• ***Чуждестранна образователна традиция*** •
• ***Foreign Educational Tradition*** •

CHEMISTRY EDUCATION IN BOTSWANA: TOWARDS REALISATION OF VISION 2016

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Summary. Botswana is an independent sovereign nation situated in Southern Africa. The nation has recently adopted the policy document "VISION 2016" for its long-term development. All sectors of the country are in process of formulating policies and implementing them to reach the goals, described in this document, by year 2016, the 50th year of the country's independence. Major changes have already taken place in education sector both at secondary and tertiary levels. Both curricula and assessment systems have been reviewed recently. The article gives an overview of the education system and the current status of chemistry education in Botswana.

1. Introduction

Botswana is an independent sovereign nation situated in Southern Africa. It is a landlocked country that has a geographical area of 600,370 sq km. The total population of the country is approximately 1.7 million. The per capita GDP is P17 000 (approx. US$3 000). The country has maintained one of the highest growth rates in the world since its independence in 1966 [1]. The economy, one of the most robust on the continent, is dominated by diamond mining. The dramatic development in recent years has put Botswana among one of the consistently fast growing economies in the world.

The Government of Botswana revised its national education policy in 1994 [2]. It aims to prepare the citizens for the transition from a traditional agro-based economy to the industrial economy that the country aspires to. The edu-

cation and training strategy aims at ensuring that the people of Botswana, as a major national resource, would have invested in them an education necessary for national development. Besides the demands of the economy, the government considers access to basic education a fundamental human right. The education system must develop moral and social values, cultural identity and self-esteem, good citizenship and desirable work ethics.

A Presidential Task Force set up in 1996, prepared a long-term development policy for Botswana called VISION 2016 [3]. As per this vision, Botswana's education sector will have readied itself for the dynamic needs of the country in particular and the world as a whole by the year 2016, the 50th year of Botswana's independence [4]. After acquiring a good education, the citizens will be well equipped with skills to become the best producers of goods and purveyors of service. They will have an opportunity for tertiary education and either technical or vocational training. The cultural and linguistic diversity would be deeply entrenched in the education system. Most of the people will be computer literate. The communication capacity in the electronic media would be fully utilized. These will enable Botswana to become an informed nation. In order to fulfill the objectives of the document VISION 2016, all educational institutions recently revised their curricula and assessment methodology both at secondary and tertiary levels.

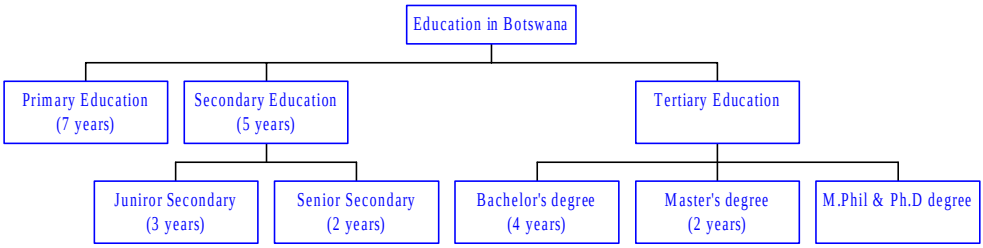
Science by its nature involves creativity and experimental activities characterized by inquiry methods of learning. This is one of the reasons why science is popular among students [5]. Through learning science, children can understand the rapidly changing environment around them. Children learn about objects and events by asking questions, investigating and experimenting to find appropriate answers. This scientific method of inquiry develops in children, the skills and attitudes that facilitate the learning not only in science and but in other subjects as well. Specifically, science gives children the opportunity to acquire basic scientific knowledge; apply the acquired knowledge to new situations; use the acquired scientific knowledge and skills in solving problems; see relationships among the basic scientific concepts learnt and process information at their disposal scientifically. Science plays a central role in society by helping children gain an understanding of the scientific and technical aspects of the society in which they live. Using the scientific approach provides children with a better ability to use the knowledge they have acquired and to cope with the ever-changing technological developments that have become so much a part of our lives.

