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Student Performance in A-level Chemistry Examinations in Makoni District, Zimbabwe

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Abstract
The case study was carried out at three high schools in Makoni District, Manicaland Province, Zimbabwe, involving form six chemistry students and their teachers, during January to May 2011. Data were collected through questionnaires, interviews, observations and securitization of records and other documents, revealing factors affecting student performance and how performance might be enhanced. The study exposed a number of issues to be addressed by curriculum planners, teachers, examining board and students to improve examination performance. Teachers and students voiced concern about the extensive nature of the chemistry syllabus and the nature of examination questions and they felt that the abstract nature of chemistry was a major source of learning problems. Some students had misgivings about the way the subject was taught, lack of suitable text books and the very limited access to practical work, attitude of some teachers who failed to motivate students toward liking the subject, and the quality of teachers. Participants gave suggestions for improvement of performance.

Keywords: Chemistry Concepts; Chemistry Teaching; Constructivist Method; Examinations; Meaningful Learning

Introduction

The formal education system in Zimbabwe consists of five levels: The early childhood education (grade zero); primary level (grades 1-7); lower secondary level (forms 1-2); ordinary level (forms 3-4); upper secondary (forms 5-6) and tertiary education (colleges and universities). Learning of chemistry begins in the lower secondary level where concepts of the particulate nature of matter and physical and chemical changes are introduced. Atomic structure and chemical reactions are introduced at ordinary level where some schools offer physical science (physics and chemistry), or integrated science (biology, chemistry and physics) or pure chemistry. In general, O-level passes in biology, physical science (chemistry and physics), chemistry and physics are pre-requisites to studying science at A-level. Students who study chemistry at A-level do so in combination with biology and physics or biology and mathematics or physics and mathematics. Only exceptionally bright students may be allowed to take four subjects at A-level, and students are rarely encouraged to take geography as one of their subjects.

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A-level chemistry is taught in detail in preparation for tertiary education. Practices are optional at O-level, but compulsory at A-level and examined at the end of the course. Students need to pass O-level chemistry or physical science with an A or B grade to be considered for A-level chemistry studies. Some schools require students to have at least five A-grade passes and at least a B in Mathematics to be considered for A-level chemistry studies, ensuring that the students who will be enrolled for A-level Chemistry are bright.

A-level science learning requires specialist teachers who most schools are currently failing to attract because of economic challenges bedeviling the country. This is exacerbated by inability to acquire special resources such as laboratories, laboratory equipment, chemical reagents, etc. (UNICEF, 2000). Results vindicate the notion held by many people that A-level chemistry is a difficult subject (Sirhan, 2007). The fear of chemistry studies, coupled with poor re-numeration of science graduates compared with those of commercial disciplines, has caused a decline in the number of students willing to take chemistry at this level, resulting in a decrease of numbers of students taking up medical and chemical engineering fields. National economical development and general societal well-being are the obvious causalities of this attitude.

Meaningful learning takes place based on what the learner already knows (Ausubel, 1968; Novak, 1977; 2000). The many abstract chemistry concepts, which are central to further learning in both chemistry and other sciences (Taber, 2000; 2002) are important because further chemistry concepts or theories will be difficult to study if these underpinning concepts are not sufficiently grasped (Zoller, 1990; Nakhleh, 1992; Ayas & Demirbas, 1997; Coll & Treagust, 2001; Nicoll, 2001). The abstract nature of chemistry along with other learning difficulties, for example due to the mathematical nature of chemistry, means that chemistry classes require a high-level set of skills (Fensham, 1988; Zoller, 1990). Regarding a subject as difficult repels learners from continuing with studies in the subject, hence many countries have developed new syllabi for secondary schools to make subjects more learner-friendly (Sirhan, 2007).

The constant interplay between the macroscopic and microscopic levels of thought is an essential characteristic of chemistry which represents a significant challenge to novices learning chemistry (Bradley & Brand, 1985). From the learner's point of view, the problem areas of chemistry learning may persist well into university education. A number of researchers have observed the following as the most difficult topics: Stoichiometry and the mole concept; chemical formulae and equations; condensation and hydrolysis; atomic structure; kinetic theory; thermodynamics; electrochemistry; and intermolecular forces. Chemistry is a highly conceptual subject where real understanding is only achievable through meaningful learning of concepts (Holbrook, 2005).

While students apparently show some evidence of learning and understanding in examinations, researchers find evidence of misconceptions, rote learning and of certain areas of basic chemistry which are still not understood even at degree-level (Johnstone, 1984; Bodner, 1991; Kazembe, 2010a) because what is taught is not always what is learned (Sirhan, 2007). Some students will neatly reproduce their notes during examinations but display ignorance during projects, indicating that the level of understanding portrayed during examinations is not always indicative of what has been learned (personal observation).

Purpose of the study

This study will explore the factors causing poor performance by students, remedy the fear of the subject experienced by the students, reveal the obstacles encountered by teachers and students in the teaching and learning of chemistry, and attempt to reverse the negative attitudes which have developed in learners. It will also identify the gaps between students' wishes and teachers' teaching as observed by Rannikmae (2001) and help teachers map out more effective strategies to tackle the subject and promote meaningful chemistry learning (Holbrook, 2005) as well as unravel the many variables that affect student learning (Yücel, 2007). Careful design of O-level and A-level chemistry curricula will enhance development of the scientific minds necessary for careers in the sciences which will be studied at tertiary levels, Colleges and Universities. The study will help curriculum developers and planners to make the curriculum more relevant and sensitive to the needs and demands of the Zimbabwean society. Teacher educators will use the research findings to enhance development of more effective strategies and approaches for chemistry teacher training (UNICEF, 2000).

Statement of the problem

Analysis of A-level results for the four years (2007-10) reveals that student performance in chemistry is lower than in either of biology, physics or mathematics (Appendix 1). The low pass rate probably contributes to the decline in the numbers of students willing to study chemistry at A-level as the results cause students to regard chemistry as a difficult subject, an observation which at times repels learners from the subject (Sirhan, 2007). Students are enrolling for chemistry at universities ill-equipped to study chemistry and this might be related to the way they are prepared at schools, hence it is important to investigate how students are prepared for university work. Notwithstanding that students in all countries find chemistry a difficult subject and results are generally low, in Zimbabwe the A-level chemistry pass rate has become a major source of concern. Universities are finding it difficult to enroll sufficient numbers of candidates in chemistry departments because of dwindling numbers of students satisfying the entrance requirements. Hence a study of this nature might make the study of chemistry more attractive, more manageable and more meaningful to students.

Research questions

1. What factors are influencing students' performance in examinations?
2. Is school chemistry teaching and learning effective and enjoyable?
3. What can be done to free students from the fear of chemistry and improve students' performance?

Methodology

Research design

This is a Case Study in the sense that the researchers identified a problem (the poor chemistry results) and embarked on the ways to alleviate the case (Bell, 1993). The study was carried out at the three high schools which offer chemistry at A-level in Makoni District, Manicaland Province, Zimbabwe, involving form six chemistry students and their teachers. All participants completed questionnaires, were interviewed, observed, and their records scrutinized between January and May 2011. The qualitative nature of a case study permits intensive, holistic description and analysis of factors affecting student performance and its flexible nature permits the employment of various methods of collecting data, such as questionnaire, interviews, observations and documentary analysis. The prolonged engagement with the participants (Borg, Borg & Gall, 1996) allows a great deal of information to be collected as the researcher goes native and ceases being a stranger to the participants who reciprocate by opening up and disclose their problems (Macmillan & Schumacher, 1993), allowing the researcher to collect valuable first-hand and authentic information through observations (Bogdan & Biklen, 1992).

