

## **EVALUATING THE IMPACT AND POTENTIAL OF THE CHEMICAL SCIENCES IN CATALYSING THE ECONOMIC DEVELOPMENT THROUGH POTENTIAL CHEMICAL ENTREPRENEURSHIP IN LESOTHO**

Mosotho J. George<sup>1,\*</sup> and Thembi Setubatuba<sup>1</sup>

<sup>1</sup> Department of Chemistry and Chemical Technology, National University of Lesotho, P.O. Roma 180, Lesotho – Southern Africa. Tel.: +266 5221 3502, Fax: +266 2234 0000.

\* Corresponding author: [jm.george@nul.ls](mailto:jm.george@nul.ls) or [maluti2005@gmail.com](mailto:maluti2005@gmail.com)

### **ABSTRACT**

Science is central for research and innovation that are key drivers for economic development. However, with the never improving capital investment towards higher education in most African countries, the level of infrastructure in the universities hinders adequate training of human resources and the economic development emanating from science and technology innovation. This paper shares the history, impact and the prospects of the chemical sciences program at the National University of Lesotho in transforming the local economy through translation of science with emphasis on potential commercialization and entrepreneurship in partnership with local entities: cooperatives, community-based organization or private small-medium enterprises other than the few present and somewhat unwilling companies. Finally we recommend the coordination of the innovation and incubation initiatives in public sector to partner with the universities as centres of knowledge creation. [*African Journal of Chemical Education—AJCE 7(1), January 2017*]

## **INTRODUCTION**

The role of higher education institutions (HEIs) has continued to be a subject of debates recently with the expansion of the mandate from purely centres of teaching and learning through to research, incubation and support of small business but also in offering of consultancy services to small and medium enterprises as well as ordinary citizenry. This mandate has even gone further in that HEIs are also expected to participate in broad national issues of relevance to not only higher education but societal issues at large [1]. This is more so in the public universities where funding is mainly sourced through government subvention. With the consistent and “chronic” decline in governments’ subvention [2, 3], there are views that most public universities could face some form of extinction [4]; unless they undergo some kind of restructuring or they claim their political power – perform their duties and impart positive influence to their graduates to excel in using the skills they have developed during the training [5].

Relevance is often a thorny issue owing to mainly poor employment opportunities in the country where it becomes easier for the markets to blame the universities for poor relevance while this issue could be a consequence of low or poor absorptivity of the markets to the graduates other than the inability of the graduates to perform the tasks employed to perform [6], as well as inaccessible credit for entrepreneurial capital frustrating the entrepreneurial initiatives, rather than the issue of relevance as it will become apparent in this article. However, since this is not the subject of this paper, it will not be discussed further than it has already.

For higher education to be effective, multi-party partnerships between academia and private/public sectors are touted as a golden bullet enabling academic research to translate into tangible programs and policy resulting in a widely published triple helix model [7, 8]. Partnerships are believed to be responsible for the birth of new companies [9], as well being able to afford the

spread and wider access of resources. For example, private sector is able to access resources at HEIs while HEIs also access the financial resources from the private sector. The triple helix model is believed to enable development of a knowledge-based economy.

## SETTING UP THE SCENE

Lesotho – a tiny wholly landlocked country within South Africa has only one university offering natural (basic) sciences – National University of Lesotho. This university establishment dates back in 1945 when it was started as Pius XII college, then underwent several metamorphoses to become UBBS, later UBLS and subsequently the present day NUL in 1975 together with its siblings UB and UNISWA that descended from the same ancestry Pius XII – UBLS [10]. This university, and its predecessors, has produced a number of renowned alumni that graced the Southern African region especially during the racial segregation in South Africa.

However, despite its rich history, this once a giant seems to be falling asleep due to consistent and sturdy downward spiral of disposable revenue due to the declining subvention from the government (see Figure 1) that is a sole financier [11].

