

## **An Evaluation of the Type of Exercises Used by Chemistry Teachers in Kenyan Secondary Schools**

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### **Abstract**

*Acquisition of basic chemical knowledge is supposed to be at secondary school level; however, there is sufficient evidence to show that many students in the developing world come out of the secondary school system having learnt very little science. The type of techniques of teaching used by organic chemistry teachers could contribute to the students' poor mastery of subject matter. This study sought to explore the type of exercises given by chemistry teachers in the class after presentation of new content. Twenty four teachers, two hundred and six students and twenty heads of departments took part in the study. Questionnaires were used to collect data for the study. The study revealed that most teachers did not give written exercises to be done in class during lesson presentation and that the assessments done were school organised tests given at the end of the month, mid-term or end of term. The research further found that a big proportion (87.50%) of the teachers did not adequately plan for the assessments they intend to give their students. Unplanned-for assessments made students concentrate on issues not relevant to the syllabus hence contributed to the poor performance in the summative examinations set by the Kenya National Examinations Council. From the study findings, it is recommended that Teachers should plan the exercises to give to their learners before hand and even include them in schemes of work and lesson planning. Prior planning for assessment would ensure that the three main aims of learning science, namely to acquire scientific knowledge, to develop scientific skills/ processes and attain positive attitudes, are catered for in the assessments.*

**Key Words:** Evaluation, Exercises, Chemistry, Teachers, High Schools

### **INTRODUCTION**

Chemistry is a subject whose applications are recognized in many areas of society. Industries, the medical world, agriculture and so on make great use of chemical knowledge. To be innovative, one needs to have the basic relevant knowledge and skills of organic chemistry. The acquisition of basic chemical knowledge is supposed to be at secondary school level; there is sufficient evidence to show that many students in the developing world come out of the secondary school system having learnt very little science (Tsuma, 1998). The performance in the sciences in the national examinations is one pointer to the scanty mastery of science's concepts. Reports from the Kenya National Examination Council (KNEC) indicate that performance in questions drawn from organic chemistry is poor.

The Kenyan secondary school chemistry syllabus is currently examined in three papers: Paper IA, Paper IB and Paper II. Papers IA and IB are theory papers with paper IA being objective type covering the whole syllabus while paper IB has structured questions covering some parts of the syllabus. Paper II is a practical paper. However, it is in the theory papers that weaknesses in organic chemistry are observed. Some of the reasons given for the poor performance in these papers by KNEC include:

- a) Inadequate coverage of the syllabus.
- b) Negative attitude of the students towards organic chemistry.
- c) Poor teaching by the chemistry teachers.
- d) Inadequate use of teaching/learning resources.

According to Bruce and Weil (1992), the extent to which learners master a concept depends on the way it is presented to them. Rajput and Strivastava (2000) similarly agree and suggest steps that teachers should use if they have to present lessons effectively. Thus, to a number of educators, the way teachers teach contribute significantly to the extent of learning attained. The researcher therefore focused on the techniques of teaching; specifically the exercises given in the class after presentation of new content.

### **Assessment**

Examinations and assessment form an integral part of the educational process as a whole. Kempa (1990) points out that assessments are used for a variety of diverse purposes ranging from educational ones like measuring the students' attainment at the end of the course to societal roles like the maintenance of educational standards. The teaching process is incomplete without thoughts and plans on how assessment will be done. Some of the guidelines as proposed by Kempa (ibid) and supported by Montequé (2008) that could help the teacher come up with effective assessments are:

- a) The teacher thinking about the person(s) that will make decisions about the types of assessment and assessment weighing: will it be the teacher, the students or the examinations officer?
- b) Considering how the teaching and assessment approaches might affect students' learning approaches and outcomes. The teacher should try to plan assessment items that will allow students to show their understanding of the subject rather than how many facts they can remember.
- c) Planning ways of providing regular, meaningful feedback to students.
- d) Considering using peer or self-assessment processes to encourage students to become critical of their own work.
- e) Considering the approaches students might take to the proposed assessment tasks. Does the assessment encourage students to understand, extend their learning or relate the subject to real-world situations?
- f) Considering students' overall workload.
- g) Thinking of the teacher's assessment tasks related to the objectives for student learning.
- h) Preparing a detailed statement of assessment procedures for example timing, type of assessment, criteria for assessment, marking scheme and relation of assessments to objectives.