Questionnaires

Questionnaires (Appendices 4 & 5) were used to collect basic descriptive participants' information: age, sex, academic achievements, opinions, attitudes, preferences and perceptions. This enabled the characterization of the sample and summarization of the information which was then presented in the form of tables making it easier to describe and interpret. The participants used the open-ended questions to lavishly demonstrate their knowledge of what they deemed relevant to the questions.

Interviews

The data from interviews (Appendices 2 & 3) consisted of direct quotations from participants about their experiences, opinions, feelings and knowledge (Best & Khan, 1993), consistent with the purpose of interviews being to find out or access the perspective of the person being interviewed. An interview guide ensured that all participants were subjected to the same questions under similar conditions and covering the same topics systematically (Patton, 1990).

Observations

The data from observations consisted of detailed description of people's activities, and the full range of interpersonal interactions and organizational processes that are part of observable human experience (Patton, 1990). It also consisted of details of behaviors, events, and the contexts surrounding the events and behaviors (Best & Khan, 1993). The observations were continuous over the whole data collection period (10 January to 30 March 2011) and were more objective than interviews and surveys because they were independent of participants' self reports. They were made during theory lessons, practical sessions, and study or assignment sessions, in formal and informal discussions. Borg, Gall and Gall (1993) described direct observation as essentially a technique for gathering "live" data about the individuals and events being studied. The data are "live" in that the behavior and events are recorded as they occur and are more reliable than paper and pencil reports.

Documentary review

Document analysis is an important aspect of data collection which yields extracts, quotations, or outline passages from organizational program records, memoranda and correspondence, official publications and reports, surveys, etc. (Patton, 1990). The following documents were analyzed: schemes of work, student progress records, report books, syllabuses, text books, students' exercise books, examination scripts and marking schemes, bearing in mind that data appearing in print are not trustworthy and making efforts to establish trustworthiness through triangulation.

Data analysis and presentation

Data analysis was continuous throughout the data collection period as it guided the data collection itself. Collected data were compared, coded and relationships between individual cases were established. Some of the data were presented in frequency distribution tables in order to reveal the data characteristic patterns, facilitating data description and interpretation.

Sampling

The authors recognize the subject of this study as a national problem but chose to narrow it to a district for it to remain manageable. The chosen district has three schools which offer chemistry at A-level. The sample included all 51 A-level chemistry students in the district, comprising of 16 students from school X, 23 from school Y, and 12 from school Z, totaling 30 boys and 21 girls aged 17-19 years. That the schools were boarding schools implied existence of constant variables which influenced reliability and validity of results. Three teachers (one from each school), all male and degreed, with experience varying from 5 years to above 10 years participated.

Gaining field entry

Armed with an introductory letter from The University of Zimbabwe Department of Science and Mathematics Education, permission to carry out research at the three schools was obtained from Ministry of Education, Arts, Sports and Culture Head Office, then the Provincial Office and the District Office; from the School Heads, teachers, students and parents of students (Best & Khan, 1993). The first two weeks were spent familiarizing with the schools administrations, participating teachers and students and no data were collected. The Headmasters and teachers perceived the importance of the study and requested copies of the write-up. Students were excited about the opportunity to participate in a research.

Results and Discussion

The performance of A-level chemistry students appears to be a result of: students' background, abstract nature of chemistry, the extensive A-level chemistry syllabus, the nature of the examination questions, the way the subject is taught, and the attitude of students.

Students' background

All students enrolled for A-level having studied mathematics and biology, but differing in how they studied physics and chemistry at O-level. One group did pure chemistry and pure physics whilst the other group did physical science -physics and chemistry combined- (Table 1).

Table 1. Distribution of the students' performance at O-level

Grade/subject	Mathematics	Physical science	Chemistry	Physics	Biology
A	44	20	23	9	49
B	6	8	0	5	1
C	1	1	0	0	1

Chemistry was a last choice subject for 14 of the 29 students, who did Physical Science at O-level, second choice for 12, and only 3 made it their first choice. The students who enrolled for science subjects were very bright as evidenced by their O-level passes. Five had 5 or less A grades in their certificates; 12 had 5-6; 25 had 7-8; 8 had 9-10; and 1 had 10 A grade passes. Table 2 indicates that mathematics is the most preferred subject, 41.2% having it as a first choice subject and chemistry was the least favoured with 49% having it as a third choice subject, indicating the reluctance of students to study chemistry.

Table 2. Subject preference frequency distribution

Preference/subject	Mathematics		Physics		Chemistry		Biology	
1st	21	41.2%	7	13.7%	8	15.7%	15	29.4%
2nd	12	23.5%	11	21.6%	18	35.3%	9	17.6%
3rd	18	35.3%	5	9.8%	25	49.0%	4	7.8%

The students who made biology their first choice subject said biology is easier to understand and apply since it is about the living things they see every day. Students were able to get higher marks from it than from other subjects. In abstract subjects like chemistry they meet concepts they are not familiar with, for example orbitals, intermolecular forces, intramolecular forces, etc. which are not readily applicable to real life and cannot be seen or felt physically.

Students who preferred mathematics expressed their passion for calculations. Most of them had similar sentiments for physics. They said that mathematics and physics were easier to study because one only needs to understand a few concepts then apply equations with little or no explanation required.

The students (45.1%) wrote negative comments about chemistry and some (11.8%) complained about the syllabus having too much content requiring extensive reading and memorization. They complained that chemistry is tricky, confusing and involves complicated explanation of abstract concepts. Its examination questions are difficult to understand, leading to answers that do not satisfy the examiner. Only 5.9% of the participants said they liked chemistry. Most of those who made chemistry their first choice did so because chemistry is a pre-requisite for their intended careers or because of their desire to face challenges.

Questionnaire results

The extensive nature of the chemistry syllabus

Some of the students (15.7%) said that the overloaded chemistry curriculum made the subject very time-demanding and more difficult to pass than any of their other subjects. Students (frequencies in brackets) said that their problems in learning chemistry were due to the following factors: too much content (7.8%); examination questions were difficult to answer (19.6%); negative attitude towards the subject (5.9%); lack of appropriate books (2.0%); lack of interconnectivity between some concepts (7.8%). Teachers and students concurred with Jegede (2007) that the subject was too wide, demanding, cumbersome and difficult to understand, with practices and failure in chemistry examinations scaring and putting students off chemistry. Students showed anxiety toward the abstract nature of chemistry and the way it was being taught by teachers, some of whom lacked interest, innovation, encouragement and resourcefulness. Johnstone (1984) reported that there was a positive relationship between teachers' quality and interest of students in science subjects. Lack of well-equipped chemistry laboratories, excursions and field trips prevented students linking chemistry and industry, the environment and everyday life (Jegede, 2007).

Relevance of the chemistry curriculum

The A-level chemistry syllabus used in Zimbabwe was adopted from the Cambridge University syllabus in 1998. Many changes have occurred in technological development and societal needs since then. The Cambridge University syllabus itself has been modified, but the Zimbabwean syllabus has remained static and the curriculum must be reviewed so that it responds to the needs of Zimbabwean society and improve relevance to the learners. The relevance of what is taught and the way it is taught is critical for conceptual learning to take place and a subject that lacks relevance will be unpopular with students (Holbrook, 2005). Chemistry teaching which lacks relevance does not promote higher order cognitive skills, leaving gaps between student's wishes and teachers teaching (Anderson et al., 1992; Zoller, 1993; Hofstein et al., 2000; Yager & Weld, 2000).