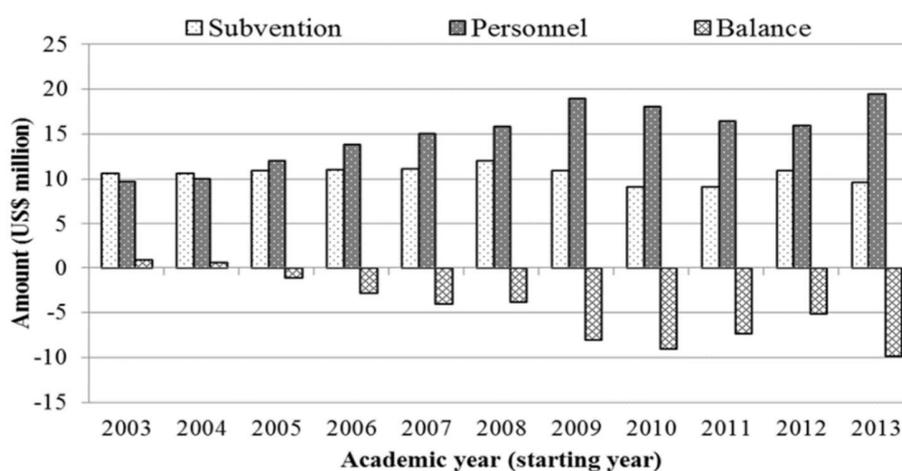


Figure 1: A glimpse of the National University of Lesotho subvention and personnel expenditure 2003 – 2013

The observed improvement in the deficit in 2011-2012 was when the University experienced the highest staff loss in its history [12]. This decline in financial resources frustrates the teaching and learning of sciences more than any other disciplines [13]. Besides the reality of dwindling resources, this institution is confronted with yet another challenge of receiving brutal and unwarranted negative publicity in local media for being unable to respond to the national challenges [14, 15], some going as far as labelling it a “glorified high school” [16].

While there is no consensus about the reasons for the declining subvention, arguments point to different issues depending on who make them. These arguments include lack of patriotism by the rulers/political authority, unruly behaviour/insubordination of academics at the institution towards the political authorities, deterioration of the standards at NUL as has been pointed out earlier, just to mention but a few. However these arguments point more towards issues of governance rather than the relevance of the institution’s programs. Amongst the plethora of articles, editorials and columns published in local media about the institution, only one was identified that suggested the financial plight of the institution as one of the main reasons why the institution cannot do as well as it should [17]. The author’s arguments were in tandem with those expressed elsewhere that the performance of a university and its international ranking thereof is dependent on the funding and availability of functional infrastructure [18, 19]. As a result, there have been a number of initiatives aimed at transforming/restructuring the university, some arising from the wisdom of the institution’s management, some were a result of direct instruction from the political authority while others are simply in response to the financial difficulties.

Perhaps before getting into the thesis of this manuscript, it is worth appraising the global trends in science and technology. As the manuscript is centered on the chemical sciences, the authors delved more into the chemical sciences notwithstanding the importance of the other

sciences and/or programs. Traditionally, the Faculty of Science had been offering basic sciences in a double major and/or major-minor combinations arguably for the purposes of 1) providing a foundation for professional qualifications such as medicine and engineering, 2) knowledge creation and science education as well as 3) enabling the graduates to take up graduate studies. However, in the period 1990 to 2000, the term technology started to trend globally as technology was touted as a means through which nations could free themselves from economic bondage. Consequently, in order to align itself with the then contemporary trend, the University through the Faculty of Science, as the main custodian of science and technology development, advised itself to introduce technology programs, and as a consequence the Faculty metamorphosed into the Faculty of Science and Technology. Thereafter the academic departments followed suit giving rise to the current Department of Chemistry and Chemical Technology which is a subject of this report. While this Department, like its sister departments used to offer the traditional double major, or major-minor combinations, as mentioned earlier, it later introduced the Chemical Technology programme and its name also changed to Department of Chemistry and Chemical Technology in order to inspire hope and confidence in its prospective clientele, students and the local community.

Among the courses taken in this program is an industrial internship where students are expected to spend 6 months working closely with the industry learning about the industry operations as well as carrying out a practical research to address some of the challenges faced by the industry/company they are engaged in. Due to the close interaction with the private sector it was hoped that this program could be more relevant to the market needs as well as contributing more towards the transformation of the economic landscape of the country owing to the many applications of chemical sciences: manufacturing, engineering and analytical sciences. While this internship provides a learning experience to the students, it also affords easy labor to the companies

concerned, while it provides those companies a chance of identifying candidates with the right skills, aptitude and attitude hence saves such companies the time and expense involved in the recruitment processes to fill any prospective vacancies [6].