Although Kempa (1990) and others have useful guidelines, there is hardly any document from them that gives examples to teachers on how to implement each of the guidelines. A chemistry teacher, for example, needs to see how the relating of assessment to objectives can be done in the specific topic he/she is teaching. Without examples, teachers might read the guidelines but find the implementation difficult.

Thus it is evident that the importance of assessments during the teaching of Chemistry cannot be underestimated. Planning of these exercises is key for any teacher who seeks to ensure that the students perform well in the subject.

## MATERIALS AND METHODS

This study was carried out in three districts: Keiyo and Uasin Gishu districts of Rift Valley Province and Kakamega District in Western Province. The target population consisted of 21 secondary schools randomly selected from the three districts. From each school, a random selection of students was done giving a total of 206 students that were used as respondents. All the students used were form fours who had just done their chemistry examination papers. In addition to the students, 24 teachers from 18 of the secondary schools used in the study were used. Teachers from three schools, namely Tambach High School, St. Peter's Seminary and Chebisaas High School, declined to respond to the questionnaire. Four schools presented more than one teacher to respond. The teachers used were those that taught the form four classes that had just done the Chemistry examination. Apart from St. Peter's Seminary, all the heads of science departments from the 20 schools filled the questionnaire. The use of heads of departments increased the amount of data by increasing the respondents to 250.

This study used a descriptive survey research design focusing on the current classroom procedures. The procedures for the analysis, classification and interpretation of data were descriptive as well. The research obtained data through use of three instruments namely the students' questionnaire, the teachers' questionnaire and the questionnaire for heads of science departments.

## RESULTS

### Nature of the Research Subjects

*The teachers.* The teachers' questionnaire schedule (TQS), head's of departments questionnaire schedule (HQS) and students' questionnaire schedule (SQS) were the instruments used to source data. The TQS and HQS had thirty seven and thirty five questionnaire items respectively. The TQS' first four questions and HQS' first eight question items was 'Reported results on four demographic variables' namely; gender, professional qualification, experience and subject major at college. It was assumed that these variables would assist in giving explanations to the findings of the study. The heads of departments involved in the study were also found to be teachers of chemistry. The teachers and heads were grouped together in presenting data on the four variables giving the total number of respondents 44 (twenty four teachers and twenty heads of department).

The items on gender raised data which showed that there were 31 male and 13 female teachers of chemistry that were involved in the study. Given that the schools were randomly picked, the data shows that there were more than twice the number of male chemistry teachers as there were female chemistry teachers. This proportion of female teachers is low given that, in Kenya, women represent over 51% of the total Kenyan population (Kenya Census Report, 1999). The same item revealed that the random selection resulted in 13 male heads of science departments compared to 7 female heads. This seemingly higher proportion of females being promoted could be due to increasing gender awareness in appointments and promotion.

The item on years of experience gave nine teachers as having taught for five years and below with 35 teachers in the study as having taught for more than 5 years. It is expected that a 5 year teaching experience would have provided the teacher with an opportunity to attend to curriculum reform meetings, set and mark internal and external exams, participate in science congresses, attend chemistry teachers' workshops and meetings, respond to quality assurance officers' comments and any other activities that make him/her improve instructional techniques. Such a teacher could be more innovative and confident in teaching the subject. Thus, the instructional techniques that such a teacher uses will be, in the opinion of the researcher, be the best she/he can use. The item on subject major showed that 24 teachers (54.5% of those involved in the study) took chemistry as a major subject in their college/university. This implied that more than half of the teachers used in the study had more than adequate chemistry content to teach secondary school chemistry. It could also imply that schools were giving form three and form four classes -teachers who had majored in the subjects they were teaching.