The nature of examination questions

Teachers and students feel that examiners appear to use examinations to evaluate teachers, schools, districts, etc instead of evaluating whether learning is taking place. Teachers are teaching with a vision of having a very high pass rate so that they can get recognition. Students want to pass the national final examinations because the results greatly influence their future and so they want to pass by any means. Both teachers and students use any means to achieve their goals. Under such situations the "chalk and talk" method dominates the way the subject is taught and anything that may seem to result in the students passing is followed.

Some students (15.7%) claimed that they did not have difficulties in understanding the chemistry concepts during lessons or when studying but they had difficulties in interpreting and answering examination questions. Some complained that one had to write a lot for just a few marks and it was difficult to know exactly what the examiner wanted, for example no marks were given when certain words were not included in the explanation. Some students feel that the marking schemes are unreasonably rigid and some examination questions do not appear related to what is taught, thereby de-motivating students and destroying their confidence. Students will have large amounts of chemistry data which they cannot use when answering the questions and struggle to figure out what the questions require. One teacher wrote, "…some examination items are too challenging for students and topics are not balanced in the examination papers or some questions are more difficult than the expected for the level. A different teacher added that some assessment areas examined do not tally with syllabus requirements.

The way the subject is taught

Some of the questionnaire responses suggest that the thrust of teaching and learning is on passing examinations rather than real understanding of concepts. Student thrust was on examination techniques, 39.2% of them feeling that teachers need to improve on the way they prepare students for examinations. Only 7.8% of the students urged teachers to improve the way they teach and use of models to illustrate the concepts so that the students can fully understand the concepts. Some students suggested that teaching media such as models and e-learning should be used to illustrate abstract concepts about structures, bonding, and shapes of molecules. Students will then view complex three-dimensional structures, or behavior of particles. Faith wrote: "Teachers should work on appropriate teacher-student relationship to create environments more conducive to learning and influence students to like the subject." Some students (9.8%) felt that teachers were not giving them encouragement and opportunities to participate and promote active learning during lessons. Russy wrote: "… teachers should conduct lessons where students play active roles because we do not forget what our fellow students teach us", alluding to the introduction of aspects of cooperative learning (Kazembe, 2010b).

One of the teachers wrote: "Students should be given more practice on answering examination questions." The danger of preparing students for examinations through past examination questions is that teachers will concentrate on giving students questions and answers instead of teaching them to reason and come out with answers. Concentration on past examination papers will leave less time to learn the concepts besides encouraging memorization of concepts. Use of the constructivist's approach equips students with knowledge which they can use to solve problems from first principles, enhancing meaningful learning. The complaint by some students that there is too much content to be memorized tends to vindicate that memorization of information by students is rampant.

The abstract nature of chemistry

Most of the concepts met in chemistry learning at this level are abstract, for example the atomic structure, the mole, molecular and ionic structures, substance structures, intermolecular forces. Learners experience difficulties learning such concepts because they cannot visualize or touch the objects or phenomena. Joseph wrote: “Chemistry is quite challenging … the problem is that we have never seen most of the things we learn about and it is difficult to imagine what the chemicals look like or how they behave…”

Practical work

Experiments are most recommended in the teaching of sciences, especially Chemistry, because according to the constructivist theory, the learners can construct knowledge as they learn actively from experiments, leading to knowledge that lasts a long time. This learner-centered approach is a more effective way of learning than the teacher-centered approaches where knowledge is transmitted from the teacher to students who then memorize the ideas, leading to knowledge that is short lived and frequently is of little use.

Some students (9.8%) complained that chemistry practical work was difficult because there does not appear to be a link between the practices and the theory. Molly wrote: “… there are no books which give advice on how to approach practices.” Questions on the “assessment of planning skills” require students to design experiments from given situations which examiners assume students should do as they cover the syllabus. Students who have only done practices related to the usual titration, enthalpy change, reaction rate and qualitative analysis will find this section difficult. Bono wrote: “I find calculation and interpretation of results from practices so challenging that I cannot process them and get the expected answers and conclusions.” Teachers admitted that students had difficulties in practical work and suggested that students should do more practices. However, students’ responses and examiners’ expectations suggest that the remedy would be in hands-on learning during theory lessons, to illustrate the theories and laws of chemistry. The practical section of the syllabus should be revised and linked to the theory section.

Attitudes

Attitude is an influential factor for success in learning. Negative attitude causes individuals to carry out tasks with very little or no enthusiasm. Some students’ responses revealed a negative attitude towards chemistry. One student said that she never passes chemistry no matter how much she reads it. Another student, Gamn, wrote: “Our teacher always tells us that Chemistry is difficult to pass read as can be seen from the number of read as in chemistry compared to results from other subjects.”. Such attitudes tend to frustrate and repel students from putting effort in the subject.

Students who develop positive attitudes usually work hard and do well. Tapiwa wrote: “Chemistry is manageable if one develops a positive attitude towards it.” Molly wrote: “It is possible to pass chemistry because other people have passed it.” With such an attitude a student is bound to work hard and pass. Yücel (2007) reported that the effect of attitudes toward science on student achievements in science lessons is greater than the effect of students’ abilities.

Textbooks

Students consult text books to consolidate what they learn during lessons. Some of the students (13.7%) wrote that their low achievement rate resulted from the way information was presented in the Chemistry text books. Jamela wrote: “The text books do not clearly explain the topics, as can be inferred from the questions asked in examinations, especially in connection with bonding and chemical periodicity". Judy and Obie suggested: "We should have text books which are user friendly and Zimsec must ensure publication of books for practical skills." Other students added that e- learning would improve the range of sources of information."

Favourable and unfavourable topics

The participating students were asked to indicate the topics that were either favourable or unfavourable to them giving reasons for each case, to enable researchers to establish hindrances to student understanding of the topics (Tables 3 to 7). Teachers were also asked to list the topics that they enjoyed and those they did not enjoy teaching, so that researchers could get a deeper understanding and meaning to the lower than expected performance.

Table 3. Frequency distribution of favourable topics

Topic	Frequency
Stoichiometry	15
States of Matter	8
Periodic Table	25
Bonding	12
Reaction Kinetics	22
Organic Chemistry	25
Electrochemistry	16
Chemical Energetics	22

The participants gave varied and apparently contradictory explanation, due to the existence of two groups within the population. One group does Mathematics, Physics and Chemistry whilst the other does Mathematics, Biology and Chemistry. The students who do Mathematics, Physics and Chemistry reported Physical Chemistry topics as favourable.

Table 4. Frequency distribution of topics enjoyed by students who did physics

Topic	Frequency
Stoichiometry	5
Reaction Kinetics	8
Electrochemistry	5
Chemical Energetics	8
Equilibrium	5

Some students expressed that they enjoyed these topics because they involved calculations. The other reasons included:

- They are very easy to understand, requiring short and precise answers
- They involve application of principles and have less content to memorise.
- The content is well explained in many texts.
- The topics are not abstract, involve diagrams, and are interesting.
- The questions are not very much demanding.

The group doing Mathematics, Biology and Chemistry did not like topics involving calculations, 85.2% of them being girls, chose topics from the Inorganic and Organic sections (Table 5).