Despite the anticipated potential of the program and the enthusiasm demonstrated by the private sector at the inception, the few existing potential companies present in Lesotho started to show lack of interest in taking the students into these internship programs. Amongst the reasons these companies cited included that the lecturers were perceived not to be serious – they were accused of dumping the students to the companies and disappeared, some of the projects were purely academic hence irrelevant to such industries/laboratories that host the students. Given this situation, compounded with the poor chemical industries prospects in the country [13], this situation has forced a review of the structure of this industrial internship to include small-medium enterprises (SMMEs) and community-based organisations (CBOs). This manuscript intends to provide a bird's eye view of the potential impact this programme can make towards improving the Lesotho's economy landscape through the internship program. The examples are drawn from a five-year period commencing from 2010.

## **THE CONCEPTUAL FRAMEWORK**

This essay is based on the premise that properly formulated programs coupled with mentoring are necessary to imbue the entrepreneurial mind in the graduate while the traditional programs and instruction will do very little if at all anything. Without proper inspiration and mentorship, the graduates will always have a lot of theory, which they can hardly find its relevance in entrepreneurial activities. This brings an interesting dimension, whether the staff who instruct these programs are properly trained and have a will to embrace and own this challenge. Or whether

this is just a wishful thinking that the graduates should be able to miraculously develop the skills and the drive to go into entrepreneurship without much training and mentorship. We argue herein that the universities should do their bit to introduce entrepreneurship into the curriculum, and fortunately for the chemical technology programme this could be achieved using the industrial internships as it will be shown later.

## **METHODOLOGY**

A qualitative survey was performed using the reports of the projects that were accessible to the researchers through the Departmental collection. These projects had been carried out both internally during the final teaching year and externally carried out with the industrial partners during the attachment period. Relevant topics were identified by reading the titles, abstract and conclusions thereof. Where there were doubts relevant staff were engaged to verify or clarify what was not sufficiently clear to the researchers. The topics were separated by their area of specialization, theoretical or practical as well as potential applicability to chemical industry. The enrolment statistics was obtained from the Faculty Office and validated with those obtained from the Head of Department. The views of the institutions offering internships were also documented from verbal communications and the record of the proceedings during the students' internship report presentations at the end of the internship period. Data interpretation was mainly carried out using simple Microsoft Excel® 2010 software embedded in the computer's operating system.

## RESULTS AND DISCUSSION

### *The student enrolment since the inception of the program*

Owing to the structure of the program, namely, the need for industrial internship, the program had been made accessible to only less than 10 students at the inception. This was to enable the placement of the students into the few opportunities for the industrial attachment that were possible, while also enabling the successful completion of the internal research projects taking cognizance of the limited infrastructure both physical space and instrumentation. Despite the study focussing on the 5-year period, the enrolment profile was made from the inception of the program to 2015 when the study was conducted due to easy availability and verifiability of the data. Figure 2 shows the trend of the enrolment since 2002 when the program started.