The items on qualifications in both the TQS and HQS gave data showing that five out of the forty four teachers were untrained teachers. All the untrained teachers had a Bachelor of Science (BSc.) degree with no education courses done at their universities. Twelve were diploma holders and twenty seven were trained university graduate teachers.

The data revealed that over half (62%) of the chemistry teachers in schools were trained university graduates. Trained university graduates are the best manpower that many countries of the world can offer as teachers in their secondary schools. Such a group is expected to apply the most effective instructional techniques and innovations in delivering the subject matter.

**The students.** The first six questionnaire items on students questionnaire schedule (SQS) were demographic questions that sought to know more about the nature of the students that were involved in the study. It was hoped that such data could provide additional information for explaining the findings of the study. From the random selection of 21 schools, 10 were found to be boys' secondary schools, 6 were girls' schools, and 5 were mixed secondary schools. The data showed that of the 206 students involved in the study, 135 were boys and 71 were girls. It was also found that, in mixed schools, more boys than girls volunteered to take part in balloting and responded to the questionnaire. It was observed, in particular, that girls were reluctant (shy) in taking the first step in balloting leading to the distribution by gender of students that took part in the study from mixed schools. This could indicate that in mixed schools, girls generally allow the boys to take challenges or tasks first before they (girls) attempt them. These girls take a second

position in volunteering to solve problems. Perhaps this could be a cultural influence where communities expect boys to take the first or leading step whenever a community is faced by a challenge.

Data about the type of primary schools the students in the study attended showed that 168 (81.55%) of the students came from public primary schools, leaving only 38 students those that came from private primary schools. The representation in each secondary school generally showed a similar pattern with more students having come from public schools. This is expected since there are many more public primary schools than private primary schools.

### Assessments Administered in Class

There were questionnaire items about the scheme and type of assessments given during lesson presentations. These questionnaire items were given to students, teachers and heads of departments. The responses were as shown in Table 1.

Table 1. Responses to questionnaire items on type of assessments given

Questionnaire Item No.	Type of Respondents	Answer Choices					Total
		A	B	C	D	Blank	
16	Students	182	13	4	3	4	206
17	Students	11	173	10	7	5	206
12	Teachers	1	0	21	0	3	24
28	Teachers	6	2	9	2	5	24
29	Teachers	3	1	2	18	0	24
30	Teachers	2	0	22	0	0	24
31	Teachers	0	18	3	3	0	24

Fifty percent of the heads of departments, responding to questionnaire item number 28 of the HQS, said any written assessments in organic chemistry were done during the continuous assessment tests (C.A.Ts) organized at the end of the month, the middle of the term or at the end of the term. Responses about the type of home work given to students revealed that 83.98% of the students, in questionnaire item number 17 of the SQS, said that the home work that was given to them was challenging and relevant to the material they had learned.

Questionnaire item number 12 of the teachers' questionnaire schedule (TQS) sought information on the planning that is done before assessing students. The responses showed that 87.50% of the teachers did not consider it necessary to include assessment procedures in their schemes of work. This could be interpreted to mean that there is no prior planning for the type of assessment procedures to be used in assessing students in organic chemistry instruction

## DISCUSSIONS

This work sought to obtain information on the type of assessments that are done during the lessons. The findings revealed that half (50%) of the heads of departments did not

give any written assessments during lessons but that written assessment is left to be given at the end of the month, mid-term or end of term.