Table 5. Frequency distribution of topics favoured by students who did Biology

Topic	**Frequency**
Periodic Table	3
Reaction Rates	8
Organic Chemistry	13
Chemical Energetics	4
Bonding	2

The topics were said to be favourable mainly because they were not loaded with calculations and they could be easily read and understood. There were other reasons:

- The topics are well elaborated in text books.
- They are easy to understand and do not involve a lot of calculations.
- The topics were well explained in lessons and are applicable to real life phenomena.
- The topics are easy to read and apply in examinations.
- The questions on these topics are not confusing.

A similar trend was observed for unfavourable topics (Table 6).

Table 6. Distribution of topics selected as unfavourable

Topic	Frequency
Equilibrium	12
Chemical bonding	9
Group vii	3
Chemical periodicity	4
Organic chemistry	18
Electrochemistry	7
Inorganic chemistry	6
Options	3
Reaction rates	7
Chemical Energetics	5
Stoichiometry	4

The participants’ major reasons for not enjoying the topics were:

- Too much content.
- Too difficult to understand.
- Examination questions are difficult and confusing.

Table 7. Distribution of topics which were considered to be too long

Topic	Frequency
Equilibrium	8
Organic Chemistry	15

Electrochemistry	4
Inorganic Chemistry	3
Reaction rates	2
Stoichiometry	3
Chemical Energetics	4

Students stated that chemical equilibrium, chemical bonding, chemical periodicity, option topics, reactions and chemical energetics were too difficult to understand and that examination questions on these topics were difficult to answer. Wadzanai wrote: “Examination questions on equilibrium and electrochemistry are a bolt from the blue even if you work hard. I have never come across their sources and marking schemes on responses on these topics are ever strict.” Thus the students lose hope in the subject. Students who do physics, chemistry and mathematics wrote that the organic chemistry section has too much content to memorise and there were no calculations involved. Bob wrote, “Since I am doing Physics I don’t understand the Biology part which is in the Biochemistry option”. The other reasons for not enjoying certain topics were:

- Topics such as atomic structure, bonding and chemical periodicity are too abstract.
- The content is not clearly explained in the text books and notes.
- The examination questions on The Periodic Table are too difficult.
- The organic chemistry section has too many reactions which require memorisation and are easily forgotten.
- Combining half equations and finding E_{cell} is challenging in electrochemistry.

Students who do biology, chemistry and mathematics stated that topics such as chemical equilibrium, electrochemistry and chemical energetics involved too many calculations. Sofie wrote: “The Born – Haber cycles are tiresome and students are prone to making errors as they do calculations. E^0 values from the Data Booklet are not easy to use because of difficulty deciding which half equations to use”. Rutendo wrote: “I forget or get confused when asked about the Periodic Table and Bonding. I read and understand but I cannot answer the examination questions correctly.” Ginaz blamed teachers for his dislike of inorganic chemistry and reaction rates and wrote: “The topics are boring and teachers do not explain them well.”

One of the teachers wrote: “Inorganic chemistry is difficult to teach because it is all about analysing trends”. Thus, agreeing with the 13 students who listed topics from inorganic section as unfavourable and with Ginaz’s explanation that teachers do not explain concepts in these topics well.

The other teacher wrote that electrochemistry and options were difficult topics to teach, concurring with 7 students who indicated electrochemistry as unfavourable and 3 students who castigated options. Teachers admitted to have difficulties teaching the topics because they are abstract and there are no suitable aids, in agreement with the students who called for use of models and computers to assist visualise structures and processes. The third teacher wrote that teachers need staff development to enable them to teach the option topics. Problem solving approach could enhance students’ problem solving skills and prepare students for high order questions which require application and analysis.

Changes that might improve the performance

The responses on how the performance can be improved exposed a number of issues to be addressed by curriculum planners, teachers, examining board and students. Major issues identified from the questionnaire responses include: more examination practice, use of teaching media, relevant text books for the Chemistry syllabus, practices, teaching approaches, content reduction, students' attitude towards the subject, and quality of teachers.

Examination practice

Students (33.3%) suggested that more time be allocated to examination practice. Chipo wrote: "Students should be given more examination questions for practice. Such sentiments show that the learning process is examination oriented with emphasis on acquiring knowledge for examination rather than understanding the concepts. Such practice promotes receptive learning, mechanical memory and passive imitation which do not prepare students for critical thinking. Such students get stuck when confronted with examination questions which require application of concepts and the questions would appear as if they do not correspond to the syllabus. Thus teaching and learning for examination approach leaves gaps between what students learn and what they encounter in the examinations. However, teachers and students concurred that improvement in examination performance can be achieved through examination practice. The examination-oriented learning is centred on the centralised national summative assessment which is used for entry into universities, technical colleges, work, etc. and, therefore, it determines the future of the student. On the other hand it is used to assess the effectiveness of the teacher, the school, the district, the province and the nation (the system) instead of assessing the learning process. Thus both the teacher and the student find it beneficial to have examinations passed by any means.

Teaching approaches and methodologies

Since the teaching/learning in these schools is focused on passing the examinations, the teaching has remained largely teacher-centred, ignoring the development and mastery of scientific methods of solving problems as required by the curriculum (UNICEF, 2000). Students' responses indicate that they think teachers are not teaching what comes in examinations. Samson wrote: "Teachers should teach what come in examinations". Use of teacher-centred methods encourages students to memorise what the teachers give them and will fail to develop scientific attitudes, values, processing skills and high order tasks, which they require to solve high-order tasks, through application and evaluative reasoning. Use of student-centred approaches would equip students with higher cognitive skills. Joy wrote: "Teachers should conduct lessons where students play active roles, because they do not forget what peers teach them". Other students advocate for cooperative learning in which they exchange ideas, argue and contribute their conceptions, a practice that would allow misconceptions to be exposed and be corrected (Kazembe, 2010a). The practice would be in line with the constructionist theory of learning in which the student constructs knowledge through the activities or experiences which lead to permanent understanding of concepts. James wrote: "The teacher should refer to examples of things met in everyday life for better understanding." Linking concepts to everyday experiences makes the concepts more relevant and useful. Teachers need to contextualise the concepts so that the students can realise their importance. Molly added: "…such as trips to enhance our practical knowledge of the subject." However, teachers complained that students do not participate during lessons because they do not want to work. However, even with that excuse, teachers and curriculum developers apparently hold the key to improvement of chemistry-learning.

Curriculum planners need to familiarize themselves with current world trends in science education whose ultimate goal is to develop students with broad, deep and interconnected levels of scientific literacy, conceptual understanding and contextual application of knowledge. They should ensure that science education concentrates on developing higher-order cognitive skills based on critical thinking and problem solving (Zoller & Pushkin, 2007). Research has established that students who are trained in problem-solving skills demonstrate greater conceptual understanding than those who are not trained. Many students are able to solve problems algorithmically but lack the understanding necessary for solving conceptual questions (Zikovelis & Tsapalis, 2006).

However, most chemistry curricula treat conceptual understanding and the appreciation of the nature of science as if unimportant, yet they are of great value for functionality in students' lives, influencing the relevance of chemistry to the home, the environment, future employment and developments within the society. These curricula put more emphasis on examination content than on applications. Teachers should be urged to understand how their students learn so that they can devise effective teaching strategies (Clow, 1998; Holbrook, 2005; Yücel, 2007).