Chemistry is an experimental science. It is known as central science because many important branches like medicine, engineering, agriculture and earth sciences are tied to chemistry [6]. Many industries important to life such as food, water, medicines, chemicals, fertilizers, paints and plastics relate to chem-

istry. Chemistry Education therefore has an important role to play in the development of any nation, which aspires to be a highly industrialized economy. Although the aim of the present article is to describe the status of chemistry education in Botswana it would be wise to describe briefly about the country's education system.

2. The Education System in Botswana: An Overview

Botswana, like in most of the developed countries, has a three-tier education system that can be divided into primary, secondary and tertiary education (Scheme 1) [7]. A total of sixteen years of study is required to obtain a Bachelor degree. A further education in any specialized area may lead to a Master, M. Phil. and Ph. D. degrees.



Scheme 1

2.1 Primary School Education

Primary education in Botswana is a joint responsibility of the Ministry of Education and the Local Governments. It takes the first seven years of basic education. It has two levels of learning - the lower primary (standard 1-4) and the upper Primary (standard 5-7). The programme is developed around the acquisition and application of foundation skills and thus emphasizes the acquisition of communication, numeric and literacy skills, the development of an awareness of the interrelationship between Science, Technology and Society and the acquisition of socially desirable skills and attributes. Its implementation is based on the learner-centered approach where curricular materials and learning/teaching strategies are responsive to the needs of the learner. In the Lower Primary, the subject packaging is broad, with some subjects integrated to facilitate theme and project teaching. The focus at the Upper Primary level is mainly on the development of pre-requisite skills for the junior secondary school curriculum.

The Examinations, Research and Testing Division (ERTD) of the Ministry of Education administer the Standard Four Attainment Test and the Primary School Leaving Examination (PSLE). The PSLE are administered at the end of seven years of schooling. The achievement of students in the national examinations is reported using dimensions that indicate the performance of students in

different cognitive levels across the syllabus content. The subjects offered at this level are English, Setswana (local language), Mathematics, Science and Social Studies.

2.2 Secondary School Education

Secondary education is also the responsibility of Ministry of Education and is handled by the Department of Secondary Education that plans, formulates programmes, implements, monitors and evaluates the National Secondary Education System. At secondary school levels, ERTD administers Junior Certificate Examinations (JCE) after the end of three years curricula and the Botswana General Certificate of Secondary Examinations (BGCSE) at the end of two year curricula.

Junior Secondary School Program

The Three-year junior secondary school program is an integral part of the ten year Basic Education Program. It objective is to develop foundation skills such as decision making, problem solving, team work and computing, the vocational orientation of academic subjects as reflected by the application of concepts, knowledge and processes and the appreciation of technology, manipulative skills and familiarity with tools, equipment and materials. The whole curriculum package is infused with sensitive emerging issues and other cross-curricular issues have been infused in.

Senior Secondary School Program

The senior secondary students in Botswana used to study the curricula of the University of Cambridge Local examinations Syndicate (UCLES) up to 2000. Now the BGCSE has developed its own curricula to cater the need of the nation. All the government schools are teaching these curricula. The private schools in the country, however, are free to run courses of their choice. The Senior Secondary Curricula takes cognizance of the nature of knowledge, the contribution that different subjects offer and the infusion of sensitive emerging issues. The base of its organization is grounded on the Ten-year Basic Education Program. The program is diversified to include academic, technical and commercial subjects. It also promotes a culture of life long learning and a link with the working world.

2.3 Tertiary Education

The Department of Student Placement and Welfare of the Ministry of Education is the driving force in the facilitation of Tertiary Education and training that provides a sustainable and transparent financial support system. The department of Vocational education and training's vision is to have a competent, innovative and internationally competitive national human resource with the ability to contribute to the socio-economic and technological advancement of the country.

After successful completion of BGCSE (Botswana General Certificate of

Secondary education) examination, the students seek admission into tertiary level institutions or vocational training institutes depending on their grades, availability and liking. These institutions include the University of Botswana, Botswana College of Agriculture, and several colleges of education and technical colleges across the country.

As a major to ensure the quality of programs, the University of Botswana replaced the annual system of study and progression by semester system in 2002. Emphasis is given in the new system on continuous assessment of the students by giving them regular quizzes, assignments and tests etc. In order to develop independent learning habits, tutorial classes have been scrapped from level 200 to 400 courses in the semester programs.