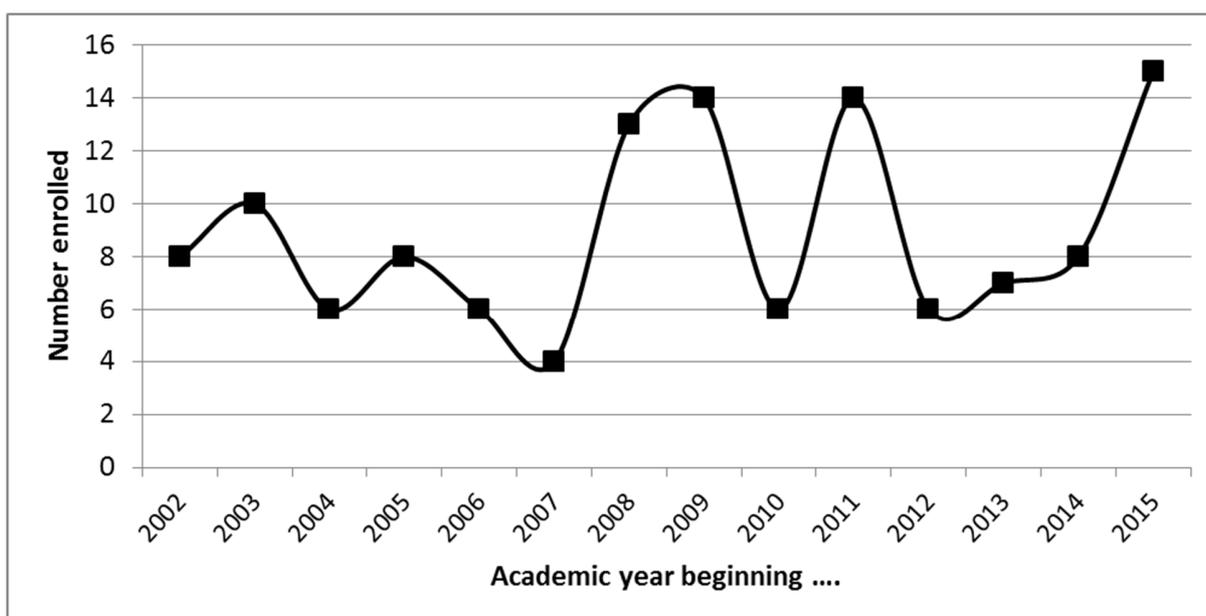


Figure 2: The enrolment in the BSc Chemical Technology program from 2002-2015

As can be seen, the enrolment has never been consistent since the 2002 when the program started. As discussed, the program was limited to a maximum of 10 students at the beginning with limited allowance to about 15 as the staff complement increased slightly with the recruitment of

chemical engineers in the staffing profile. However, there were years where the numbers could not improve at all such as 2007 when the total population was 4.

### ***Assessment of the type of projects undertaken both internally and during the internship***

Figure 3 shows the classification of the type of projects undertaken classified according to whether the project was purely academic (basic), applied or has a potential for commercialization or entrepreneurship. These projects were projected over the five years commencing 2010.

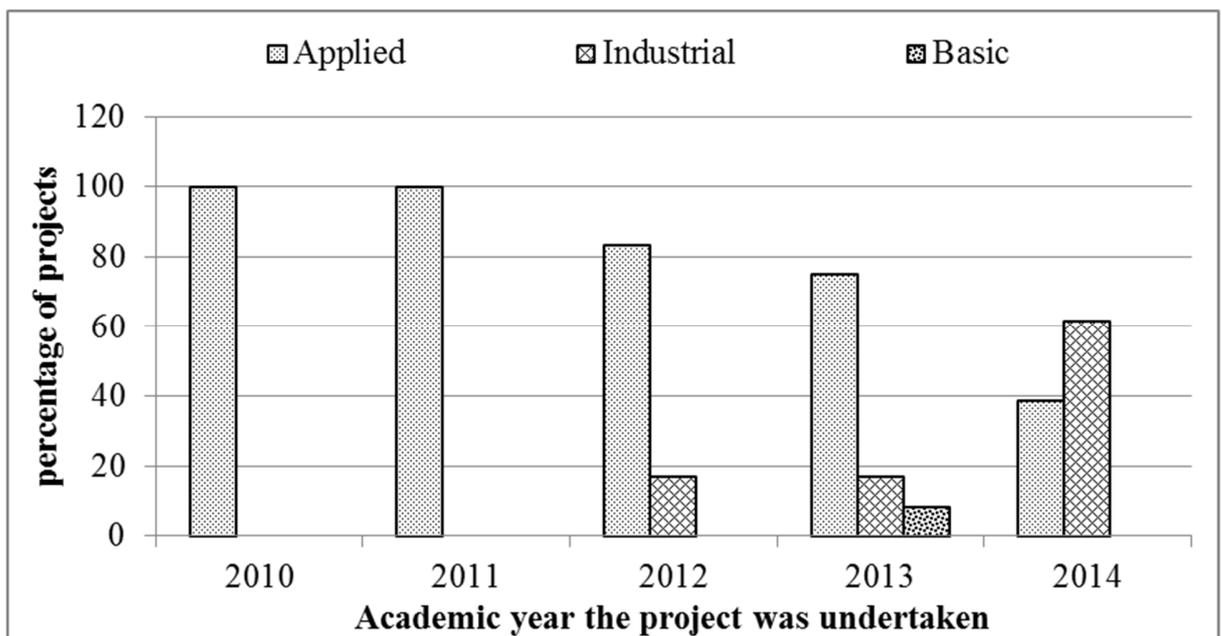


Figure 3: The classification of the type of projects undertaken over the 5-year period

As can be seen, there has been a slow shift towards projects with a potential for commercialization or entrepreneurship from 2012. This was after the institution recruited a chemical engineer. A very small percentage of projects (about 10%) were purely academic in nature, and these were only reported in 2013. Considering that there were only 7 students then, this translates to only one project.