Kempa (1990) points out that in recent years, attention has been given to the issue of how the results of examinations and assessments can be expressed and communicated in a meaningful and informative way. He argues that the single grades that are conventionally used to summarise examination and assessment results provide little information about the qualities that are reflected in them (results). Assessments that are given at the end of term tend to do precisely that, that is, give a non-informative grade. Educators are currently advocating for other modes of communicating assessments results such as the use of profiles. A profile, according to Kempa (1990), is a document that presents information about a student's performance over a range of different skills and abilities. To do this, a lot of assessments, most of which should be formal, that is, involving written exercises, would be done during the lesson. Through this, the teacher can get first hand information on the abilities of the student such as following instructions, comprehending the question asked, ease of grasping the concepts, presentation of answers, application of knowledge learned and so on. With such information, the teacher can modify the teaching techniques, the resources used, pace of presentation et cetera so that the learners can achieve the expected outcomes.

Gagne and Briggs (1979) assert that objectives serve as guidelines for developing instruction and for designing measures of student performance. The same interrelationship between objectives, instruction and assessment is also endorsed by Kerr (1963). Thus assessments function as determinants of the content and orientation of instruction and hence, the curriculum. In other words, the curriculum is led by the type of assessments. Since curriculum implementation is done during lesson presentation, formal assessment of the effectiveness of this implementation should start here.

Bruce and Weil (1992) argue that assessment in class can lead to using feedback to modify behaviour once a student's problem is identified. Contingency management is applied where the treatment of specific maladaptive responses using reinforcement in the classroom is done. In that way, a student's weaknesses are corrected early before they get out of hand. Thus the finding that formal assessments are not done during the organic chemistry lessons could lead to the accumulation of problems that lead to the students' performing poorly in this section of the chemistry course.

The research further found that a big proportion (87.50%) of the teachers did not adequately plan for the assessments they intended to give their students. This was revealed when the teachers said that they did not find it necessary to include assessment procedures in their schemes of work and they actually did not include them. Wiliam *et al.* (2004) points out that planning for assessment is just as important as planning for teaching. During the planning for assessment the teacher gives a closer look at the objectives of the lesson and the teacher-student activities as written out in the schemes of work. These will guide the teacher on the type of assessments to emphasize. Kempa (1990) points out that there are three main assessment procedures in science. These are oral, written and observation. If the objective of the lesson is for the students to be able to prepare and collect hydrogen gas, then a suitable assessment procedure would be to observe students preparing and collecting hydrogen gas. In other words, the task would

be to give the learners materials and ask them to prepare and collect hydrogen. Prior planning for assessment would also ensure that the three main aims of learning science, namely to acquire scientific knowledge, to develop scientific skills/ processes and attain positive attitudes, are catered for in the assessments. Even when using written assessment, the teacher has to decide whether to use objective or structured type or essay type of written questions based on the objectives and the activities that will take place during lesson presentation.

If an assessment is constructed at the end of the month or term, chances are adequate attention would not be paid to the objectives of the lessons as they were taught, the activities that took place, the content delivered, the difficulties experienced by learners and so on. Ideally, assessments, having been considered while writing schemes of work, should be constructed during lesson planning but, as the earlier findings revealed, teachers hardly make lesson plans. Thus, at the end of the term, it is possible for a teacher to come up with an assessment picked from past papers or text books that does not meet the expectations of the curriculum. Such unplanned-for assessments could make students concentrate on issues not relevant to the syllabus hence contributing to the poor performance in the summative examinations that are set by the Kenya National Examinations Council (KNEC).

### **CONCLUSIONS AND RECOMMENDATIONS**

The study revealed that most teachers did not give written exercises to be done in class during lesson presentation. The assessments done were school organised tests given at the end of the month, mid-term or end of term. The finding that formal assessments were not done during the organic chemistry lessons could lead to the accumulation of problems that lead to the students' performing poorly in the chemistry course.

Due to lack of planning for the assessments, it was possible for teachers to come up with assessments picked from past papers or text books that did not meet the expectations of the curriculum.

It is thus recommended that assessments and other exercises administered in class be considered while writing schemes of work, and constructed during lesson planning. Prior planning for assessment would ensure that the three main aims of learning science, namely to acquire scientific knowledge, to develop scientific skills/ processes and attain positive attitudes, are catered for in the assessments.

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### **BIO-DATA**

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