
</tr>
<tr>
<td>7. Presence of any anxiety or phobia for Organic Chemistry affects their performance.</td>
<td>4.3333</td>
<td>0.1880</td>
<td>4</td>
<td>Agree</td>
</tr>
<tr>
<td>8. Students’ understanding that Organic Chemistry is a complicated and challenging course, affects their performance.</td>
<td>3.9090</td>
<td>0.2846</td>
<td>8</td>
<td>Agree</td>
</tr>
<tr>
<td>9. Provision of any extra handouts/notes in Organic Chemistry improves their performance.</td>
<td>3.9167</td>
<td>0.2289</td>
<td>7</td>
<td>Agree</td>
</tr>
<tr>
<td>10. Demonstrations using models improves their understanding and performance.</td>
<td>4.0833</td>
<td>0.1930</td>
<td>6</td>
<td>Agree</td>
</tr>
<tr>
<td>11. Use of active learning methods like short exercises during lectures improves their understanding.</td>
<td>4.1667</td>
<td>0.2706</td>
<td>5</td>
<td>Agree</td>
</tr>
<tr>
<td>12. Use of examples from day to day life during lectures helps in generating interest and understanding Organic Chemistry.</td>
<td>4.4167</td>
<td>0.1930</td>
<td>3</td>
<td>Agree</td>
</tr>
<tr>
<td>13. Use of lecture outlines, concept maps, diagrams help in Organic Chemistry learning.</td>
<td>4.3333</td>
<td>0.1421</td>
<td>4</td>
<td>Agree</td>
</tr>
<tr>
<td>14. Group discussions improve their understanding and performance.</td>
<td>3.9167</td>
<td>0.3362</td>
<td>7</td>
<td>Agree</td>
</tr>
</tbody>
</table>

INSTRUCTIONAL METHODOLOGY
The results related with methods of instruction are presented in Table 3. The lecture method using chalk and board is the most popular method of instruction followed by the demonstration method using molecular models. Our survey results with students (Mahajan and Singh 2003) also showed that the lecture and demonstration methods were the preferred methods of instruction.

From this finding, we can infer that the present teaching methodology is suitable for students. Other methods used by instructors were exploration/discovery method, short assignment during lectures, individual demonstration and demonstration through experimentation.
Table 3. Methods of instruction.

<table>
<thead>
<tr>
<th>Teaching Method</th>
<th>Valid percent of methods of teaching Organic Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture method using chalk and board</td>
<td>80 %</td>
</tr>
<tr>
<td>Lecture method using transparencies and OHP</td>
<td>53 %</td>
</tr>
<tr>
<td>Oral explanation of notes on handouts</td>
<td>33 %</td>
</tr>
<tr>
<td>Dictation of notes</td>
<td>7 %</td>
</tr>
<tr>
<td>Lecture method using Power Point slides and CDs</td>
<td>0 %</td>
</tr>
<tr>
<td>Demonstration method using models</td>
<td>67 %</td>
</tr>
<tr>
<td>Any other method</td>
<td>27 %</td>
</tr>
</tbody>
</table>

Analysis of open-ended questions

Reasons for under-performance in Organic Chemistry
The instructors have given the following reasons for students’ underperformance in Organic Chemistry at the undergraduate level.

- Poor background of Organic Chemistry from pre-university level
- The students find Organic Chemistry concepts very complicated.
- The students do not want to put effort themselves rather believe in spoon-feeding by their instructors.
- Time constraint as the students have a heavy load of work.
- Lack of practice that is writing to learn.
- Large intake of students result in crowded lecture halls.
- Poor study patterns
- The students tend to memorize rather than understand the concepts therefore fail to apply it in new situations.

Suggestions for improvement
The instructors on improvement of Organic Chemistry teaching and learning in the SADC region made the following suggestions.

- The students should be encouraged to write and practice exercises.
- The course should be completed well in time or the time allocated for the course should be increased.
- The frequency of small group tutorial sessions and discussions must be increased.
- The exploratory approach through experimentation must be used more frequently.
- The students should be provided with more learning aids.
- The lecturers must draw a relationship with prior knowledge and current topic as it helps students to understand.
- The students should be advised on good study methods, for example, they should be encouraged to make notes themselves.
- Short questions during lectures.

CONCLUSION
The findings indicate that tutorial and laboratory sessions are the most important factors that greatly improve the performance in Organic Chemistry. Other factors that improve their understanding in the subject are active learning methods, use of demonstration models, lecture outlines and handouts, concept maps and diagrams. Time constraint may be responsible for under-performance. Provision of detailed course outline and extra handouts may improve their performance. The most preferred method of instruction is lecture method using chalk and board followed by demonstration method using models. The instructors have felt lack of time, prior knowledge and insufficient writing and practice responsible for the poor performance in the subject. The instructors suggested on increasing tutorial sessions, advising good studying patterns in Organic Chemistry and insisted on writing assignments regularly.
ACKNOWLEDGEMENTS
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REFERENCES