Practices

It appears as if practical work is given only in preparation for the practical examinations. Students (11.8%) expressed the need for more practical work. One of the teachers wrote: "More practical work should be carried out to give students practice. Apparently teachers concentrate on experiments which come in examinations. The function of experiments should be to assist in the learning of theories and these should be done during theory coverage. Practical work helps students understand the concept, because when students observe or see they do not forget easily as Joy wrote, "we don't forget what we will have seen." Wadzanai wrote, "We should perform experiments in organic chemistry so that we get a better understanding of the reactions and conditions for the reactions." Students also suggested that experiments should be done from O-Level onwards. Shumi wrote, "Students should start doing experiments at O-Level." Chido suggested: "Practical work should be done because it is more interesting to see things happening, rather than merely listening to explanations. Practical work is motivating and students understand better if they do experiments. Thus, practical work would achieve a lot towards making students enjoy chemistry.

Quality of teachers

Students consider teaching as an unattractive career, only to be taken as a last resort. Those who acquire good grades in science will take up science or technology-related careers and leave the mediocre to join the teaching profession (UNESCO, 2000), adversely affecting the quality of education in schools. One of the teachers holds a Bachelor of Science degree and the other two hold Bachelor of Science Education degrees. One had wanted to be a medical doctor; the other two had wanted to be engineers. None of the students aspired to become a teacher: 12 aspired to be engineers, 18 to be medical doctors, 10 to be pharmacists, 1 anesthetist, 2 physiologist, 7 miners, and 1 astronomer. However, none wanted to be a nurse, or a mechanic, or a builder, or a technician, or a driver. That they wanted higher rewarding careers does not necessarily make teaching a *residium ficatorum*. Even some of those who enter careers of their dreams may still end up teaching, albeit at higher levels.

An effective teacher should have mastered the content as well as pedagogical knowledge. Students suggested that there is need to improve teacher competency. Ozi wrote, "There is need to teach teachers how to teach certain topics". Thus, either the teachers do not have sufficient subject content knowledge or pedagogical content knowledge. Rudo wrote, "Highly qualified teachers are needed." However, at this level we normally have one person teaching all chemistry. It is not possible for a person to like all branches of chemistry. Circumstances force teachers to teach even the areas they do not enjoy and are still expected to behave as if they enjoy those areas.

Relevant text books for the Chemistry Curriculum

Students (17.7%) suggested that text books which correspond to the Zimbabwean syllabus should be published so as to improve performance during examinations. Kudakwashe and Joana wrote: “ZIMSEC must publish text books which are relevant to the ZIMSEC Chemistry syllabus”. Students use text books to consolidate the concepts that they learn during the lessons.

Curriculum content

Teachers and students concurred that the Chemistry curriculum was overloaded. Rudo wrote: “There are too many topics to be covered”. Mr Bob, a teacher, wrote: “There is too little time to cover the content of the syllabus.” Another teacher said: “We have to rush through the syllabus to create time for revision and examination practice.”

Teaching media

The abstract nature of the concepts in chemistry leads to low achievement in chemistry examinations, and students have stated that it is difficult to understand concepts about things which cannot be seen. Hence the teacher must make good use of visual aids. Computer programs that assist in the visualization of the complex structures and processes are available. The internet can be used to locate a wide variety of resources showing different structures and processes. Students are also motivated when they use the computer in their learning. Thelma wrote: “The use of the internet for updated information leads to better understanding”. Models, charts, videos, TV educational channels, etc. are useful tools to help students understand the complex abstract concepts. Callisto wrote: “Visual aids should be used to explain bonding”, while Bony said: “Teachers should use models to illustrate the structures”. These statements show that students understand better if visual aids are used to augment the value of verbal explanations.

Motivation and Attitude

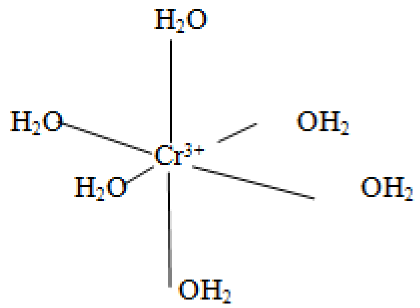
Motivation is one of the most important factors that control learning and teachers face challenges when their students are not motivated to seek to understand the required concepts. Johnstone & Kellett (1980) established that the difficulty of a topic as perceived by students is a major factor in their ability and willingness to learn it. Students (7.8%) expected teachers to motivate them and foster development of positive attitudes and encouraging them to think that chemistry is manageable as well as get rid of the phobia towards chemistry. Teachers should not tell students that chemistry is difficult and requires intelligent students to pass it. Jeff said: “such statements cause fear and reduces students’ confidence towards the subject.

Documentary review

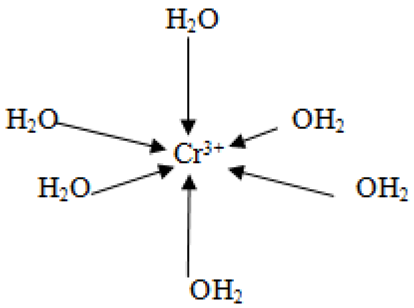
Exercise books, examination papers, marking schemes, record books, and schemes of work, syllabuses and text books were analysed and reviewed in order to get a deeper understanding of the problem areas.

Students exercise books

Analysis of assignment, test and practical exercise books revealed the quality of communication between the teacher and the student as well as shortfalls in the teaching and learning process. The marks in the students exercise books were quite good, all being above half mark. However, the marks for tests and practices were mostly below the half mark, revealing that students did not understand the concepts. Students could easily answer most questions for the assignments as they were generally low order recall questions extracted from the text books. This information vindicated students' statements in the questionnaires and interviews they had no problem "understanding" the concepts during lessons but had problems with tests. The questions for the tests and practices were from previous examination papers and were of high order, requiring application of scientific enquiry methods. The presentation of the work was inadequate, with some of important features such as arrows to show coordinate bonds in complex ions missing. One student represented a hydrated Chromium 3$^+$ ion as:



instead of



In some cases students fail to solve simple tasks such as writing equations correctly. Students had difficulty balancing equations especially ionic ones, writing formulas of substances, and they tended to leave out states of matter when writing equations.

Analysis of exercise books revealed that students had difficulty expressing chemistry ideas because operation in a second language introduced unfamiliar or misleading vocabulary whose meanings differed between everyday usage and chemistry usage. Students did not only struggle to understand chemistry ideas, but they had to cope with reduced usable memory as some of it had to be used to handle language transfer (Cassels & Johnstone, 1985; Johnstone & Selepeng, 2001). Thus, a chemistry student was examined for chemistry aptitude as well as for language knowledge. For example one student, in a test, defined the reaction rate as, "the time taken for the concentration or amount of a substance in a reaction to change," instead of the change in amount or concentration of a substance per given time in a reaction. The student knew the words used to define reaction rate but could not put them in the right order and thus the meaning changed in the process of constructing the sentence. Thus, in agreement with Gabel (1992) and Dori & Hameiri (1998) that some of the difficulties that students have with chemistry may not necessarily be related to the subject matter itself but to the way it is communicated. Language problems may lead to misunderstandings, confusions and generation of misconceptions. Sirhan (2007) suggested that the learner be given opportunity to verbalize and discuss ideas as they are being presented, giving opportunity for exposing and correcting misunderstandings and confusions.

