UGANDA CHRISTIAN UNIVERSITY

A Centre of Excellence in the Heart of Africa

FACULTY OF SCIENCE AND TECHNOLOGY

Department of Engineering and Environment

A REPORT FOR A BIOLOGY AND CHEMISTRY PRIMER FOR UDERGRADUATE STUDENTS (ABACUS-1) – VOLUME 1 GENERAL CHEMISTRY

JUNE 2016

ACKNOWLEDGEMENTS

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1.0 Introduction

A Biology and Chemistry Primer for Undergraduate Students (ABACUS-1) is a project that developed a General Chemistry Primer that introduced basic chemistry concepts and integrated relevant practical experiments to allow a foundation or refresher for Undergraduate students and enhance better performance in science related courses regardless of incoming (pre-university) subject combination.

The project builds on in house University capacity which has produced excellent course materials, including textbooks and workbooks for Undergraduate Students in Basic Computing, Health and Wholeness, among others.

1.1 Problem Statement and Rationale

As declared in the Uganda Christian University vision and mission statement, one of the main reasons of University education is to contribute to the education and training of students and professionals who will then have a positive impact on Uganda.

Science programs at Uganda Christian University especially where chemistry knowledge is required indicate that some of the enrolled students lack an Advanced Level chemistry background which affects their academic performance. This is normally reflected in the data collected by the Department of Engineering and Environment through informal interviews with first year students during a departmental orientation about the subjects done at Ordinary and Advanced Level. It is therefore important to introduce basic chemistry concepts and integrated relevant practical experiments to allow a foundation or refresher for these Undergraduate Students.

1.2 Project objectives

1. To develop a General Chemistry Primer for Undergraduate students incorporating relevant basic theory and practicals.
2. To pilot the developed Primer in selected science related courses at the Uganda Christian University.

3. To track any changes in student enrolment, uptake and performance in the selected science related courses during the study period.
4. To catalogue lessons learned and revise the Primer as necessary.

1.3 Research Question

Can providing Undergraduate students with a relevant basic chemistry primer for taught lectures, tutorials, and self-study lead to better performance in science-related courses regardless of incoming (pre-university) subject combination?

1.4 Justification

Introduction of basic chemistry concepts and integrated relevant practical experiments will allow a foundation or refresher for Undergraduate Students and improve their performance in science courses that require basic chemistry knowledge.

1.5 Outputs of the project

1. A General Chemistry Primer for Undergraduate Students (ABACUS Volume 1)
2. Improved performance of science shy students in science related courses where chemistry knowledge is required.
3. Compilation of lessons learned to inform any revisions and wider disseminations of ABACUS Volume 1, and future work on ABACUS Volume 2- A General Biology Primer for Undergraduate Students.

2.0 Research Design / Findings

First, baseline data was compiled on the selected science related undergraduate courses requiring chemistry knowledge at the Uganda Christian University, as several programs include core course units in Chemistry. This included data on: applicants (numbers, education background including Advanced Level subjects taken), gender, enrolment and performance. Data on students' education background was obtained from informal interviews from the Engineering and Environment departmental first year students' orientation and data on enrollment and performance was obtained

from the Faculty of Science & Technology. The project team partnered with the University Admissions Office, University Teaching & Learning Directorate and University Quality Assurance Directorate. The project team obtained data only on Bachelor of Environmental Science and Bachelor of Science in Civil & Environmental Engineering programs. The data collected went as far as possible and will thereafter be compiled with every intake.

2.1 General Chemistry Primer for Undergraduate Students

The project team incorporated input and worked with Chemistry experts and instructors from the Faculty of Science and Technology to develop a General Chemistry Primer for theory and practicals. Ten chapters of the primer were developed, reviewed and edited by Chemistry experts. The working draft developed was made available to Chemistry instructors and was piloted in Environmental Chemistry II course unit for the Bachelor of Science in Civil and Environmental Engineering and Bachelor of Environmental Science students' year three for use as a teaching and reference text/ self-study for the Easter (January) semester 2016.