### ***Classification of the applied projects by field of application***

Figure 4 shows the classification of both the applied and potentially commercial projects by area of application for the academic year 2013-2014. The Department had just made a resolution to allow the students to take internships with the SMMEs and the CBOs having observed that such categories of business were highly appreciative of the internship program in that most of the organisations approached believed they would gain significantly from the students attached to their establishments. The total number of students that undertook the internship in that year was thirteen (13) with a majority (9) being attached to SMMEs and CBOs except two (2) that were attached at the ceramic company and one (1) attached at a pharmaceutical company.

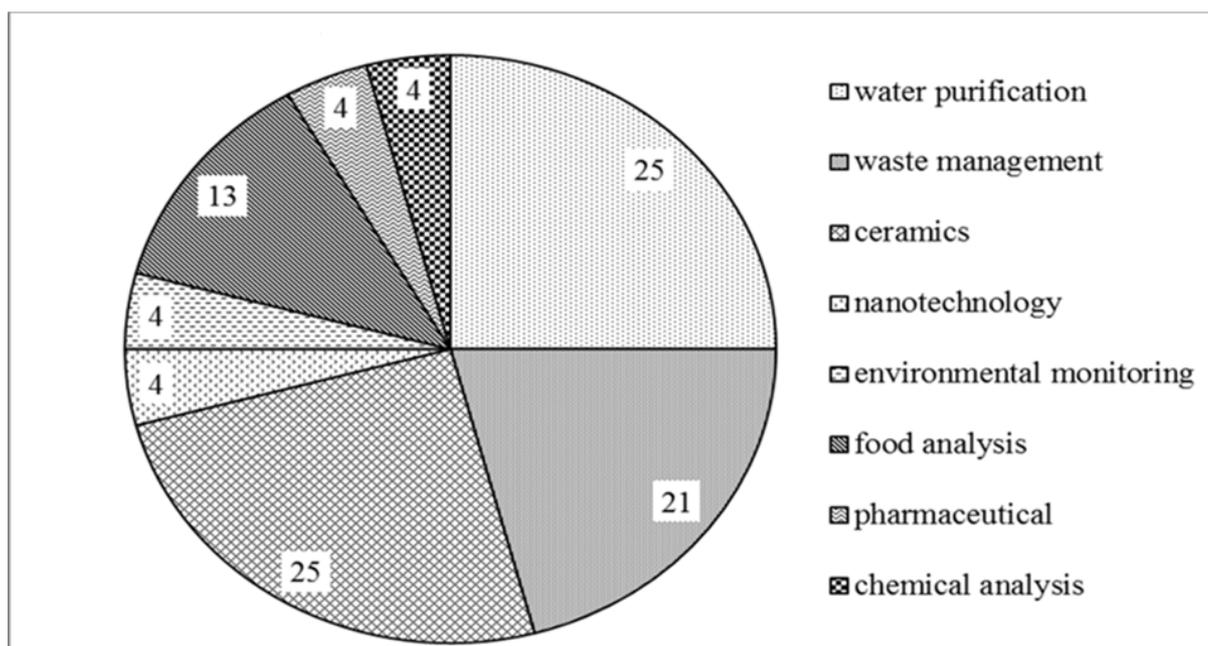


Figure 4: Classification of the applied chemistry projects by area of application for the academic year 2013-2014

As can be seen, the most dominant areas are water purification tied with ceramics at 25% each, followed by waste management in general at 21%, food analyses came in at third place with 13% with the rest scoring equally at 4% each.

### *Classification of the projects with potential commercialisation*

This section dealt with the projects with immediate application for business, or where there was already some small-scale production taking place before, during or immediately after the internship program, in such establishments. Figure 5 depicts the different areas under which the projects with industrial potential were performed in the academic years 2013/14 and 2014/15 where a total of 28 projects were undertaken. The reason this period was chosen was because it followed the decision to target the community-based organization and small-scale manufacturers other than medium-based enterprises that seemed to be reluctant as has been pointed out.