Inspection of practical exercise books revealed that the practices were frequently limited to titrations and qualitative analysis. Records revealed that just a few experiments on enthalpy change and reaction rates had been done and there were no practices based on organic chemistry. This vindicated students' responses in both questionnaires and interviews that organic chemistry is difficult because no practices were performed in this section.

Examination papers and marking schemes

There was no consistency between the allocated marks in question papers and the amount of work revealed in the marking schemes. For example question 3c from A-level Chemistry, Paper 1, section A of 2010 examination:

3(c) Experiments to determine the order of the reaction gave the following results:

Experiment	Initial (I^-)/mol $dm^{-3}s^{-1}$	Initial (H^+)/mol $dm^{-3}s^{-1}$	Initial (H_2O_2)/mol $dm^{-3}s^{-1}$	Initial rate/ Mol $dm^{-3}s^{-1}$
1	0,01	0,1	0,005	0,083
2	0,01	0,1	0,010	0,166
3	0,01	0,2	0,005	0,332
4	0,03	0,1	0,005	0,249

i) Deduce the order of reaction with respect to each of the three reactants.
ii) Calculate the rate constant stating its units (6)

The answers that were expected are as follows:
c (i) Exp 1 and 2 doubling only (H_2O_2) doubles rate hence order 1 with respect to (H_2O_2)
Here the examiners were instructed to reject the straight answer, that is, order 1 with respect to (H_2O_2). Exp 1 and 3, doubling [H^+] quadruples the rate, hence second order.
Exp 1 and 4, trebling only (I^-) trebles the rate, hence order 1 with respect to (I^-).
In each of the answers above one mark was awarded. If a candidate left out the calculation or the explanation then he/she would lose the mark. It would be better if two marks were awarded, one for calculation or the description and one for the answer. Such mark allocation would give the impression that the student does not know anything when in fact he/she knows something and should be rewarded for that something. Again the markers were instructed to deduct the mark if there was no calculation. In c) ii the marks were fairly distributed 1 mark was given for the rate equation, 1 mark for calculation, 1 mark for the answer with correct units.

Paper 1 questions were also found to be complex. One question would require linking knowledge of various concepts as well as having problem solving skills. The same applied to question 1b and 1c from A-level Chemistry, paper 1 of 2010 which read: "A sample of rusty iron wire was completely dissolved in 1 dm^3 aqueous sulphuric acid producing a solution of both $FeSO_4$ and Fe_2 $(SO_4)_3$. The solution was divided into two equal portions. A 25.0cm^3 sample of the first portion was titrated with aqueous potassium manganate (VII) of concentration 0.02 mol/dm^{-3}. It required 27.2 cm^3 of potassium manganate (VII) for complete reaction.

1. Write down the overall equation for this reaction.
2. Calculate the concentration of Fe^{2+} (*aq*) in the acid solution. (4 marks)

The first part requires the student to be conversant with the Redox Reactions in which the student has to be able to select the relevant half equations and construct an overall equation. If the student fails to construct the equation correctly automatically he will not be able to solve the second question which involves the use of the concepts of stoichiometry and the mole. Although the student might be able to solve the second part the first acts as a barrier. Thus instead of the student getting 2 marks for the second part if it was not linked to the first, the student gets zero. Taking into consideration the complexity of the questions and the fact that students have to make a choice of six out of 8 questions it seems two hours are not enough for an A-Level student to finish the examination.

Syllabuses

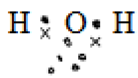
Analysis of the syllabuses (the old and new) revealed that the codes were the only change that had taken place in their contents in the past 13 years. Changes in technology and society need the development of a curriculum which caters for the new needs of the society. The syllabus is divided into a theory section and a practical section. In the practical part, the practices for examinations and the apparatus to be used are listed, encouraging teachers to concentrate on what will be examined on and ignoring what might help students to understand concepts. For example the syllabus has no practical based on organic chemistry and, therefore, no organic practical will be done because teachers may not consider them relevant since they will not be examined on.

Textbooks

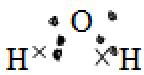
The text books used in the A-level chemistry classes in Zimbabwe were designed for syllabuses like Cambridge, AEB, London, etc. The Zimbabwean syllabus was designed from the Cambridge syllabus and these text books were relevant at the time. The text books have been updated to suite the syllabuses as they were modified whilst the Zimbabwean syllabus was static. Analysis of the presentation of the content in the books revealed that the information was scattered and some of it is not relevant to the Zimbabwean syllabus. Students struggle to select relevant information when studying and end up having too much content, most of which they will never be examined on.

Errors have been observed in some of these text books, for example, in A-Level Chemistry by Briggs, 5^{th} Edition on page 18 question number 6 requires students to determine the formula of an organic compound from the results of combustion analysis of a sample of the compound. If the student works out the problem correctly, the correct answer would be C_3H_8. However the answer provided as the solution given on page 581 is C_3H_6, which is wrong. If students practicing the questions get the correct answer and compare it with the one given in the text book, might end up confused. Students adopting wrong working to get the same answer as in the textbook would fail to correctly solve similar questions in the examination.

In Chemistry in context by G. Hill on page 88 the dot and cross diagram of the water molecule is drawn as follows:



and on page 91 it is drawn as follows:



Such representation can end up confusing students. They would not know which one is correct. The former would pose problems when the students get to the topic of shapes of molecules where the students will be tempted to conclude that the water molecule is linear instead of saying it is bent or V- shaped. Such representations contribute to formation of misconceptions and lowering students' performance.

Some examples given in text books apply to conditions obtaining in Europe and not relevant to Zimbabwean students. For example some texts quote a temperature of 900^{o}C for the production of ammonia whilst some books quote 450^{o}C. Students will not know what to follow. Hence students urged the academia in Zimbabwe to write text books for Zimbabwean schools.

Schemes of work

Theory was well schemed for in schemes of work but practices were not included. Analysis of teaching methods revealed that the "chalk and talk" and the discussion methods dominated. Failure to vary these methods probably contributes to making the subject dull and boring to students. Similarly, few teaching media are planned for and none of the three schools used the computer as a teaching medium, despite all of them having computers which would facilitate learning, reduce the workload, and motivate students.

Observations

Observations were recorded as the activities occurred, during theory lessons, studies, practices and discussions. The three teachers were observed teaching using the lecture method with the "chalk and talk" method predominating. Frequently teachers would draw/sketch diagrams on the board to illustrate some complex structures and sometimes refer students to text books. The teachers concurred preferring the method because it allowed them time to cover the bulky syllabus. This approach encourages rote learning rather than real understanding of the concepts as student participation was very limited.

Observation of practical lessons revealed that the laboratories were generally overcrowded. In one school sixteen students were doing their practices in a laboratory that can accommodate a maximum of ten students, leading to a high frequency of breakages and accidents. It was also difficult for the teacher to monitor the individual student's work. In another school there were 23 students where the students were split into two groups. The teacher said that this requires more time and increases his load. The practices were limited to previous practical examinations because the materials available are those left from previous examinations. The teachers blamed the low rate of practical sessions on lack of funds and stated that they frequently only had funds for titration, qualitative analysis exercises and occasionally enthalpy change or reaction rate practices.

Observation of students during studies and discussions revealed that they concentrate on the revision of past examination questions. Frequently students read Red Spots or Blue spots which are compilations of past examination questions and suggested solutions. The tendency is reading the question, attempt to answer the question and then refer to the suggested solution.