3. Chemistry Curricula in School

3.1 Chemistry at Primary and Junior Secondary level

Chemistry teaching in primary schools begins at the primary level as a part of the Environmental Science curriculum that begins formally from standard three onwards. The term 'Chemistry' is however not used until much later. The opportunities for learning chemistry increase as students continue in junior secondary schools. At this level the students are taught Integrated Science that includes Biology, Chemistry and Physics. Experimental science is also conducted mostly related to theoretical aspects studied in class.

The syllabus is divided into modules covered over a period of three years. The chemistry modules include Measurements and Units; Matter; Water in Botswana; Forms of energy and energy changes; Air; Water as universal solvent; The building blocks of matter; Metals and nonmetals; and Chemicals in the home.

3.3 Chemistry at Senior Secondary level

At senior secondary level, Chemistry is available as an elective subject. It is offered as a single subject and as a combination with one or two other science subjects. The students who qualify for pure science stream take Biology, Chemistry and Physics as separate subjects. Others study Chemistry in the combined science stream.

The chemistry teaching exposes learners to practical applications of Chemistry in everyday life. The syllabus is divided into topics and sub-topics. It broadly covers Matter, Chemical Reactions, Stoichiometry, Metals and non-metals, Chemistry in the Environment and Carbon Chemistry.

4. Chemistry at Tertiary level

At the tertiary level, students continue their Chemistry studies primarily at the University of Botswana. Some Chemistry and Chemistry-related courses are offered at the Botswana College of Agriculture, Faculty of Engineering and

Technology, Colleges of Education and Technical colleges.

4.1 Undergraduate Programs in Chemistry

Chemistry is offered at the Department of Chemistry, Faculty of Science of the University of Botswana at undergraduate level. The Department trains the students to qualify for a Bachelor degree in Chemistry as a single major and a Bachelor degree with a major or minor in Chemistry. The department also offers chemistry for various service courses such as Home Economics and Nursing Science (BNS). The objective of different programs offered is to train qualified chemists at different levels in order to meet the human resource needs of Botswana and to contribute to the fulfillment of vision 2016. The credit requirements in chemistry courses for a single major in chemistry, major in chemistry and minor in chemistry are 85, 56 and 26, respectively [8]. However, the students are required to do at least 120 credits to complete the graduation. All the students complete at least 20 credits in general education courses and remaining from the electives prescribed by the university.

In the first year of study, the students are offered two general chemistry courses, one in each semester, each comprising of four credits. These courses include topics from measurements and units, nomenclature, moles and stoichiometry concepts, atomic structure, valence and hybridization, chemistry of carbon compounds, thermochemistry, solutions, colligative properties, chemical kinetics, chemical equilibria, acids and bases and ionic equilibria. All students doing medical and engineering also take these courses. From the second year onwards Chemistry offered is branched into Physical, Inorganic, Organic and Analytical sections. The core courses taught at these levels are listed in Table 1. However, a detail description of all the topics is beyond the scope of this article. A few significant changes made during the recent revisions are separation of laboratory course from theory courses (earlier practical exercises were integrated in theory papers) and introduction of a course called Chemical Informatics, which tells students about different methods of information collection. It is noteworthy to mention that all single major and major students at fourth year level must take a research project as well which equals to 3 credits.

Table 1. Core courses from sophomore to senior level (200-400).

Analytical Chem.	**Inorganic Chem.**	**Organic Chem.**	**Physical Chem.**
1. Introduction to analytical chemistry	1. Atomic Structure, Bonding and Main Group Chemistry	1. Structure & Survey of Functional Groups I	1. Introductory Physical Chemistry
2. Analytical Chemistry Labs I	2. Inorganic Chemistry Labs. I	2. Organic Chemistry Labs. I	2. Physical Chemistry Labs. I
3. Separation	3. Coordination	3. Structure &Survey of	3. Thermodynamics &