Equipment was obtained from The World Academy of Sciences (TWAS) grant, set up in chemistry laboratory for chemistry experiments. This equipment was required to complement the available Uganda Christian University equipment to develop, test and optimize experiments in General Chemistry to ensure hands-on visualization and internalization of basic chemistry concepts and measurements in order to supplement the theory that is being taught to students in class. Using knowledge on relevant environmental samples such as soil extracts, wastewater, drinking water, plant extracts among others will allow the students to conceptualise more advanced uses of the General Chemistry learned and show the relevance and contextualization of the General Chemistry to applications in fields such as Environmental Science, Civil & Environmental Engineering, Agricultural Science, Public Health and Nursing Science thereby ensuring student appreciation for the knowledge and skills within their chosen career/ field.

Feedback was obtained from both the instructors and students in a structured survey of Knowledge, Attitude, Practice, and Uptake (KAP survey). Student course and instructor guided discussions on effectiveness of the text, complementary teaching aids (visual aids, lab protocols) and practicals were carried out. Continuous assessment performance tracking was done especially on assignments, tests and exams of students in Environmental Chemistry II where the ABACUS-1 primer was piloted.

2.2 Data analysis

Data collected was analysed using Statistical Package for the Social Sciences (SPSS) and Microsoft Excel 2010 package and then compared with past and current enrolment performance.

2.3 Limitations/ Difficulties

Data on: applicants (numbers, education background including Ordinary and Advanced Level subjects taken; gender), admissions, enrolment, completion and attrition was not obtained from the UCU Central Academic Office. The project team used data collected from informal interviews with first year students and performance data from the Faculty of Science and Technology; Department of Engineering and Environment.

2.4 Changes in student enrolment, uptake and performance in the selected science related courses during the study period

Table 1: Old Alpha Grades as stipulated by National Council for Higher Education

Grade	**Marks**
A	80-100
B+	75-79
B	70-74
B-	65-69
C+	60-64
C	55-59
C-	50-54

2.4.1 Bachelor of Environmental Science (2013/14)

Out of 15 students who enrolled for this program, only 5 students sat for Advanced Level Chemistry subject.

The Old Alpha Grades as stipulated by National Council for Higher Education (NCHE) were used in the discussion of students' University Grades. The discussions below indicate Environmental Chemistry I course unit within the Bachelor of Environmental Science program in the Faculty of Science and Technology that requires basic Ordinary and Advanced Level chemistry concepts.

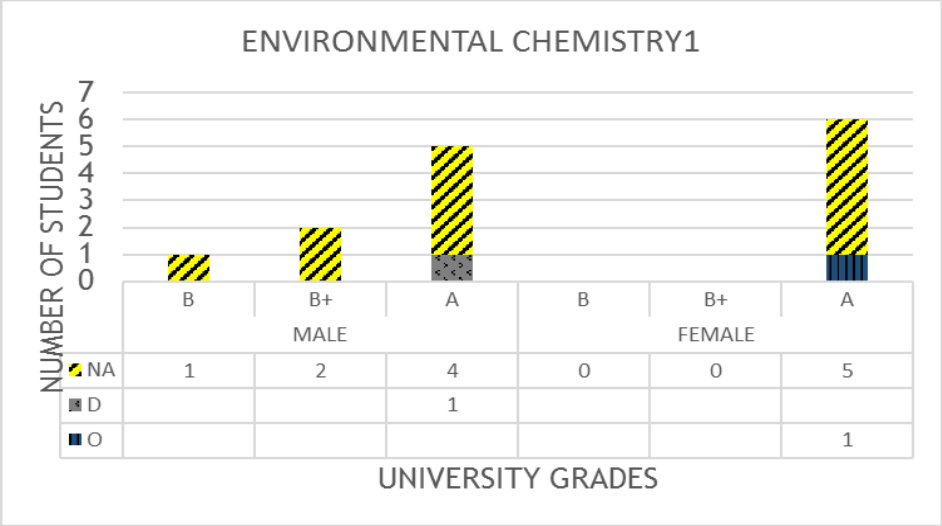

Figure 1: Advanced Level grades for students who enrolled for Bachelor of Environmental Science and their performance at University in Environmental Chemistry 1 Course unit

The female students performed better than the males with all above 80% and all the students who sat for Advanced Level chemistry results scored above 80%.