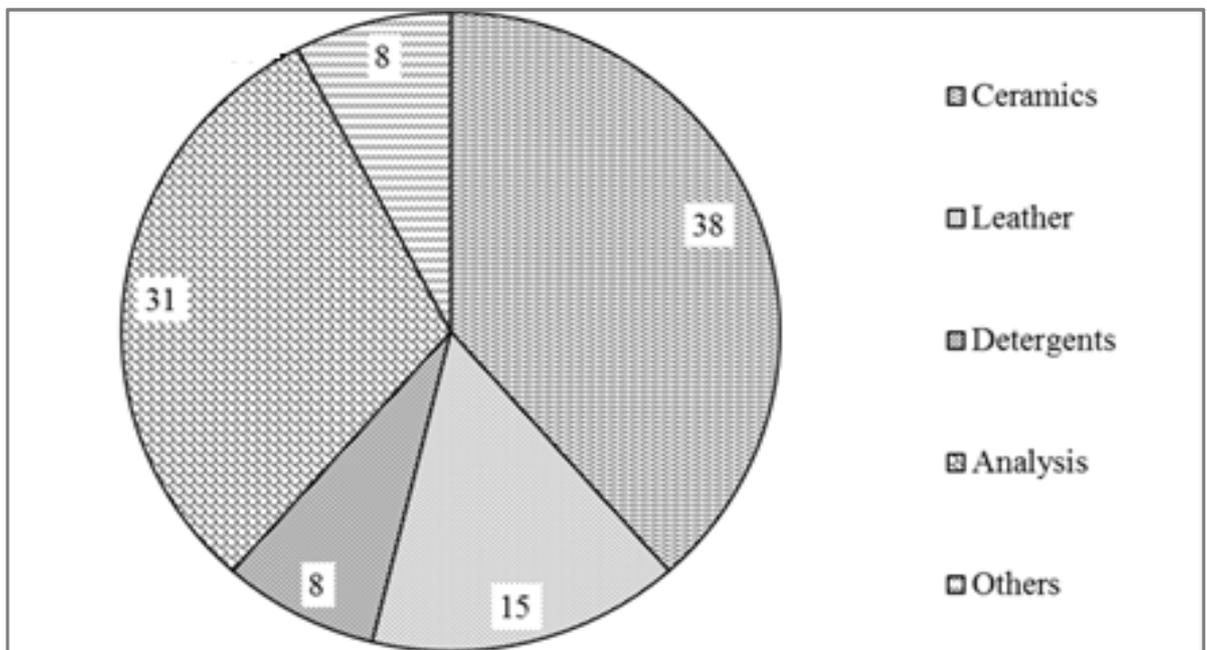


Figure 5: Classification of the projects with potential for commercialisation and entrepreneurship

From Figure 5, it seems the area of ceramics and stone technology dominate the areas of application (38%) followed by chemical analyses (31%). These ceramics' projects included preparation of artificial sand from sandstones, exploration of agates for jewellery making, exploration of local clays for pottery, the production of alternative ceramic bricks using different chemical treatment, just to mention but a few.

The projects in food industry included mostly chemical analyses of the prepared foodstuffs by the CBOs to satisfy the trading licenses requirement with the Ministry of Trade, some of which the results have been published in applied chemistry journals [20, 21]. Other projects included preparation of topical creams and jellies, recycling and re-beneficiation of solid waste, modelling and factory design for different chemical products [22], as well as formulation and characterization of multi-purpose detergents [23, 24], improving tannery processes for a rural small-scale tanner, preparation of arts and artefacts using polymers for improved portability and stock production of certain products, as well as improving and refining the engineered stone product which has been an on-going project that resulted in the establishment of a public company Afri-Quartz (Ltd) that is yet to resume operations pending long bureaucratic process required by law. All these projects came consequent to a shift to more entrepreneurial projects, which was identified as an opportunity to make meaningful impact on the face of difficulty presented by dysfunctional infrastructure and poor funding that impede cutting edge research [13], and also heeding the call by the country's king that the prevailing unemployment rate in the country has become a national crisis [25].