Techniques 4. Analytical Chemistry Labs. II 5. Analytical Spectroscopy 6. Advanced Analytical Techs. 7. Sample handling and Biochemical Analysis 8. Adv. Lab. Course	Chemistry 4. Inorganic Chemistry Labs. II 5. Group Theory and Organomettalics 6. Advanced Transition Chem. 7. Advanced Organometallic and solid State Chemistry 8. Adv. Lab. Course	Functional Groups II 4. Organic Chemistry Labs. II 5. Physical Organic Chemistry 6. Heterocyclic Chemistry 7. Secondary Motabolites and Biomolecules 8. Adv. Lab. Course	Electrochemistry 4. Quantum Chemistry 5. Physical Chemistry Labs. II 6. Advanced Physical Chem. I 7. Advanced Physical Chem. II 8. Adv. Lab. Course

4.2 Graduate Programs in Chemistry

The graduate programs were started at the Department of Chemistry in the University of Botswana in 1992 with the introduction of M. Sc. degree programs in Analytical and Natural Products Chemistry [8]. These programs looked attractive to the students as many students from Botswana and the neighboring countries joined them in the succeeding years. The popularity of these programs led to the expansion of the chemistry graduate programs into the M. Phil./Ph. D. programs in Analytical and Natural Products Chemistry in 1996. With an objective to train students to acquire advanced skills and knowledge in the chemical sciences that are required by the government, parastatals and private sector in the coming days the department realized the need to broaden the scope of the graduate programs. Accordingly, these programs have now been redesigned. The new M. Sc. in chemistry program embraces the four traditional branches of Chemistry, namely Physical, Inorganic, Organic and Analytical Chemistry. In the first semester, all M. Sc. students take four core courses, each of 3 credits, from these areas. In the second semester, the students take a total of 12 credits from core and optional courses, all from any one of these branches. A range of optional courses such as analytical spectroscopy, thermal and radiochemistry analysis, metals and semiconductors, organometallic chemistry in organic synthesis, polycyclic and heterocyclic aromatic chemistry, radicals and organic photochemistry, chemistry of primary metabolites, polymer chemistry, advanced chemical kinetics and diffraction methods are available. The second year is for dissertation projects. The M. Phil./Ph. D. degrees in all the four areas are awarded by research work only. However, the students are required to take one/two literature review project(s) besides their main research project. Students are already registered for M. Phil./Ph. D. programs in physical, inorganic, organic and analytical chemistry. The department is equipped

with modern facilities including two NMR spectrometers (one of 600 and other of 300 MHz), HPLC, GC-MS, FT-IR, UV-VIS spectrophotometers and AAS etc. The main research areas in which the department is currently actively engaged are natural products isolation and characterization, organic synthesis employing carbenoids/ketenes, heterocyclic synthesis, surface chemistry, polymer chemistry, co-ordination chemistry, synthesis and characterization of organomettalics, bioanalytical chemistry, development of potentiometric sensors in flow injection analysis, development of analytical methodologies for environmental pollution assessment and analysis of drugs using electrospray mass spectroscopy.

References

1. Republic of Botswana official website: http://www.gov.bw

2. http://www.gov.bw/moe/headquarters/rnpe/RNPE%20Pages/rnpeone.htm

3. http://www.gov.bw/gem/vision_2016.html

4. The Govt. of Botswana, *Booklet of Vision 2016 "Long Term Vision for Botswana: Towards Prosperity for All"*.

5. **Jemison, M.** *Education Updates* 43, 3 (2001); www.ascd.org/publications/ed_update/200106/3.htm

6. **Brown, T. L.** *Chemistry: The Central Science*. Prentice Hall, N. J., 2000.

7. http://www.gov.bw/moe/cde/index.html

8. **Majinda, R. R. T.** *et al*. A *Handbook of the Chemistry Department*, University of Botswana (2003).

ХИМИЧЕСКОТО ОБРАЗОВАНИЕ В БОТСВАНА

Резюме. Ботсвана е независима държава в Южна Африка. Наскоро там бе приет политически документ "Визия 2016" за дългосрочното й развитие. Всички държавни сектори са в процес на преустройство за постигане на целите, описани в този документ. Годината 2016 съвпада с 50-та годишнина на независимостта на тази бивша английска колония. Вече има съществени промени в образователния сектор, както на средно, така и на висше ниво. Статията е обзор на образователната система на Ботсвана и описва съвременното състояние на химическото образование там.

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