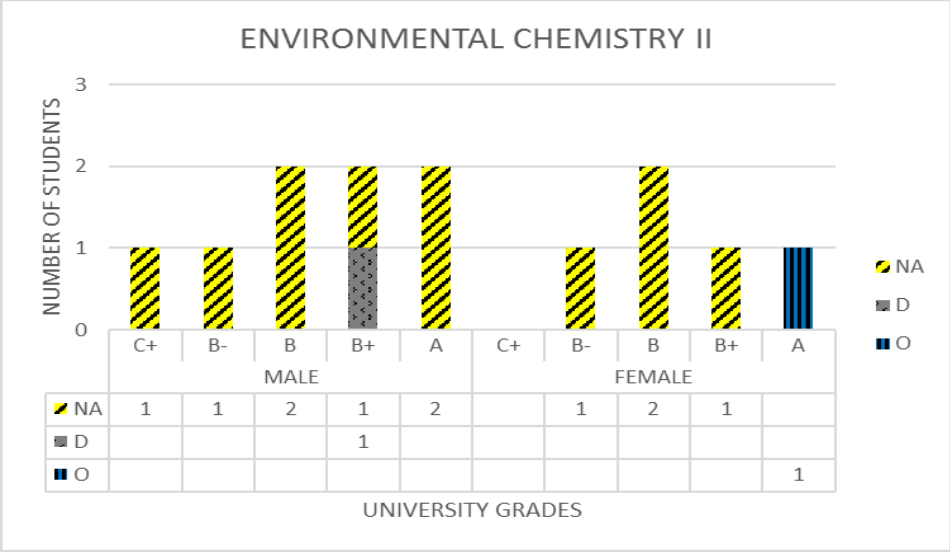

Figure 2: Advanced Level grades for students who enrolled for Bachelor of Environmental Science and their performance at University in Environmental Chemistry II Course unit

All the students scored above 60% with best students scoring above 80% in Environmental chemistry II. The performance in Environmental chemistry II shows that 80% of the students who did not sit for Advanced Level chemistry scored above 70% implying that the students could have been referring to the Chemistry Primer.

2.4.2 Bachelor of Science in Civil & Environmental Engineering (2013/14)

Out of 85 students that enrolled for this program, 32 students sat for Advanced Level Chemistry subject.