This encourages students to memorize solutions to some questions. It would be more beneficial if students studied their notes and text books and understand the concepts before attempting to answer the questions. Students were also given past examination questions as homework. Teachers said that work on past examination questions expose students to typical examination requirements. However students are able to access the answers from Red Spots and Blue Spots and usually they scored high in their assignments. In tests students got low marks because they are unable to reproduce the answers and because they do not have analytic and problem solving skills, showing that this approach leads to low understanding of concepts.

Interviews

Interviews were held two weeks after completing the questionnaire. The purpose of the interviews was to obtain detailed and rich information (Best & Khan, 1993). Initially the intention was to interview the 51 participating students. However, some students were not available when the interviews were conducted; hence the interviews involved the three teachers and 42 students (16 from school X, 17 from school Y and 9 from school Z). The questions asked in the interview were similar to those asked in the questionnaire and were intended to triangulate data obtained from questionnaires. The following were the major questions for students:

- How is your performance in chemistry compared to other subjects? Why?
- Which chemistry topics do you consider to be difficult? Why?
- What do you think the teacher could do so that your performance improves?

The major questions for teachers were:

- How is the performance of students in chemistry? Why?
- What topics are difficult? Why?
- How can the performance be improved?

Table 8: Distribution of responses by students on how they perform

Response	Frequency
I do very well	8
I am average	19
Sometimes very well but sometime very badly	6
I perform badly	9

Only 19.0% of the interviewees showed confidence in chemistry. The majority of students (64.3%) said their performance was low because there was too much content to master and concepts were very difficult to understand. The questions were also difficult to interpret and determine what they required. Jobo said, "There is too much content and sometimes I end up confusing the concepts. For example in the equilibrium constant expression, the concentrations are raised to a power (n) and the same with the rate equations, concentrations are raised to a power (n), but the two expressions are different. It is difficult to master the principles governing each concept." Jane said, "When studying Chemistry I understand the concepts but when it comes to examinations it will be a different story altogether". Jeff shared the same sentiment that, "What you read in the text books is not what you encounter in the examinations." Such sentiments were also expressed in the questionnaire.

Table 9. Distribution of topics students considered to be difficult

Topic	Percentage
Stoichiometry	25.0
Chemical Equilibria	73.8
Inorganic Chemistry	19.1
Organic Chemistry	35.7
Reaction Rates	7.1

Students said the topics were difficult because they involve abstract concepts such as calculations, citing stoichiometry, pH and pKa in Chemical Equilibria which were bulky and involving complex calculations. In inorganic chemistry students had problems explaining "solubilities of group II sulphates and hydroxides" and "variation of oxidation states of group IV elements." Students did not find organic chemistry difficult to understand but there was too much content to remember. The large number of reactions, reaction conditions and mechanisms confused students. Ketty said, "Many reactions occur under different conditions and I end up confusing reaction mechanisms and reaction conditions in examinations".

Students considered chemistry critical to medicine and industry; hence 31% of them felt that teachers needed to increase student presentations during lessons as students do not forget what their colleague teaches them and what they will have presented on. The majority (57.1%) said that teachers should increase examination practice exercises and introduce e-learning to enhance the learning of chemistry. Research also came to the limelight with 31% urging teachers to give students more research work since students will understand and retain what they research on. Students were optimistic about improving their performance: "I should change my attitude towards chemistry and start working toward passing. I should also read widely and do more research in chemistry." Most (76.2%) enjoyed chemistry lessons and understood teachers as they taught, but said that they were not performing well because what they were taught differed from what appeared in examinations, suggesting a gap between the taught material and the examined. Teachers' responses were in agreement with students' responses and concurred that although the percentage pass rate appeared high, the grades were usually low with very few As, a few Bs and more Cs, Ds and Es. Teachers blamed the following on the low pass rate:

- The abstract nature of the subject.
- Too many papers which make it difficult to average an A.
- Inadequate examination time, for example Paper 1 (free response questions).
- Difficulties in tackling questions which require application.
- Lack of familiarity with demands of questions.
- Students want to be spoon fed and have a negative attitude towards the subject.
- Time-tables too crowded/very little time for content coverage.

Teachers stated that stoichiometry and equilibria were the most difficult topics to teach and concurred with students that the chapter on equilibria was too long and had too many formulae. One teacher said that options were difficult to teach because teachers did not have enough knowledge on the content, especially the use of E^0 values and their interpretation. The construction of equations from the half equations also contributed to making electrochemistry a difficult topic to teach.

A teacher at a girls school said that students had problems with topics involving calculations while a teacher for boys said that students had problems with topics which do not involve calculations, for example the organic section. The third teacher gave Equilibria, Stoichiometry, Organic section and Options as areas in which students faced challenges. For Equilibria and Stoichiometry the teacher said that students easily got confused in these topics. For the organic section the teacher said there were too many reactions and students were required to know all their conditions and mechanisms. Teachers also concurred that most students did not participate during the lessons and only a few actively engaged in knowledge construction. Mr Mago said, "Students just want to be spoon fed while they sit back and relax. They do not want to work!"

Teachers gave suggestions to improve performance:

- Revisiting, up-dating and reducing the curriculum content
- Standardizing the examination questions
- In service training and reduction of class size
- Students should have a more positive attitude to the subject and work hard.
- Making use of the computers, models and more practical.
- Suitable text books for the Zimbabwean syllabus.

For both teachers and students, there was a strong agreement between the information obtained through the questionnaire and that obtained by the interview.

However, whilst these suggestions by teachers are commendable, teachers themselves should take into consideration students' cognitive level and ask questions of the HOCS type in their formative assessments to enable students to develop the necessary cognitive skills for success at A-level examinations. Student teachers should be trained in HOCS type questioning, setting and teaching problem solving techniques (Karamustafaoglu et. al., 2003). Teachers also need to be aware that the difficulty with conceptual questions may be due to lack of specific factual knowledge. Ability to solve problems is not necessarily inherited but can be learnt and, thus, can be enhanced by teaching emphasis. Teaching style or repeated exposure to sets of problems/ topics may increase conceptual understanding as well as algorithmic understanding and the degree to which an item may be categorized as requiring conceptual thinking may be a function of the background of the student and what the student has been taught (Nakhleh, 1993; Tsaparlis et. al., 2005; Kim, 2008).

Conclusion and Recommendations

The areas of concern appeared to center on: the abstract nature of chemistry, the extensive A-level chemistry syllabus, the nature of the examination questions, the way the subject is taught, and the attitude of students. The extensive A-level chemistry syllabus and the nature of the examination questions are a prerogative of the Examining Board and the Curriculum Development Unit. The abstract nature of chemistry is intrinsic to the subject, but teachers have influence on the way the subject is taught and both teachers and students can mould the attitudes of students to enhance examination performance.

Teachers need to go beyond teaching facts or guiding students to acquire isolated scientific concepts. They should focus on the development of teaching skills so as to promote scientific and technological literacy among students. The students in this case study have demonstrated that there are big gaps between students' wishes and traditional teaching. Teachers will find it difficult to close these gaps and still cover the demands of the present syllabuses. Curriculum planners and developers should guide teachers further from teaching facts and concentrate more on teaching concepts to make syllabus coverage more manageable. Teachers themselves need in-service professional development facilities to help them cope with the demands of the 21st century, motivate students' learning and take school science away from purely textbook based teaching (Holbrook & Rannikmae, 2002; Rannikmae, 2005). Thus if the examining board makes the syllabus more manageable and examination questions more realistic, and if schools authorities provide the required facilities, teachers might find it easier to employ the scientific method to the benefit of meaningful learning and students will find the subject more appealing and manageable to the benefit of examination performance. Thus, the solution to performance improvement rests on curriculum planners and the teachers.