### **Exploring the Outlook for Future Prospects**

From the analyses of the impact of the shift in focus from purely academic or industrial internship to manufacturing and entrepreneurship through partnerships with SMMEs and CBOs, there seems a small light at the end of the tunnel. Since the beginning of 2015 calendar year, there are three registered companies established by the recent graduates of this program, namely, Chem-Cleaner (Pty) Ltd, Heavenly Touch Soap Manufacturers and Reed Basketry (Pty) Ltd, while a few more have started operating although without trading licences; these manufacturers still receive

considerable support from the University/Department. The latter of the mentioned three has ventured into Arts and Crafts using reed having secured seed funding from local business. Besides these graduates, many more have been winning competitions for innovative entrepreneurship ideas [26]. The Department through the Technology Incubation Group has also been offering training workshops for ordinary Basotho who are interested in venturing into chemical entrepreneurial activities such as making soap [27].

The establishment of the Technology Incubation Group in the Department of Chemistry and Chemical Technology working in the area of ceramics and engineered stones technology has sparked a wave on entrepreneurship. The same Department has initiated a University-wide initiative for establishment of the Innovation Hub the policy of which is under development. Besides this, the Department was highly instrumental in establishment of the webpages NUL Research and Innovations as well as NUL Science, Innovation and Entrepreneurship on social media where research output and initiatives are being profiled on weekly basis while in the latter, the students are advised to advertise their entrepreneurial ideas, advice pieces or even seek assistance in addition to the same issues posted on the Research and Innovations page.

Since the inception of these two communication tools, there is a positive vibe that seems to have inspired the students and staff to work even harder. There has been a production of yoghurt from a sister department in the Faculty of Agriculture which is already trading on the University campus and soon to reach the external market after receiving some capital investment to build a plant [28]. Recently the Pius XII chick and later other chicks were hatched from an artificial incubator developed by a sister Department of Physics and Electronics [29].

## GENERAL DISCUSSIONS AND CONCLUSIONS

In conclusion, it can be stated that indeed chemical sciences can contribute positively to the economic outlook of the country and thus contribute with impact to the crisis of unemployment situation in Lesotho. A shift from classical chemistry projects to a more practical and applied chemistry has led to the birth of a new spirit of entrepreneurship. The multiplicity of the projects undertaken points to the availability of wide spectrum of competencies which make the University a strategic partner to the Government as it seeks ways of turning around the crisis of unemployment into entrepreneurship opportunity. While economists argue that entrepreneurship is not a survival avenue where people just get in to survive hunger which is one of the reasons put forth in explanation of why so many local entrepreneurs fail to graduate from small business to middle and higher.

As can be seen, the number of students taking this programme is very low, as it has been argued, this is precipitated by the lack of adequate infrastructure to take more students. Even then, not all the students enrolled in the programme are undertaking projects with entrepreneurship potential. There is still a lot of discomfort among staff as to what the role of entrepreneurship is in the teaching of chemistry as a subject. Many still argue that the programme is intended to equip students as chemical technologists and not, put bluntly, chemical industrialists or artisans. This thus suggests a need for a thorough self-evaluation by the Department if the issue of entrepreneurship should be driven forward in line with the National Strategic Development Plan of 2012-2017 [30] and the NUL Strategic Plan 2015-2020 [31].

However, besides these internal barriers, there are also extra-territorial barriers that thwart most of the initiatives and somehow lead to a general feeling of lethargy. The most important one is the poor funding status of the University which negatively and largely impact general resourcing

of infrastructure development, both physical infrastructure and instrumentation, in addition to poor retention and recruitment of adequately trained staff.

The other important aspect is the lack of funding opportunities for the students' business ideas. The University has been talking about the establishment of an incubation centre/hub, but this could simply be a dream with the elusive funding sources. Without the implementation of the much talked about National Innovation Hub as proposed in the National Science and Technology Policy [32] that was drafted some more than ten years ago [33], this will forever remain a dream.

There needs to be coordination between different governmental institutions that are entrusted with business development in Lesotho, namely, Basotho Enterprises Development Corporation and Lesotho National Development Corporation as both are making a lot of efforts, be they in feasibility studies or workshops, about establishing business incubators for Basotho entrepreneurs. One would recommend that these state institutions should work closely with another forgotten department in Government, namely, the Appropriate Technology Services to arrive at a common ground than working in silos as it is currently happening. This department could do with a bit of space and infrastructure development, so that it can be able to carry out its mandate. Since ideas are coupled with innovation hubs, one cannot help but think this is a perfect opportunity to partner with the University as universities are places where both creative minds and youthful energy co-habit in the form of professors and students. Besides, this has already been argued in details in this piece and elsewhere.

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