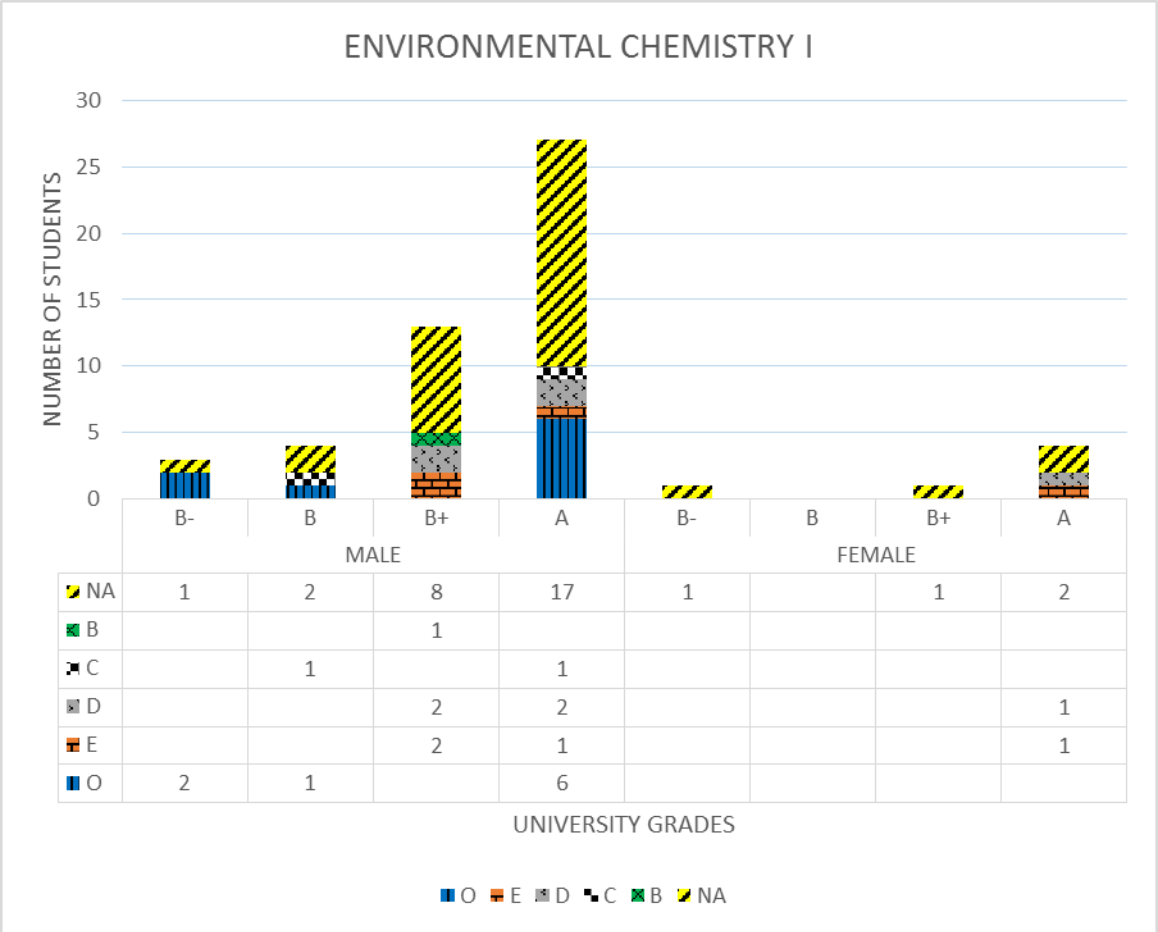

Figure 3: Advanced Level grades for students who enrolled for Bachelor of Science in Civil & Environmental Engineering and their performance at University in Environmental Chemistry I Course unit.

The general performance of this class as shown in Figure 3 above in Environmental Chemistry I was good as all scored above 65%. 81% of the students who sat for

Advanced Level Chemistry scored above 75%. The female students performed better than the male students with only one of them scoring below 70%. The 4 students who scored below 70%, 2 of them never sat for Advanced Level Chemistry and the other 2 scored an O in Advanced Level Chemistry as shown in Figure 3.