Although this paper focusses on students' and teachers' views concerning how to improve chemistry students' performance on traditional A-level chemistry in Makoni District of Zimbabwe, the Curriculum Development Unit ought to incorporate the prevailing view in science education that the teaching to 'Know' for the 'Examination', is no longer acceptable in the educational world. Teaching and Assessment in science is now expected to aim at the development of students' higher-order cognitive skills. The main concern for the Curriculum Development Unit ought to be the development of the curriculum and the requisite examination strategies to suit the current world trends in science education, so as to develop the young scientists who will man the necessary scientific and technological institutions and industry.

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Appendix 1.

Results at the three high schools in Makoni District in 2007-2010

X HIGH SCHOOL
2007

Subject/ Symbol	A	B	C	D	E	O	F
Mathematics	6	11	7	7	4	-	-
Chemistry	1	5	4	3	1	1	-
Biology	-	10	4	1	-	-	-

2008

Subject/ Symbol	A	B	C	D	E	O	F
Mathematics	7	12	8	1	2		
Chemistry	-	3	6	2	-	-	-
Biology	5	5	1	-	-	-	-

2009

Subject/ Symbol	A	B	C	D	E	O	F
Mathematics	11	10	6	2	1	-	-
Chemistry	-	5	7	4	1	-	-
Biology	3	5	3	3	-	-	-

2010

Subject/ symbol	A	B	C	D	E	O	F
Mathematics	8	5	10	2	1	-	-
Chemistry	-	3	5	4	1	-	-
Biology	8	5	3	-	-	-	-

Y HIGH SCHOOL
2007

Subject/Symbol	A	B	C	D	E	O	F
Mathematics	15	10	12	6	1	-	-
Physics	10	3	-	-	-	-	-
Chemistry	-	8	15	1	-	-	-

2008

Subject/Symbol	A	B	C	D	E	O	F
Mathematics	8	10	19	9	3	4	-
Physics	6	6	4	2	-	-	-
Chemistry	5	9	6	5	-	-	-

2009

Subject/Symbol	A	B	C	D	E	O	F
Mathematics	16	8	9	8	2	2	-
Physics	6	4	-	-	-	-	-
Chemistry	1	2	11	3	-	-	-

2010

Subject/Symbol	A	B	C	D	E	O	F
Mathematics	22	11	8	5	1	-	-
Physics	12	3	-	-	-	-	-
Chemistry	10	10	1	3	1	-	-

Z HIGH SCHOOL

2007

Subject/ Symbol	A	B	C	D	E	O	F
Mathematics	5	10	9	7	4	-	-
Chemistry	1	3	5	3	1	1	-
Biology	2	3	2	1	1	-	-
Physics	3	2	3	1	-	-	-

2008

Subject/ Symbol	A	B	C	D	E	O	F
Mathematics	4	7	11	2	2	1	-
Chemistry	-	3	4	2	2	1	-
Biology	3	4	1	1	1	-	-
Physics	4	2	2	-	1	-	-

2009

Subject/ symbol	A	B	C	D	E	O	F
Mathematics	7	9	11	2	1	1	1
Chemistry	-	1	5	3	2	-	1
Biology	3	5	3	2	1	-	-
Physics	2	3	2	1	-	-	-

2010

Subject/ symbol	A	B	C	D	E	O	F
Mathematics	6	5	10	2	1	1	-
Chemistry	-	4	5	4	1	-	-
Biology	5	4	3	1	1	-	-
Physics	3	3	1	1	-	-	-

Appendix 2. Interview guide for students

1. How is your performance in Chemistry comparing with other subjects?
2. What could be the reasons for the performance?
3. Which topics do you consider to be difficult in Chemistry?
4. What makes them difficult?
5. Do you consider Chemistry to be a useful subject? Explain.
6. Are there any topics you consider to be of no use?
7. How do you rate Chemistry lessons?
8. Do you find Chemistry homework easy or difficult?
9. What do you think the teacher could do so that your performance improves?
10. What could you change yourself so that your performance improves?

Appendix 3. Interview guide for teachers

1. How is the performance of students in Chemistry in comparison with other subjects?
2. What could be the reason for this performance?
3. Which topics do you consider difficult to teach?
4. What makes topics difficult?
5. Which topics are difficult for students?

6. How do you rate the Chemistry curriculum?
7. How do students participate in class?
8. How do students do their homework?
9. How can the performance be improved?

Appendix 4. Questionnaire for students

Dear Student

This questionnaire is part of a study being conducted to establish factors affecting students' performance in chemistry at A-level. You are kindly requested to contribute to the study by answering questions on this form. Your identity is not required. Your views will be treated as a group data and used for the improvement of chemistry teaching and learning at A-level.

Questions

1. Indicate your age in years by ticking in the correct box: 15 16 17 18 19
2. Indicate your gender by ticking in correct box Male Female
3. Indicate your O-level results (symbols)
   Maths Physical Science Chemistry Physics Biology
4. Total number of A-grade passes
5. State the subjects which make up your combination
6. State the order of subjects in terms of preference starting with the best
7. Why do you have this order of preference?
8. How do you compare chemistry with the other subjects in terms of level of difficult?
9. Chemistry is a very difficult subject
   Yes No Give reason for your above response
10. List the topics you enjoy in chemistry
11. What makes you enjoy the topics?
12. List the topics you do not enjoy in chemistry
13. What makes the topics enjoyable?
14. Do you enjoy chemistry homework? Yes No Why?
15. Do you enjoy chemistry lessons? Yes No Explain
16. Do you intend to continue with chemistry as a major after secondary school?
    Yes No
    What would you like to do after your studies?
17. What improvements should be made to enhance your performance?

Thank you for your cooperation.

Appendix 5. Questionnaire for teachers

Dear Sir/ Madam

This questionnaire is part of a study being conducted to establish factors affecting students' performance in chemistry at A-level. You are kindly requested to contribute to the study by answering questions on this form. Your identity is not required. Your views will be treated as a group data and used for the improvement of chemistry teaching and learning at A-level.

Questions

1. Indicate your qualifications by ticking in the correct box

Cert. in Education B. Ed B. Sc Any other (specify)

2. A-level chemistry teaching experience
   Below 5 years 5-10 years Above 10 years
3. Did you major in Chemistry? Yes No If no, what did you major in?
4. Did you want to be a chemistry teacher from the beginning?
   Yes No If no what did you want to be?
5. What are the difficulties faced by A-level students in chemistry?
6. Which topics are difficult to teach in A-level chemistry?
7. What makes them difficult to teach?
8. Which topics are easy to teach? What makes them easy to teach?
9. How do students participate during lessons? Actively Moderately Passively
10. What could be the reason for the above answer?
11. How is the A-level curriculum in terms of:
    Depth of content? Amount of content? Time for content coverage?
12. How do you rate final assessment?
13. What changes can be made to improve the performance in chemistry by A' level students?

Thank you for your cooperation.

Dear Sir/Madam

Re: Application for authority to carry out research at your school

I write this letter to apply for authority to carry out research at your school. The research is intended to be carried out in March 2011. The research topic is: Exploring factors influencing the performance in chemistry by A' level students.