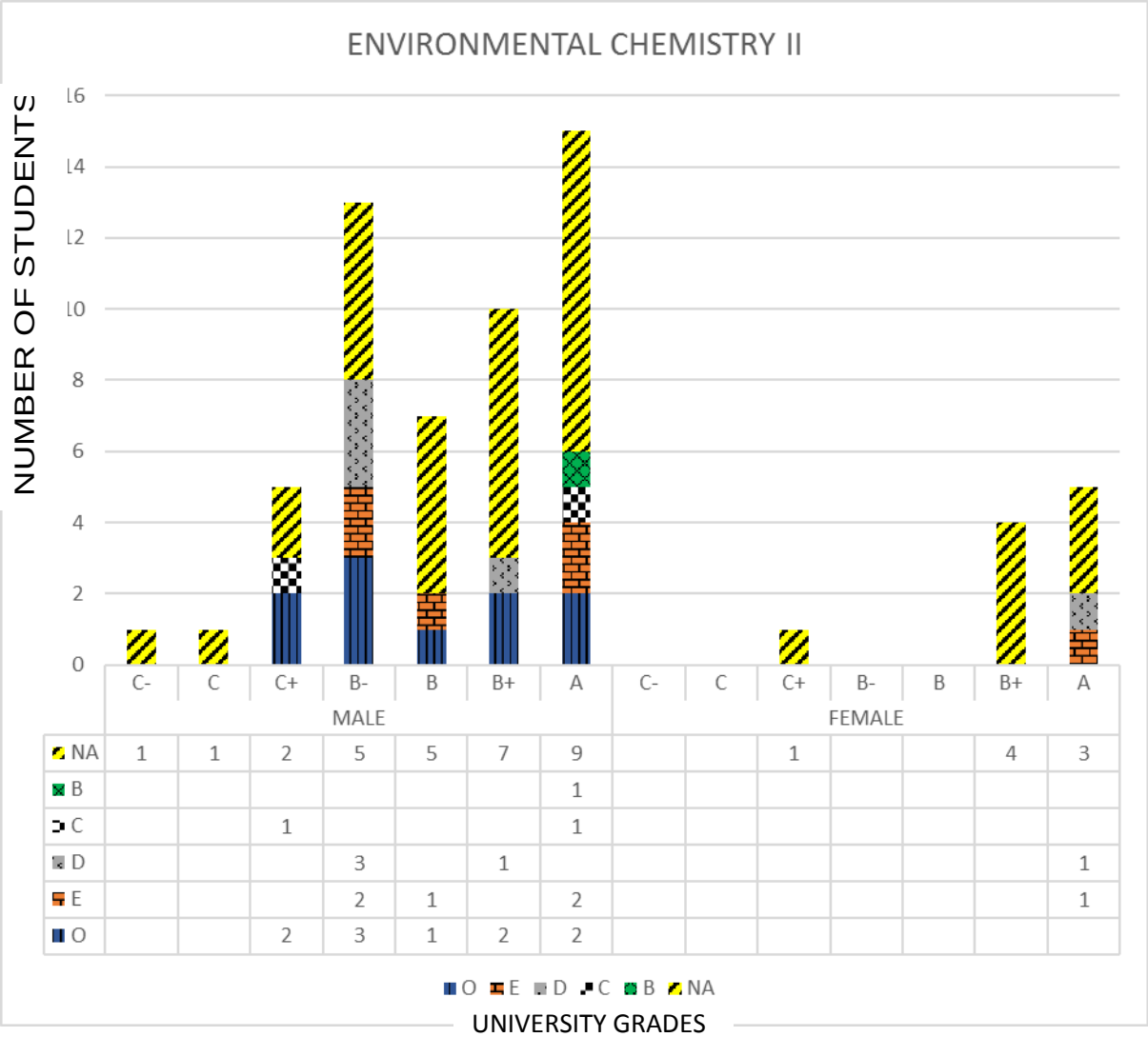

Figure 4: Advanced Level grades for students who enrolled for Bachelor of Science in Civil & Environmental Engineering and their performance at University in Environmental Chemistry II Course unit

All the female students scored above 60% with only one girl scoring below 70%.

74 % of the students who did not sit for Advanced Level chemistry scored above 70%. These performed better than the students who sat for Advanced Level chemistry as they had 54% scoring above 70%. One of the possible explanations of this performance could be that the use of the Chemistry primer increased the confidence of the students who did not sit for Advanced Level chemistry.

3.0 Lessons Learned

During the process of piloting the Chemistry Primer, the students who had sat for Advanced Level Chemistry had no interest in reading or referring to the primer.

Both Environmental Science and Civil & Environmental Engineering students suggested that the Chemistry Primer should have been introduced to them during the Environmental Chemistry I and General Chemistry course units because they thought that it was more applicable then since it introduces basic chemistry concepts.

Besides making the Chemistry Primer as a self-study or reference text book, the students suggested that some of the concepts within the primer should be taught to them other than referring to the text / self-study only.

Performance results from Environmental Chemistry II course unit as shown in Figures 2 and 4 indicate improved performance of Bachelor of Science in Civil & Environmental Engineering and Bachelor of Environmental Science students especially those that had not sat for Advanced Level Chemistry, which implies that students could have been referring to the Chemistry primer during their class assignments and this increased their confidence in Chemistry.

4.0 Conclusions

The following conclusions were drawn;

After piloting the Chemistry Primer, findings show that the overall performance in Bachelor of Environmental Science (2013/14); 80% of the students in this class who did not sit for Advanced Level Chemistry scored above 70% in Environmental Chemistry II course unit implying that students could have been referring to the Chemistry primer.

In the Bachelor of Science in Civil and Environmental Engineering, 74 % of the students who did not sit for Advanced Level chemistry scored above 70% and performed better than the students who sat for Advanced Level chemistry. The explanation of this improved performance could be that the use of the Chemistry primer increased the confidence of the students who did not sit for Advanced Level chemistry.

5.0 Recommendations

The project recommends the following:

Uganda Christian University through the School of Research and Post Graduate Studies should encourage more researchers and fund more research projects especially graduate students and staff to come on board so as to improve performance in various departments especially science shy and struggling students, ensure quality and enhance capacity building through research publications.